ASSESSMENT OF OWNER RISK ASSOCIATED WITH COMMERCIAL AIRPORT CAPITAL AND MAINTENANCE PROJECTS

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Title

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MASTER OF SCIENCE

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ABSTRACT

The thesis produces a risk management process that effectively determines risk and its effects on commercial airport owner activities. To achieve this goal, the thesis reviewed these objectives:

1) Determination of major risks in the US commercial aviation industry

2) Assessment and analysis of these risks in US commercial facilities

3) Producing risk dynamic in a project cycle associated with airport owner activities

The owners of airport facilities face multiple risks in the planning, design & construction of commercial airports. Literature on airport risk and damages was reviewed and used to produce a survey sent to select facilities in the USA. Survey feedback was analyzed utilizing the probability impact matrix, risk ranking equations and normal descriptive statistics. Results of this analysis produced a Top 10 risk list for project objectives affected by noted risks and a general Top 20 risk list assigned to a project cycle risk dynamic.

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ABBREVIATED TERMS: AVIATION RELATED

ACI- NA: Airports Council International – North America

ACRP: Airport Cooperative Research Program

AIP: Airport Improvement Program

ALP: Airport Layout Plan

ALAP: Advanced Loan Acquisition Program

ATO: Air Traffic Organization

DBE: Disadvantaged Business Enterprises

FAA: Federal Aviation Administration

ICAO: International Civil Aviation Organization

NAL: National Aerospace Laboratory

NASA: National Aeronautics and Space Administration

NPIAS: National Plan of Integrated Airport systems

RITA: Research and Innovative Technology Administration

SASP: State Airport System Plan

ABBREVIATED TERMS: OTHERS

AIA: American Institute of Architects

AIS: Agricultural Impact Statement

CAD: Capital Airport Development

CMR: Construction Manager at Risk

DB: Design-Build

DBB: Design – Bid – Build

DOE: Department of Energy

DOT: Department of Transportation

EA: Environmental Assessment

EIS: Environmental Impact Statement

ES: Eligibility Statement

GMP: Guaranteed Maximum Price

LEED: Leadership in Energy and Environmental Design

NCHRP: National Cooperative Highway Research Program

OSHA: Occupational Safety and Health Administration

TRB: Transportation Research Board

WSDOT: Washington State Department of Transport

ABBREVIATED TERMS: KEY COMMERCIAL AIPORT OWNERSHIP RISKS

PRP: Permitting related processes (i.e.) Environmental Impact Statement (E.I.S) approval predevelopment (etc.) that slow down project development.

DAB: Debt accruement which cannot be effectively balanced by the owner of the project.

GIBF: Government intervention and bureaucracy in funding related processes.

IIFP: Inadequate internal funding options (i.e.) airport user fees & passenger facility charges (etc.) to cover airport development.

PSDFP: Project schedule affected by delays from numerous funding approval processes.

LINSP: Litigation issues arising from negligence of safety related processes on site during construction phase of development.

PDCPC: Project design constructability issues affecting project cost.

NMAAO: Negative effects of maintenance activities on airport operations.

PTSMPF: Project type and scope misrepresentation due to poor planning and feasibility related issues.

PPGAP: Planning procedures affected by government approval & associated processes.

CSURD: Consultant staff hired unable to meet to meet project requirements and standards.

CANCAP: Construction activities negatively affect airport operations.

CIOIP: Conflict of interest between ownership and other parties whilst determining initial project parameters.

DPI: Disaster preparation issues.

MECMPD: Monitoring equipment and communication during maintenance activities.

MECCPD: Monitoring equipment and communication during capital project development.

NAGPD: The Negative effects of "Acts of God" on project development.

LCOPD: Local community opposition to project development.

LDIPDP: Land development issues (eminent domain / sacred burial grounds) stall project development process.

ODOGB: Occurrence of dispute between ownership and aviation governing bodies over policy requirements for development.

CHAPTER 1. INTRODUCTION

1.1. Background

The commercial aviation industry experiences risk in the planning and management of airport capital and maintenance projects. The National Aerospace Laboratory (NAL) estimates that worldwide, commercial airports experience risks within the $4,000,000,000 - $10,000,000 range (A.D. Balk, 2008).

Most of these financial costs and associated time related setbacks from risk damage are borne by hierarchical leadership within the commercial aviation industry. Government agencies and appointed airport representatives (airport owners or project managers) bear the impact of such damages on project related objectives at most commercial airport facilities (WSDOT, 2012). Being able to determine risk beforehand requires using risk management. This practice effectively plans for and safeguards against risk in the aviation industry. Risk management's goal is to ensure that potential opportunities associated with a given project venture are taken advantage of and subsequently, that project objectives are met (Gabel, 2010) .

It is the application of risk management principles to airport ownership activities related to capital and maintenance projects that will limit the impact of risk on project objectives associated with commercial airport capital and maintenance projects.

Despite the importance of risk management noted in the commercial aviation industry, most individuals in administrative positions at commercial airports lack the basic knowledge of risk management practices associated with ownership related activities. As a result, such airport administration employs specialists in the area of risk management to handle risk issues that pertain to capital and maintenance projects. In a research study by the National Transportation

Research Board, 11 of 19 large sized airport operators employed a designated airport risk manager charged with the authority to make final insurance purchasing decisions for staff and facility development and operations (Rakich, 2011) .

It is important for airport administration to also have an idea about key risk issues and the risk-management processes that can be successfully employed to mitigate and limit associated risk damage during the development of airport projects and operations. The National Transportation Research Board also discloses that airport operators without risk managers tend to rely on internal positions, such as a deputy director, a municipal risk manager (for operators that are part of a municipal agency), or legal and finance personnel, to make the final insurance purchasing decision for airport activities (Rakich, 2011). This thesis can assist such individuals with risk management duties related to commercial airport development as well.

The creation of a risk management guidebook to aid commercial airport owners who choose to address risk management enables the user to save funding that would be utilized on the services of a risk manager. The risk management guidebook can also educate participating parties on how to acquire a better understanding of risk, risk management and related processes that revolve around the ownership activities associated with commercial airport capital and maintenance projects. A description of such activities will be seen in the literature review section of this document.

1.2. Problem statement

Risk in airport administration activities has been an issue for commercial airport owners and their corresponding airport facilities around the USA. Risk is prevalent with all airport capital

and maintenance projects, and it could cost airport owners vast amounts in terms of finances and the time allocated for the development and running of such projects ventures (Touran, 2009).

Risk management, as a tool, could be utilized to systematically identify and address ownership risk regarding commercial airport projects.

This thesis is aimed at the creation of a guidebook that can be utilized by airport owners in the commercial aviation industry to identify, assess and analyze ownership risk associated with development and maintenance of commercial airports. These risks can be attached to an adequate risk management process that mitigates and controls such risks accordingly.

1.3. Aims and objectives

The developed risk management process could be utilized by numerous professional airport owners in the planning, development and maintenance of airport facilities in the USA. Being able to understand airport ownership activities at the commercial airport level will ensure 1) the adequate determination of the types of airport ownership risk, 2) the nature of ownership risks that will occur within a given commercial project cycle and 3) the specific phases of planning and development in which such risks present themselves.

Being able to pinpoint these risks and plan for them accordingly ensures a smoother transition between the given phases of development, operation and maintenance in which airport management and ownership have assigned duties. This is why “Assessment of Ownership risk associated with Commercial Airport Capital & Maintenance projects,” is being produced as a thesis document. It is proposed that the book will serve as a guide to its users in the following aspects of forecast:

- A determination of the benefits of assessing and managing risk. Application of risk assessment and management to the commercial airport environment, a retrieval and understanding of risk-management practices at differing scales of airport operations and development based on project capital and resources at hand, project exposure to risk and other factors.
- Tools and checklists for ensuring adequate risk-management practices based on project scope and size. These tools include a risk list acquired form literature pertaining to the different phases of commercial airport development and maintenance activities in the USA and the production of a Delphi method survey to acquire professional feedback from airport ownership correspondence. Utilization of statistical tools such as the probability impact matrix, risk probability impact assessment, risk ranking equations and ranking tools in Microsoft Excel. Presentation, discussion and analysis of ranked risks associated with airport ownership and other party duties at the commercial airport. Outline of further action plans that can be utilized with the future phases of the risk management process associated with commercial airport ownership risks for capital and maintenance development projects.

1.4. Research contributions

The thesis addresses the notion of identifying, assessing and analyzing ownership risk for capital and maintenance projects in the commercial airport industry. It is part of a larger research framework that was proposed by the Airport Cooperative Research Program (ACRP). Research was conducted to address risk and its management within airport operations, catering to all given airport sizes and corresponding airport uses (Touran, 2009).

The thesis, “Assessment of owner risk associated with commercial airport capital and maintenance projects”, which is the final product for this thesis, is a medium utilized to explore the use of statistical concepts to organize and analyze risk issues with discussion about 1) why such risks occur in ownership related activities and 2) how such risks can be can be approached and rectified moving forward in the risk management process.

It is believed that thesis research provided will be utilized by ACRP as part of a comprehensive addition in the final guidebook it produces to successfully assess and manage risk for airport capital and maintenance projects.

1.5. Research methodology

The research methodology used in this thesis is broken into six individual parts with a selection of tasks assigned to each part.

1.5.1. Phase one

Research starts with the selection of a topic. Phase one involves the identification and definition of the project problem “Assessment of ownership risk associated with commercial airport ownership in capital and maintenance airport projects”. Phase one is preceded by the determination of project objectives and the development of a research plan to aid in the proposed resolution of the problem.

1.5.2. Phase two

A Literature review of the following research areas associated with risk, risk management and commercial airport ownership activities associated with capital development and maintenance projects in the USA:

- An understanding of the concept of risk management, its constituent parts and the differing approaches to which the practice could be applied.
- An understanding of commercial airports and their associated administration.
- Capital and maintenance projects associated with commercial airports and the differing processes and procedures involved with their approval and development.
- The identification of risk factors associated with the processes and procedures for commercial airport capital and maintenance development projects. These risk factors specifically pertain to airport ownership.

1.5.3. Phase three

Phase three involved utilizing the Delphi method of information acquisition in the production of a survey. This survey used the identified risk factors from the Literature review. The risk factors were listed in order of the activity processes determined in the review of literature for capital projects and maintenance projects as well as their general constituents. The survey was tailored specifically towards airport administration, and the survey's objective was to utilize the responses obtained from airport administration to determine the listed risks' impact and assessment on the commercial airport development project cycle.

Once the survey was developed, pilot studies were conducted. A select number of professional experts in the commercial aviation field and individuals in academia were given the survey and asked to fill it out accordingly. The aim was to get their expert opinions about the survey's clarity and its ability to meet its predetermined objectives.

Survey modification based on the expert responses was carried out to ensure that the survey achieved its maximum potential.

1.5.4. Phase four

Phase four involved the distribution of the survey to commercial airport facilities in the United States, Canada, Europe, Africa and the Caribbean. Data collected from the returned surveys was utilized to achieve the research objectives. The survey responses from the USA were utilized predominantly for data analysis purposes.

1.5.5. Phase five

This phase involved the analysis of the data from the survey by utilizing various statistical tools (refer to Section 1.3) to determine risk severity/impact. Discussions from the analysis results were documented, and a process for a continuation of the risk-management process was stated.

1.5.6. Phase six

This phase was where conclusions with regard to the research were drawn and possible recommendations were made about the subject addressed by the research.

A graphical representation of the phases utilized in the research methodology can be seen in Figure 1.1 below:

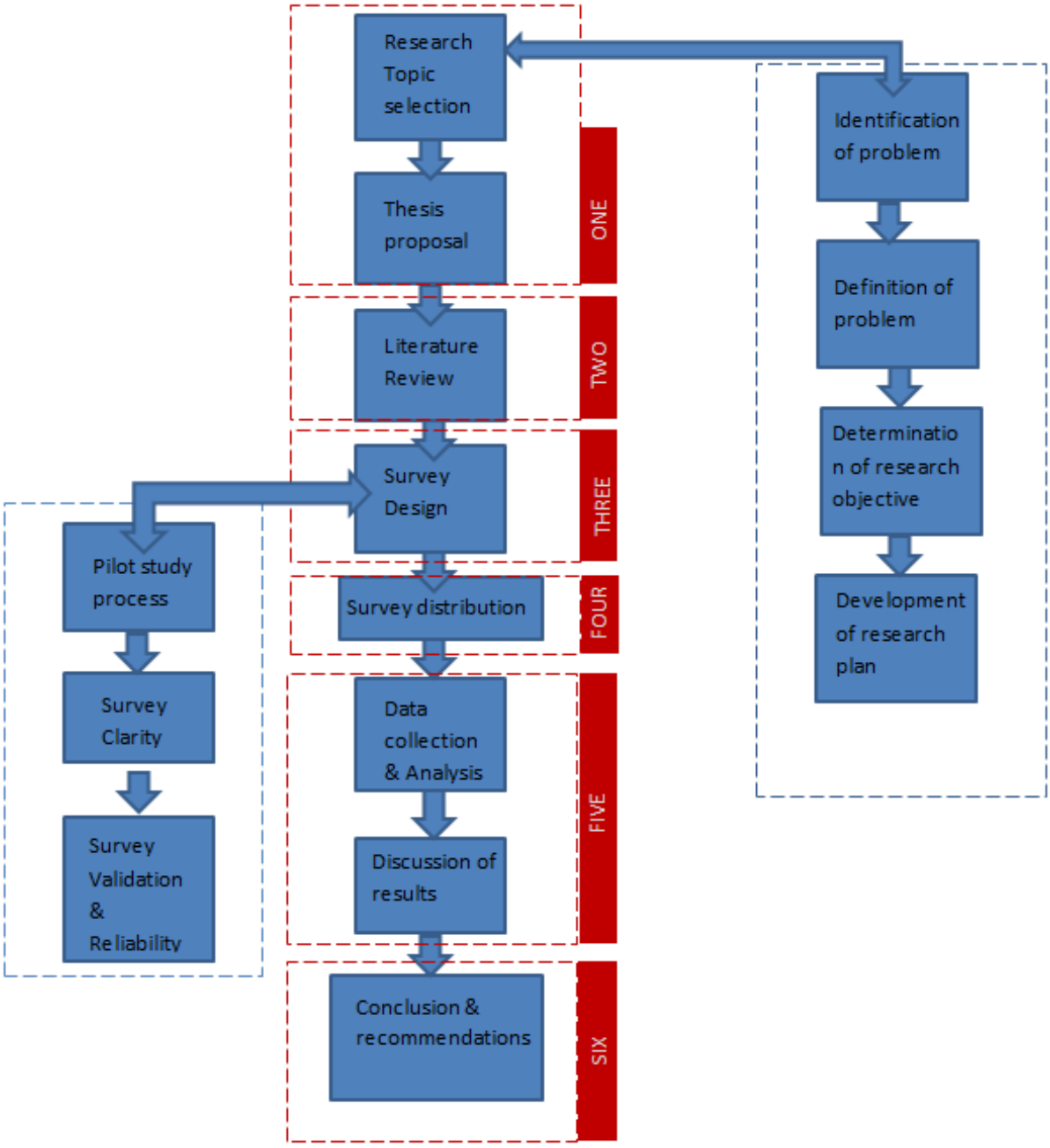


Figure 1.1: Research approach.

CHAPTER 2. LITERATURE REVIEW

The following chapter reviews risk, its components parts, its types, and its occurrence within the project phases of a commercial airport development and the tools for which to identify and classify it as associated with airport development. These are the initial steps in the risk management process associated with ownership risk in commercial airport development.

2.1. Risk and its constituent parts

Kaplan (1981) reviewed the concept of risk as being the possibility of loss or injury as well as the degree of probability for such a loss. Risk is viewed as the negative outcome of a possible event and is usually measured by damages or potential losses. As a term, risk is broken into five component parts: uncertainty, hazard, damages, safeguard and probability (Kaplan, 1981).

The first of risk's component parts, Uncertainty, points to the notion that an event will have an outcome but that the inability to determine the final result of such an event is the measure of uncertainty associated with the event (Kaplan, 1981). Uncertainty is the starting point of the component parts associated with risk.

Hazard, as another component of risk, is a source of danger capable of bringing about a loss in the form of damages if it is negatively applied (Kaplan, 1981). It is possible to know that the absence of funding for a required phase of an airport capital development project could cause potential delays and further financial issues if such a scenario occurred, but until it does, it is simply a postulation (WSDOT, 2012).

Damages, in terms of risk, would be the physically quantifiable negative outcome of an event (Kaplan, 1981).Wassermann reviewed the delayed opening of the Berlin Brandenburg Airport in Berlin, Germany, where poor planning by the architectural group involved with its development resulted in noted project construction delays, damage claims of $98 million and a schedule delay of 9 months (Wassermann, 2012).

A plan to cushion the effects of the damage caused by an event's negative outcome is the application of a safeguard that is also known as a contingency plan (Kaplan, 1981). It is important to note that contingency plans are more of a broadside solution in the risk management process, acting more as a buffer to risk's introduction (Hart, 2007). Hart reviews contingency allowance in project development and determines the necessity for contingency needs to prepare for changes in scope, errors and possible omissions when accounting for risk associated with the parties involved in project development (Hart, 2007).

Probability is reviewed last due to its ability to encompass other terms associated with risk. It is a term used to determine the outcome of a given event from repeated trials associated with that given event (Kaplan, 1981). Ali Rezaei's analysis of airline carrier heterogeneity in competitive markets within the USA points out probability's application. He draws the conclusion that, the larger an airline's presence within an airport facility, the larger its variable effects on competition within such a facility. The noted larger presence of an airline reduces the probability of external airline competition within such a facility. This postulation was derived from a repetition of tested outcomes across airline markets in the USA and as a result, has been validated as a notable occurrence. It is from the notion of probability that the component parts of risk can be validated and planned for accordingly (Ali Rezaei, 2011).

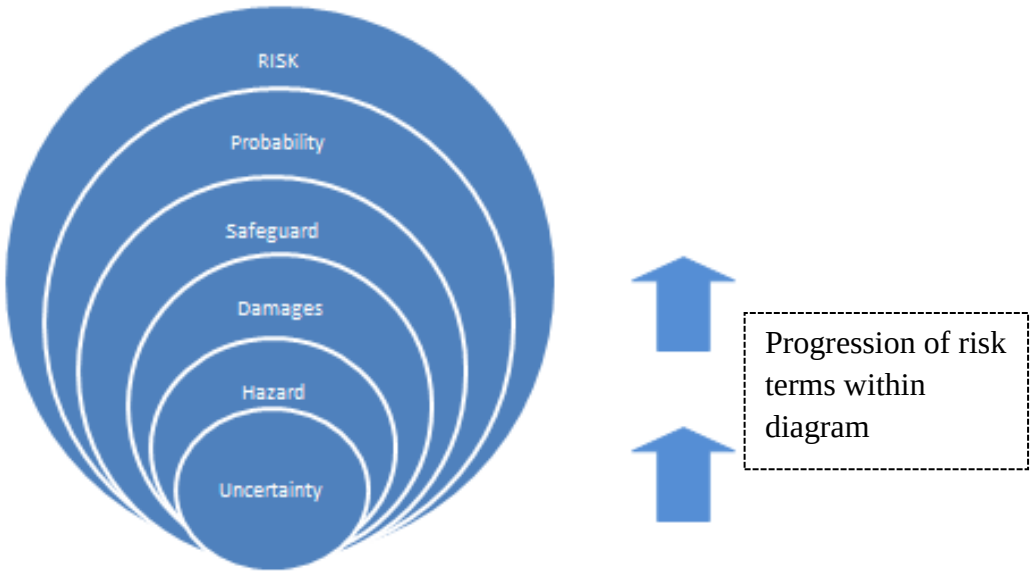


Figure 2.1: Relationship between risk and its component parts (Kaplan, 1981).

2.1.1. Risk in project development

Nielson (2007) reviews risk in project development as the element, or factor, arising during project execution and responsible for inhibiting achievements associated with project cost, schedule and goals. Burton Shaw-Gunn (2009) points out that these factors, or elements, can be externally or internally driven with negative consequences affecting performance, functionality, time of delivery, acceptance and cost. With the addition of quantifiable parameters in the form of project objectives such as cost, quality, safety, environment and time, risk is presented with definable variables that can be negatively affected for airport capital and maintenance projects (Burtonshaw-Gunn, 2009).

It is these variables that differentiate risk in project development from the risk definition in Section 2.1. With an understanding of the term risk and risk in project development in mind, risk for airport project development can be described as the culminated effects of the

risk component parts (Refer to Figure 2.1) within the given phases of capital and maintenance commercial airport projects and their subsequent operations in the aviation industry (Rakich, 2011). Such effects could lead to catastrophic loss in terms of lives, finances and time (Rakich, 2011). The Airport insurance coverage and risk management practices report (Rakich, 2011) notes that the nature of aviation risk includes, but is not limited to, life safety considerations, catastrophic loss potential and high visibility. Such risks affect capital and maintenance projects as well as the associated airport ownership, directly or indirectly, based on when they occur and how their impact is distributed to the parties involved (Rakich, 2011).

In order to introduce risk management as a tool to deal with risk, a brief understanding of risk issues associated with airport projects and operations is presented in Section 2.1.2.

2.1.2. Risk for airport project development

In Airport insurance and risk management practices report (Rakich, 2011); airport project and operation risks are categorized into four groups: (1) project-level risks, (2) airport-level risks, (3) regulatory risks, and (4) other risks.

2.1.2.1. Project level risks

Project level risks predominantly occur within an airport facility or its component parts prior to facility operation. This usually occurs during the phases, airport project development and planning until construction completion. Issues associated with project level risk include project size and complexity issues which pertain to risk reflected in a monetary value. These risks usually escalate based on project size and difficulty in attaining project parameters. Risks associated with schedule compression issues arise from compressing and controlling the

schedule proposed for project development by the parties involved (Rakich, 2011). In terms of construction phase activities for a given airport's development, schedule growth control risks occur when construction schedules change, creating unforeseen problems that affect initial construction phase objectives.

Risks associated with early cost precision revolve around discrepancies in cost during project developments that affect project cost estimates and schedules for a given project. Unforeseen project costs that occur with the project budget, resulting in a subsequent funding increase required for project development, are termed cost control risks (Touran, 2009). For airport projects with an established risk management program in place during project development, there is the risk of such a program's inability to handle risks that occur within the projects given delivery method; such an issue is defined as a risk-management/allocation issue. An example of the risk management/allocation issue would be the application of a design-bid-build project delivery method which requires low bid costs and numerous qualified bidders to encourage competition. A risk management team assigned to a project with such a delivery method may be unable to assess or mitigate for associated risks due to unfamiliarity with the delivery method (Touran, 2009).

Risks associated with life cycle cost usually affect airports post development during the operation and maintenance phase with maintainability as a risk type within this category. Such maintainability risks affect quality and ease of airport maintenance during its operation phase (Rakich, 2011).

2.1.2.2. Airport level risks

These risks are related to the control issues with which airport management and staffs are faced pertaining to the airport facility, its security and third party agreements. Issues associated with airport level risk include airport management's experience and the staff's capability risk. Such risks stem from staff and management incompetency to handle the administrative activities associated with the airport facility (Rakich, 2011). Risks involving activities related to design and construction quality, during the airport's operation phase, by airport administration are termed airport control of project issues risk (Rakich, 2011).

Designing and construction for the addition and maintenance purposes takes place to ensure that the existing airport facility is kept up to date. Risks presented by such activities, in the form of codes and standards, negligence, liability and security issues, are termed security risk (Rakich, 2011). Airport development activities that affect airport operations and passenger flow on both the airside and landside portion of the airport facility are risks that have control for the impact on passengers and operations (Rakich, 2011). Finally, risks that pertain to determining an airport's facility development based on third party interference with administration activities as a result of legal stipulations or financial stakes in the facility are termed third party stakeholder input for design and construction (Rakich, 2011).

2.1.2.3. Public policy - Regulatory issues

With airport project delivery, there are legal mandates to follow, some of which involve abiding by policies, social programs and labor unions, just to mention a few. Keeping in compliance with these mandates is vital for the timely completion and operations of airports. However, there are risks that do arise within these legal mandates that may affect the overall

objectives of airport development (Touran, 2009). Issues may arise from competition and favoritism of certain local talent for airport development when legal mandates require that bid pricing, competition and project delivery methods for airport project development be conducted a certain way. Such legal mandates may, at times, positively or negatively affect local development talent in the airport's jurisdiction and overall competition for the project. Such mandates also affect the quality of the staff employed to carry out development and have a negative outcome on project objectives in the long run (Rakich, 2011). The active involvement of airport programs in the introduction of disadvantaged business enterprises (DBE) for project development as a result of legal mandates by airport governing bodies, such as the FAA, presents risk that may hinder the meeting of required project objectives (Rakich, 2011).

Justification of project development through legal and statutory constraints to get an airport project from one stage of development to another requires intervention by the Federal, State and Local governments. This intervention occurs in the form of codes, constraints, policies, procedures and guidelines to mention a few (WSDOT, 2012). The inability to follow such legal mandates could pose project schedule and cost overrun risks for facility development or maintenance (Rakich, 2011).

In the era of sustainability, there is a required standard for building airport facilities that meet the U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) requirements. The Airport insurance coverage and risk management practices report (2011) determines that LEED requirements be taken into consideration as a risk for airport facilities that may be unable to meet the complex design and construction options that LEED may require in addition to certification for staff assigned to such project ventures. The burden of LEED requirements as a result, could hinder project objectives in the long run (Rakich, 2011)

2.1.2.4. Other issues - Risks

These issues are important determining factors in airport development and operations, but are not categorized under the previous sections in this document. The issue of adversarial relationships according to the Airport insurance coverage and risk management practices report (2011) deals with disagreements between parties involved in airport development and operation. Some disagreements stem from an inability to define duties or processes associated with airport development and operations as well as the issue of poorly drafted contracts and vague project delivery methods presented to the involved parties (Rakich, 2011). Exposure of the parties involved with airport development and operations to construction claims usually stems around authority, responsibility, work allocation and the representation of such issues in poorly worded contracts and vague project delivery methods. The inability to determine project party duties during the course of project development can lead to disputes and eventually lawsuits, hindering the achievement of project objectives (Rakich, 2011).

2.1.3. Why risk should be addressed in the commercial aviation industry

America's primary means of travel, besides the automobile, is the use of aircrafts (Horonjeff et al, 1994). NASA points to the fact that, within the United States, the primary means of travel between large cities that are at least 1,000 miles apart is by air (NASA, 2012).

As of 1990, commercial aircraft travel in the USA accounted for 450 million passenger enplanements (Horonjeff et al, 1994).Such figures had grown exponentially by 2010, with the FAA pointing out that, within related enplanement database figures, such enplanements had climbed to 713,580,637 for the year 2010 (FAA, Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports, 2012). The FAA Aerospace forecast (2012) notes that the U.S.

aviation system plays a key role in the success, strength and growth of its economy with commercial airports in the USA bringing in $22.987 billion in revenue with $4,022 billion worth of income determined after deductions and depreciation for the fiscal year of 2008 (FAA, FAA Aerospace Forecast Fiscal Year 2012-2032, 2012).As a result of the need for commercial aviation and the income figures its activities pull in on a yearly basis, the FAA, in a future forecast report for the aviation industry, has set aside $52.2 billion for all airport development projects in the USA over a 4 year period from 2011–2015 (FAA, NPIAS , 2012).

The FAA's investment is timely because demand for commercial aviation continues to grow within the USA, requiring commercial airport facilities, especially primary hubs, to adapt and develop in terms of facilities and operations in order to keep up with consumer demand.

Horonjeff et al. (1994) indicates that, as of 1990, there were 29 large air traffic hub airports, 42 medium air traffic hub airports and 64 small air traffic hub airports in the USA according to the FAA (Horonjeff et al, 1994); 20 years later, there were 29 large air traffic hub airports, 36 medium air traffic hub airports and 74 small air traffic hub airports in the USA (FAA, Primary Airports, 2012) . With an increase in small airport hub numbers and a continued development of airport facilities in the USA and across the globe, it is clear that commercial airport facilities are on the rise. There is the need for their up to date development and operations to keep up with the growing demand for commercial aviation goods and services.

According to the Airport insurance coverage and risk management practices report (2011), it is imperative that risk within commercial airport facility developments and their associated operations be addressed through planning to reduce the occurrence of damages

associated with such possible risk issues (Rakich, 2011). The final outcome of such planning is to:

- Limit the effects of risk for the acquired development funding for the commercial airport facilities in question.
- Ensure that project objectives associated with the development of such facilities are met.
- Keep risk issues associated with commercial airport operations to a minimum.
- Ensure the overall satisfaction of users who utilize the services of such facilities

2.2. Risk management

Risk management is the strategic implementation of the risk planning process discussed in Section 2.1.3. Gabel (2010) reviews risk management as a culture, process and structure that is usually directed towards the effective management of risk issues which could threaten potential opportunities and objectives associated with a project (Gabel, 2010). As a practice, it is a future predictor that determines possible scenarios within a project's development that are vulnerable to risk while providing guidelines and processes to effectively mitigate and control such risks if they occur. In project management, risk management as a practice can not only predict possible future outcomes, but can also enable its user to positively shift the odds of a project's success or failure (Gabel, 2010).

2.2.1. The Risk management process

Once risk management has been defined, the process and phases in which it occurs are mapped out. This is seen in Figure 2.2 below and explained in the subsequent paragraphs below.

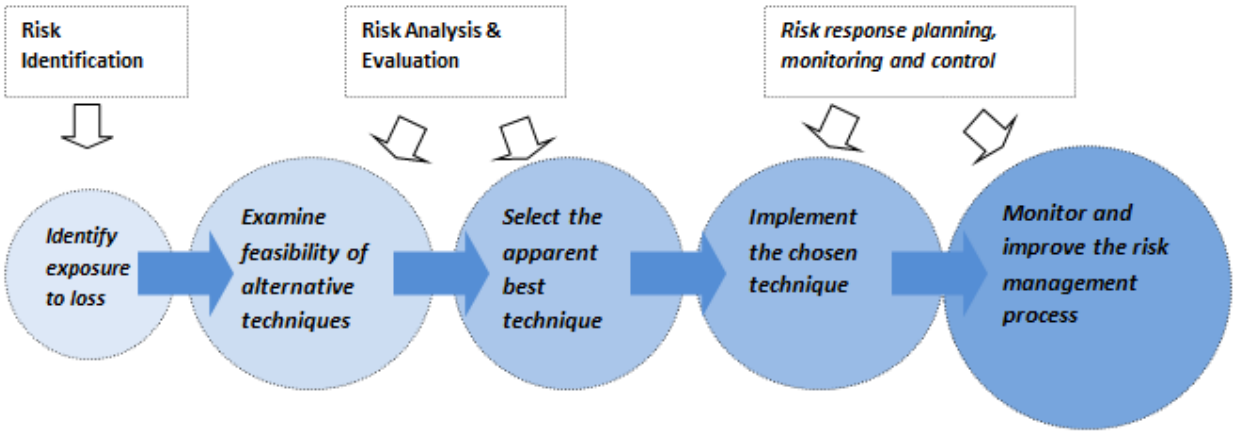


Figure 2.2: The Risk management process (Burtonshaw-Gunn, 2009).

Similar to but less detailed than the formal risk plan seen in the preceding section, Section 2.4, the risk management process presents a general overview and understanding of risk management.

The risk management process occurs in three general steps with each step broken down into associated activities (Burtonshaw-Gunn, 2009). Risk identification, the first of the three general steps, identifies risk and the possible damages resulting from the identified risk. Its associated activities review the different risks types associated with a project, their location with the project timeline and their effects on project objectives (Burtonshaw-Gunn, 2009).

Risk analysis and evaluation review techniques assess risk and reduce the effects of risk through the utilization of control tools. As a process, risk analysis occurs both quantitatively and qualitatively (Burtonshaw-Gunn, 2009). The qualitative aspect of risk analysis and evaluation

assesses the likelihood and impact of identified risk, prioritizing such risks based on their effects on the project objectives. The quantitative aspect of risk analysis utilizes tools to identify and evaluate risks, presenting possible risk controls to limit the effects. Risk analysis helps to determine the relative importance of addressing specific risks and guiding risk responses (Burtonshaw-Gunn, 2009).

Risk response planning reviews identified risks, ensures that they are properly addressed and rates how effective risk control tools have been on risks and their associated levels within a project. As part of the risk management process, risk response planning must address risk severity, be cost effective in meeting risk challenges, be timely and successful, be realistic within the project's context and be agreed upon by all parties involved with the project (Burtonshaw-Gunn, 2009).

Monitoring and control as the final stage in the risk management process entails keeping track of the identified risks that are being addressed and controlled within a given project, monitoring residual risks as they are worked upon by control tools and identifying new risks as they arise in the project system (CURT, 2004).

2.3. Risk management for airport projects

Airport development and operations require structure and planning to ensure that they are effectively conducted. Activities, such as funding, planning and scheduling, are processes involved with such planning and development endeavors. However, with such processes comes the introduction of risk issues. These risk issues usually are borne by the parties that oversee the development and running of such airport facilities (Hart, 2007). Determining who bears what risk, the quantity of risk to bear, its location in project phases and schedules, and the ways to

reduce and control such risk requires the methodical application of risk management. Risk management for airport planning is a systematic program utilized to identify, evaluate and avoid risk occurrence through the mitigation and elimination of risk elements that threaten the successful achievement of airport development project objectives (Nielson, 2007).

2.3.1. General classification of risk management for commercial airport development (C.A.D)

Risk management can be further classified into two constituent parts: Professional risk management and Operational risk management (Nielson, 2007). Professional risk management reviews risk according to the insurance program utilized by the parties involved with the airport development and operations (Nielson, 2007).

This review is due to the fact that insurance is required for most professionals in airport development and operations projects as stipulated in contract documents (Dagostino et al, 2010).

Professional risk management reviews the financial values of insurance plans and the possible effects that the risks identified within the project setting could have on such values. Professional risk management also reviews professionals affected by these outcomes and their corresponding performance in relation to project objectives (Nielson, 2007).

Operational risk management reviews the risks associated with specific events and the conditions that may prevent accomplishing project-development objectives (Nielson, 2007).

This relationship between risk management types explained in Section 2.3.1 and process explained in Section 2.2.1 is seen in Figure 2.3 below.

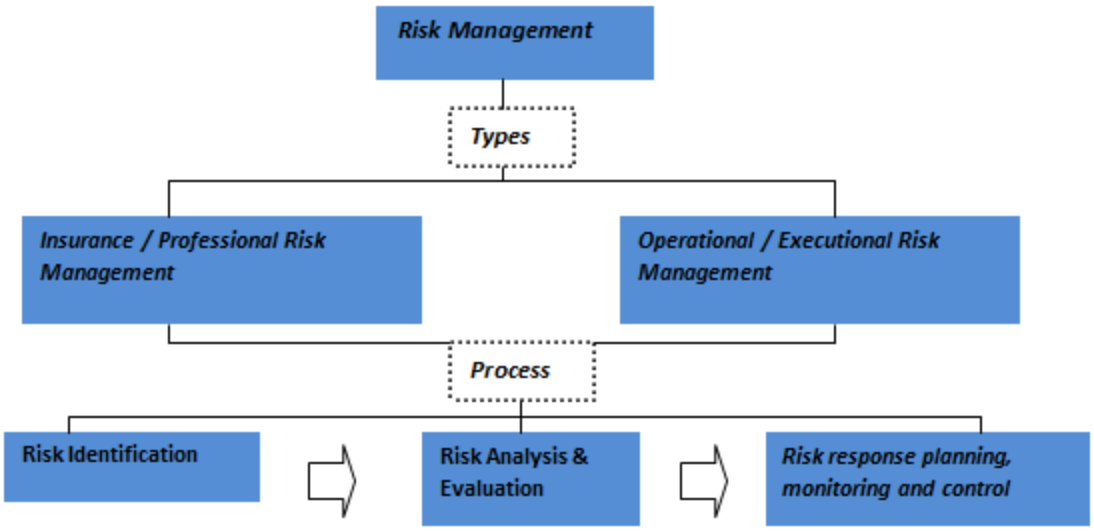


Figure 2.3: Relationship between Risk management type and processes (Nielson, 2007).

2.3.2. Benefits of risk management in C.A.D

Gabel (2012) reviews risk management as an application process that contributes to project success, ensuring that, through adequate planning for potential risks, there is an increased likelihood for project success (Gabel, 2010). Risk management recognizes uncertainty and provides forecasts for possible outcomes, determining that project outcomes are not affected due to limitations from uncertainty and associated risks (Gabel, 2010).

Risk management produces better business outcomes through informed decision making, ensuring that decisions applied to airport developments are clearly thought out as a result. It also creates a platform for positive influence on creative thinking and innovation, allowing freedom to develop creative solutions to adequately limit the presence of risks in given phases of an airport's development. There is a reduction in shock and unwelcome surprises during subsequent

phases of project development because unforeseen risks are identified, limiting a possible margin of error (Burtonshaw-Gunn, 2009).

Risk management presents a systematic approach to strategic business planning which minimizes risk effects and enables controls to be put in place to hinder such risks from occurring in the future. In the 2012 performance audit of the Denver International Airport facility by the audit service division of Denver, it was found that the airport lacked a comprehensive risk-assessment plan and strategy to deal with its maintenance related needs. The absence of a risk management plan hindered the airport's ability to efficiently plan, budget and implement critical improvements (Gallagher, 2012). If risk management through strategic business planning had been applied, maintenance related issues such as the terminal baggage carrier problem could have been avoided. Risk management provides the ability to allocate risk to the most appropriate party; pinpointing proper risk duties to the respective fields involved with airport development and reducing the improper management of risk that could affect project objectives in the long run (Burtonshaw-Gunn, 2009).

In the article "More Delays and Chaos for Berlins New Airport," Wasserman (2012) reviews the reasons behind the delay in opening the Berlin-Brandenburg Airport. One reason was improperly executed planning services by the planning group pgbbi (Wassermann, 2012). If pgbbi had been allotted a risk management group to review its project schedule and activities, this issue would have been avoided and the airport project would have been completed on schedule.

As a practice, risk management encourages risk reduction rather than risk recovery which fares well for the user because risk reduction minimizes the effects of risk on a given project

objective before the risk occurs while risk recovery deals with applying risk management strategies to deal with damage or loss that has already occurred (Burtonshaw-Gunn, 2009). Risk management also supports decision making about the effective use of resources by planning for the proper utilization of the limited resources at hand to ensure that potential waste due to unforeseen risks is avoided (Burtonshaw-Gunn, 2009).

The Denver International Airport baggage carousel network was built after much delay and cost. The carousel network never worked properly and cost Denver International Airport $1 million per month in maintenance costs until it was finally abandoned. This resource expenditure was never bargained for by the airport (Consulting, 2008).

If proper risk management practices had been applied, this situation could have been avoided at Denver International Airport in its earlier stages. The Airport insurance and risk management practices report (2011), reviews the benefits of risk management for airports by equating the weight of its function to the ever expanding nature of the aviation industry in which new and previously unexplored ventures arise. With the utilization of risk management in such ventures, exposure to risk can be effectively overseen and mitigated accordingly (Rakich, 2011).

2.3.3. Parties involved with C.A.D and their associated risk management duties

With the thesis' focus on airport ownership risk in the differing phases of a commercial airport's facility development, maintenance and operations, it is important to know what risks each given party involved with airport development is allocated. This way, risk management duties can be separated and allocated to their respective parties. In this subsection, an emphasis is being put on airport ownership risk duties.

According to Hart (2007) there are three major parties involved in the creation of any given development project: the owner, the designer and the contractor (Hart, 2007).

The project owner deals primarily with the funding and overall supervision of the given project from its planning phase until its completion phase. Issues such as excessive costs associated with project development, delays from poor coordination and communication among specialists involved in the project are handled by the owner and his staff during project development (Hendrickson, 1998). With commercial aviation associated projects, there are three types of ownership. The individual ownership firm is the most common.

As an ownership type, individual ownership for commercial aviation facilities varies based on the type of facility being erected, the services and operations being offered at the facility, and the funding and, investment of government agencies put into such a facility (Horonjeff et al, 1994). In the case of U.S. commercial airports, there is usually an investment of public interest with a majority of the funds for projects and airport operation offered by the government (Horonjeff et al, 1994). The Airport capital investment cost report (2009) indicates that, from 2008-2011, the U.S. government allocated $80.7 million of the $94.3 billion reserved for airport development towards commercial airport projects (Gu.L et al, 2009).

The U.S. government is known to cover 75% - 95% of all development costs associated with commercial airport facilities, giving the government the authority to stipulate how commercial facilities should be built (Gu.L et al, 2009). Commercial airport development cost allocation is usually enforced through agencies such as the Federal Aviation Administration (FAA) and its associated policies and procedures as well as its plans such as the Airport Improvement Program (AIP) and National Plan of Integrated Airport Systems (NPIAS).

An individual ownership firm associated with a commercial airport facility usually has minimal control of the commercial facility's development process with most Federal and State government agencies making decisions that affect the commercial airport. However, this owner still remains responsible for determining the development plan of such an airport facility (Horonjeff et al, 1994).

It is usually after project completion that the government decides to lease the airport out and to transfer outright ownership for a segment of the airport or the total airport to a private sector management firm (Horonjeff et al, 1994). It is as this point that individual ownership takes place. Acquisition of commercial airport facilities by private parties is usually called airport privatization (Horonjeff et al, 1994).

The private corporation is responsible for introducing market competition to the public sector of airport operations with an emphasis on commercial facilities. With this type of ownership, the government transfers power of the facility in question to a private sector management firm after choosing such a firm through selective procedures (Horonjeff et al, 1994). The operation and maintenance costs of the acquired facility become the sole responsibility of the private corporation (Horonjeff et al, 1994). Privatization is viewed as a way to finance aviation system improvements with limited public sector investments (Horonjeff et al, 1994).

Owners of commercial development projects and operations usually account for risk through the entirety of the project from conception to completion (Hart, 2007). Accountability for risk throughout a commercial development's project cycle usually requires that an owner

evaluates the possible risk management plans prior to project commencement in order to prepare for changes with project scope, errors and omissions (Hart, 2007).

Government agencies, such as state government transportation boards, play a vital role in commercial airport facilities during the predevelopment, development and maintenance phases. Such agencies aid in broad policy planning, such as the State Airport System Plan (SASP) which involves airport master planning and specified facility development plans. These agencies also correlate airport development plans at the national level through the National Plan of Integrated Airport Systems (NPIAS) and oversee all financial and development issues surrounding public airport needs within their jurisdiction (WSDOT, 2012). The Federal government engages in the systematic planning of airport systems across the country, utilizing the NPIAS as its mechanism for uniformity with commercial and other forms of airport planning and development. In terms of funding, the federal government provides improvement funding for commercial airport development and maintenance through the Airport Improvement Program (WSDOT, 2012).

The designers of commercial airport developments could be considered a liaison between the ownership group of the commercial facility and the contractor assigned to carry out its erection. The level of control that design groups have in the overall facility development process is usually based on the project-delivery method utilized for the airport facility's development (Touran, 2009). Design group duties are directed towards planning with the needs of the airport's development in mind. The airport designer also incorporates the system of airports that exist around the targeted airport development in the planning process and ensures that planning efforts are in line with NPIAS and SASP policies and specifications (Horonjeff et al, 1994). Designers account for risks that occur during the course of the design phase for a given project. This risk usually covers design errors, omissions and unforeseen budget costs from the initial period of

design until the project's final implementation. The magnitude of risk borne by the designer is based on the project delivery method utilized during the course of project development (Hart, 2007).

The contractor, as a consultant hired by the ownership group to complete development, is responsible for piecing together and supervising all activities and processes required to ensure the proper development of the facility in question (Burtonshaw-Gunn, 2009). If the contractor is unable to handle the coordination and supervision of large and relatively complex airport development projects, subcontractors can be employed to coordinate specific areas of the project (Nielson, 2007). A contractor's risk begins with the issuance of a request for bids or tenders by the ownership of the development in question. Usually from this point, the contractor engages in risk-management practices linked to the project (Nielson, 2007). Risks associated with subcontracted potions of a project are usually performance risks and are borne by the subcontractor. However, if risk elements do arise during the course of a project, causing a noted impact on project objectives, the owner looks to the contractor, not the subcontractor, for recovery (Nielson, 2007). As with design risk, a contractor is only able to determine the magnitude of risk to plan for based on the project delivery method utilized (Hart, 2007).

2.4. Risk planning and its application to the risk management process in C.A.D

To begin the process of risk management for airport development, a risk plan is needed. The Federal Highway Administration (FHA) determines that a risk plan is a detailed plan of action for risk management that develops, implements and monitors risk response strategies utilized to combat risk during project development (FHA, 2012).The process creates a

comprehensive, organized and interactive risk management strategy for resource utilization associated with a project's development (FHA, 2012).

Usually, larger projects with a high level of uncertainty require the utilization of a formal risk-management plan that reviews risk identification, risk analysis, risk planning, risk allocation, risk information systems, documentation and reports. Smaller projects that contain limited uncertainties will benefit from the utilization of risk documentation and tools such as a red flag items list which can be updated at critical milestones as a project progresses (FHA, 2012).

The formal risk management plan is usually implemented at the onset of a project and updated as the project progresses. The formal risk management plan is an indicator with step by step guides that enable users to determine the risks that can be mitigated and controlled during the project (FHA, 2012). Figure 2.4 shows the step by step process involved with the risk management plan and offers a brief insight about the duties associated with each step of the risk management process.

For the thesis "Guidebook for the Successful Assessment and Management of Ownership risk associated with Commercial Airport Capital and Maintenance projects", steps in the formal risk plan were utilized to organize materials, research methods and applications as well as come up with solutions for the present problems.

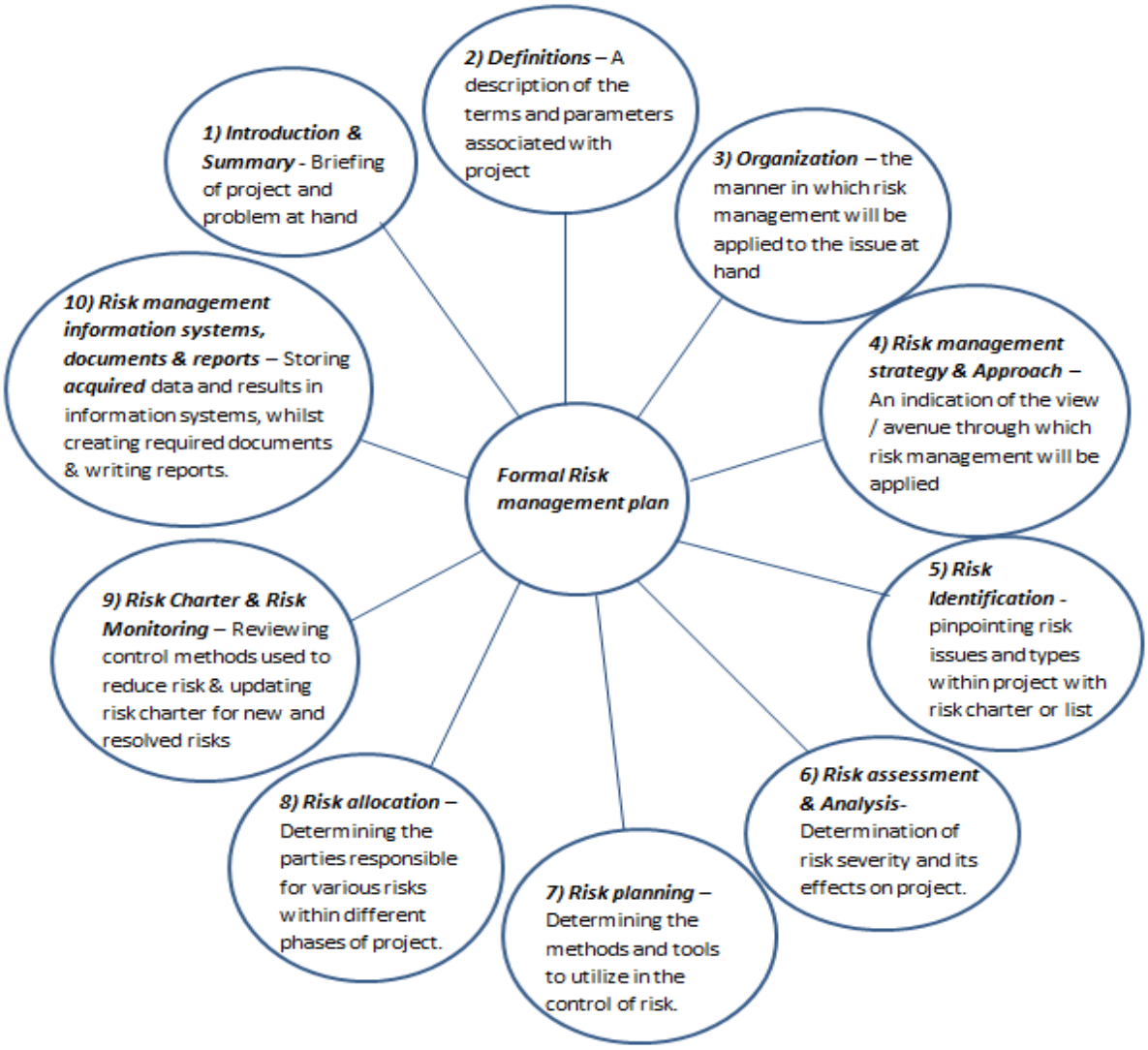


Figure 2.4: Steps in the Formal Risk Management Plan (Burtonshaw-Gunn, 2009).

Step one dealt with the introduction to the problem and was applied in Chapter 1 of this thesis. It is a review of the issue associated with the absence of risk management in commercial airport ownership representation in capital and maintenance project development.

Step two dealt with definitions and was utilized in Chapter 2 of this document from Sections 2.1 to 2.3, where descriptions associated with the risk management process for commercial airport development were described. Step three, which dealt with organizing the risk

management process associated with commercial airport development and maintenance programs can be seen in Figure 2.4 of Section 2.4 which shows steps for the formal risk management plan.

Sections 2.5-2.6 will cover step four in the formal risk management plan and deal with risk management strategies and approaches for commercial airport development.

2.5. Risk management strategies and possible approaches

There are four approaches for risk management with commercial airport development projects discussed in this section, with each method presenting a unique way to approach the issue of risk.

2.5.1. Approach 1: The Project Risk management approach

Approach one deal with utilizing the project objectives set as targets for the duration of a given project's development (Gabel, 2010).The project risk management strategy and approach reviews uncertainties with the likelihood of occurring and affecting one or more project objectives. It then mitigates against such uncertainties. In his literature review, Zou et al.(2009) reviews the west rail project of Hong Kong in which author Chen addressed risk management through the cost objective associated with the project (Zou et al, 2009). The technical risk management strategy, a subset of the project's risk management strategy approach, reviews uncertainties and mitigates for such uncertainties effects on the technical objectives associated with project development (Gabel, 2010).

Zou et al (2009) also reviews the author Chapman's paper, "Management of project risk", which mitigated for risk that affects technical issues related to project design. Most of the

technical issues were based on the measure of a project's inability to effectively utilize time and resources during its development process. These factors are considered important for project completion (Zou et al, 2009). The business risk management strategy and approach reviews risk and mitigates for its effects on business objectives, such as market share, project venture and regulatory compliance to name a few, that associated with a project's development. The safety risk-management approach reviews risk that would affect one or more safety objectives and mitigates for such risks accordingly.

In Zou et al. (2009) journal article "Identifying Key Risks in Construction Projects: Life Cycle and Stakeholder Perspectives", author Tam identified poor safety awareness, lack of training and reluctance to input resources for safety, to name a few, as safety risks associated with construction projects in China. Subsequent mitigation practices were applied in the later stages of research for construction project related safety management (Zou et al, 2009). When focusing specifically on risks that affect time related objectives; the time related risk strategy and approach is utilized. Examples of time related objectives for a development project include executing work in a timely manner, properly staffing job, and ordering materials and equipment on time, with the most common risks affecting such objectives as being poor with contract management, improper planning, cost overrun issues, changes in site conditions and others (Zou et al, 2009). The security risk management approach reviews uncertainties that would affect one or more security objectives and mitigates for them accordingly (Gabel, 2010).

2.5.1.1. Positives and negatives for Approach one

The strength and strategy of approach one lies in the specificity of its application. Most of the project objectives reviewed can be selectively addressed. Approach one reduces the risk identification workload and cost while making room for risk management specialization if such a process is utilized on a frequent basis. Approach one's disadvantages have to do with its inability to cover all aspects of risk if it is utilized to individually address specific project objectives (Gabel, 2010). Approach one opens the project up to losses that could have been covered if the risks associated with all project objectives were covered. The best scenario for utilizing approach one would be applying the project risk management strategy approach and addressing all project objectives associated with a development project. However, utilizing approach one should be based on financial viability at the time of project development by all parties involved (Gabel, 2010).

2.5.1.2. Application of Approach one

In terms of project scope and quality, commercial airports embarking on development or maintenance related activities should utilize approach one based on the size of the facility being developed (Horonjeff et al, 1994), the nature of the project being approached and the specificity of the project objectives to be met (WSDOT, 2012). When looking at resource availability to carry out airport development and maintenance projects, the affected commercial airport ownership parties should review the funding stipulations and policies set by government agencies to determine how much they will be given for development and how much they will need to provide themselves (FAA, What is AIP, 2012). This way, they can determine the extensiveness of the risk-management plan they use and how subjective it may need to be based

on the resources at hand. The time frame associated with development plans, within such federal aviation development programs as the NPIAS, SASP and the AIP, should be considered when implementing risk management practices in commercial airport development. The longer it takes to approve a project, the greater the adjustment that is made to project schedule, limiting the extensiveness of the risk-management plans in place (WSDOT, 2012).

Government intervention affects the risk management strategy application for commercial airport facilities if the facility is in its pre-operational phase. In this case, most activities associated with an airport's development are reviewed by the government agencies responsible for its funding. In the operational phase, if the airport facility is leased by the government agencies in question, the private ownership would determine how comprehensive or specific the project scope and quality of the risk management strategy is based on the funding at hand (Horonjeff et al, 1994).

2.5.2. Approach 2: The Project Phase Risk management strategy

Approach two involves applying the risk management plan through the differing phases of a given development project and allocating risk duties to the parties involved with these phases (Ospiova, 2008). In a study on the process of risk management through the context of project phases, Ospiova found that the role of various parties in the risk management process was connected to their participation in a project's phases. Risk identification, assessment and response planning/implementation were performed in the programming phase by the project owner, in the planning phase by the owner and hired consultants, and in the procurement and construction phase by the contractor.

The positives of approach two lie in its distribution of the risk management process to affected parties within the given phases of project development. The distribution of the risk management process between parties involved in commercial airport development removes the issue of contractual confusion that could result in adversarial relationships (Refer to Section 2.1.2.4) affecting project objectives (Rakich, 2011).

The negatives of such an approach lie in the fixed nature of the risk management assignment process which limits the redistribution of risk management duties once assigned (Ospiova, 2008).

2.5.2.1. Application of Approach two

The application of approach two in terms of the project's scope and quality for commercial airports depends on the magnitude of the project at hand, the parties involved in the development phases and the governmental processes required for the approval of such projects (WSDOT, 2012).

For maintenance projects, the programming and planning phases with their associated risk-management duties are not required. Procurement and construction duties are usually utilized with maintenance phases requiring risk management duties by the contractor and, to some extent the owner (Ospiova, 2008). Approach two would work for maintenance projects that require procurement and construction related activities. For commercial airport projects in the development phase, it would be advisable to utilize approach two because it allocates risk management duties to the parties involved in the subsequent phases of development, limiting confusion about who handles what in terms of the risk management process (Ospiova, 2008).

In terms of resource availability, government intervention, time and schedule, approach two could be affected by government agencies and associated plans, such as the SASP and the NPIAS. Such governmental agencies and associated activities determine funding based on the need for the facility, allocating the funds based on a time sensitive application processes (WSDOT, 2012). Approach two in turn, affects the magnitude of the risk-management plan to be implemented by airports.

2.5.3. The Project Lifecycle - Project objectives and stakeholder perspectives risk management strategy: Approach three

Approach three is a combination of project phase risk management and the project risk management strategy approach. It requires an understanding of project life cycle, the role of stakeholders in project development and the project objectives associated with a given project. It is from this angle that risk management practices can be applied (Zou et al, 2009).

It was determined that the major risks that affect construction projects, the phases of project development in which they occur, the project objectives affected by such risks, and the parties and stakeholders affected by such risk during project development, could be acquired from such a strategy. Zou et al (2009) conclude the review on this strategy by determining that affected parties must work cooperatively from the onset of a project to address potential risks in time to ensure that sound, safe, efficient and quality activities are carried out accordingly (Zou et al, 2009).

The positives of this approach are its holistic view to risk management. It covers all aspects of a given development project from conception to completion, making it an ideal approach for large and complex commercial airport projects that may be multi-faceted in nature

(Zou et al, 2009). The negatives lie in its complex nature which limits its compatibility with smaller, less complex projects that may not have the resources to utilize such a risk management strategy. It may also be a confusing concept to grasp and could be wrongly interpreted if not thoroughly reviewed.

Figure 2.5 is an influential diagram utilized by Zou et al. (2009) to map out the risks borne by the parties/stakeholders involved in a project's development cycle. The risks are the tributaries that stem from the phases of feasibility, design, construction and operation. Due to the nature of the diagram, these risks are abbreviated and can be seen in full in Table 2.1.

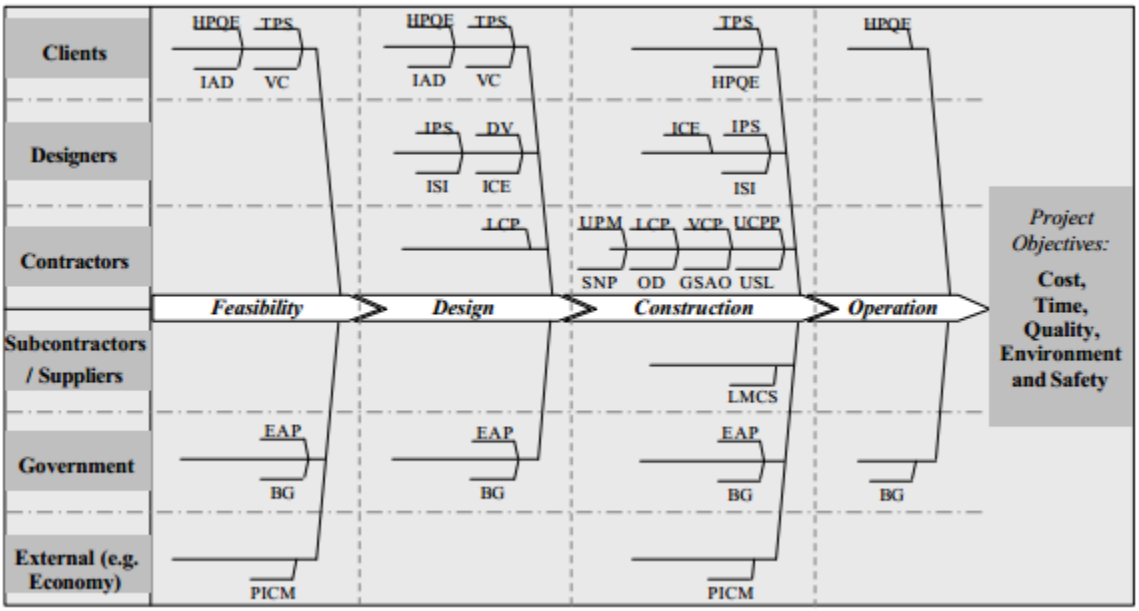


Figure 2.5: Consolidation of key risks, stakeholders & the project lifecycle (Zou et al, 2009).

Table 2.1: Risk abbreviations and full meanings for Figure 2.5 (Zou et al, 2009).

20 Key Risks	Abbreviations
Tight project schedule	TPS
Design variations	DV
Excessive approval procedures in administrative government departments	EAP
High performance/quality expectations	HPQE
Inadequate program scheduling	IPS
Unsuitable construction program planning	UCPP
Variations of construction programs	VCP
Low management competency of subcontractors	LMCS
Variations by the client	VC
Incomplete approval and other documents	IAD
Incomplete or inaccurate cost estimate	ICE
Lack of coordination between project participants	LCP
Unavailability of sufficient professionals and managers	UPM
Unavailability of sufficient amount of skilled labour	USL
Bureaucracy of government	BG
General safety accident occurrence	GSAO
Inadequate or insufficient site information (soil test and survey report)	ISI
Occurrence of dispute	OD
Price inflation of construction materials	PICM
Serious noise pollution caused by construction	SNP

2.5.3.1. Application of approach three

In terms of project scope and quality, approach three is more applicable to large scale commercial project developments in the pre-operational phase of development. This is due to approach three's holistic approach that covers all risk aspects associated with project development. A limitation here may be the unwillingness of government agencies to cater to the funding of such a risk management program and the time factor associated with the acquisition of funding from the government agencies (WSDOT, 2012).

2.5.4. The Project delivery method Risk management strategy: Approach four

With this method of risk management, risk is strategically approached based on a project's delivery system. From the delivery systems, key parties are assigned appropriate project risks (Rakich, 2011). The project delivery risk management method allows the individual in

charge of a given delivery method to determine the risk that they will be bear while splitting up what is left and allocating it to other parties involved with the project (Rakich, 2011).

There are three delivery systems discussed: The Design-Bid-Build (DBB), The Construction Manager at Risk (CMR) and The Design Build (DB).

The DBB method puts the project owner in charge of risk allocation while the contractor and designer are allocated risk duties based on statutory law and standard contracts. Despite the allocating power, the project owner still bears risk associated with erroneous design and activities not stated in pre-contractual agreements (Rakich, 2011).

In the CMR delivery method, risk is borne and allocated by the contractor. The contractor utilizes gross maximum price (GMP) in tandem with the airport administration to share costs related to risk and risk management. The contractor is also responsible for sharing project information regarding contracts, value engineering and other project developments with the owner and designer during the project's course. Setbacks to this procedure may arise if the number of parties assigned to the project rises and duties begin to overlap (Touran, 2009).

The DB project delivery method for risk management puts the design builder in charge of handling the most risk. The project owner, through contractual agreement, transfers risks such as design errors and omissions as well as design detail risks with their associated cost to the design build contractor. It is important for the owner to review the DB's activities during the course of development in order to avoid increments in contractor insurance and contingency allocations that he will have to cover (Touran, 2009).

The positives of the project delivery method risk strategy are its ability to allocate risk to the parties involved in the project development process and its holistic approach to the risk

management process. The negatives stem from its use as more of a risk allocation tool rather than a risk management method. Formal risk management planning would still have to be utilized when applying the project delivery method risk strategy (Touran, 2009).

2.5.4.1. Application of Approach four

Application four would be ideally utilized for all sizes of commercial construction projects, whether they are in post-operational or pre-operational phases, because it is more of a risk-allocation tool (Rakich, 2011).

The only hindrance to commercial airport capital and maintenance projects utilizing this approach lies in airports' dependence on government funding and the associated approval processes (government intervention) which affect time and schedules, limiting the extensiveness of the risk management process that can be utilized. The usefulness of approach four can be seen in Figure 2.6 below.

Project delivery method	At the end of conceptual design	At the end of preliminary engineering	At the end of final design	Construction
DBB	■	■	□	◦
CMR	■	□	□	◦
DB / DBOM	■	□	◦	◦

■ Desirable
□ Feasible
◦ Not feasible

Figure 2.6 :The timing of project delivery method selection (Touran, 2009).

2.6. Risk identification in project development

After determining the use of risk strategy three (Refer to section 2.5.3), risk identification as a process is applied. The United Nations Educational Scientific and Cultural Organization

(UNESCO) determines that as an approach it is applied internally and externally in the risk management process .It is applied through external identification which utilizes a designated team to conduct the risk identification process and internal identification, both of which require self-assessment. Internal identification is the more commonly used identification approach, and it utilizes questionnaires, surveys and facilitated workshops to aid in the determination of risks that will affect a project's set objectives (UNESCO, 2010).

In order to effectively apply internal identification, the preferred process for this thesis, we have to review to the approaches from which risk types can be identified. For this thesis, the project objective approach and project phase identification methods were utilized.

Risk identification through the project objective approach involves the review of project objectives (cost, time, safety, environment and quality).

Using the west rail project for Hong Kong as an example, Zou et al. (2009) notes that author Chen identified risk from a cost perspective. Chen identified 15 risks which were further categorized into 3 groups. Risk identified in terms of the project phase requires the breakdown of a project's scope into differing phases from which risk issues in each phase can be acquired (Zou et al, 2009). Zou et al. (2009) approached risk identification by utilizing project phases and shareholder-risk responsibility. A total of 51 risks were identified as being associated with the project cycle of a construction project.

2.7. Risk Identification and Classification tools in the Risk management process

With an approach found to identify risk, there is a need for the application of tools and techniques to acquire existing risk issues within a given project's development. This section reviews 10 such risk tools and techniques.

The King Fahd University of Petroleum and Minerals (KFPUM) determines that the simplest risk identification tool to utilize is brainstorming which works by listing as many ideas as possible that are linked to a given topic or objective regarding risk issues with the eventual identification of a large number of risks. As a tool, it provides quantity, rather than quality, in terms of results, but these risks are eventually narrowed down in the risk management process (KFPUM, 2012).

The Delphi technique requires the general agreement of experts regarding risk for a given project's development. Acquisition of such expert opinion is acquired by issuing a survey containing risk elements to the experts in question, which they then validate through corrections, discussion among themselves and revisions. The final result is a list of concrete risk factors (KFPUM, 2012).The survey approach application of the Delphi technique is utilized in the risk identification and assessment portion of the thesis. An example of the Delphi technique is seen in Figure 2.7 with a computer based survey.

Utilizing the interviewing method requires the creation of pertinent questions pertaining to risk from the development at hand and a subsequent interview session with experienced professionals within the given field of concern. The interviewer usually identifies risk within a project based on experience, project information and sources that are identified as helpful (KFPUM, 2012).

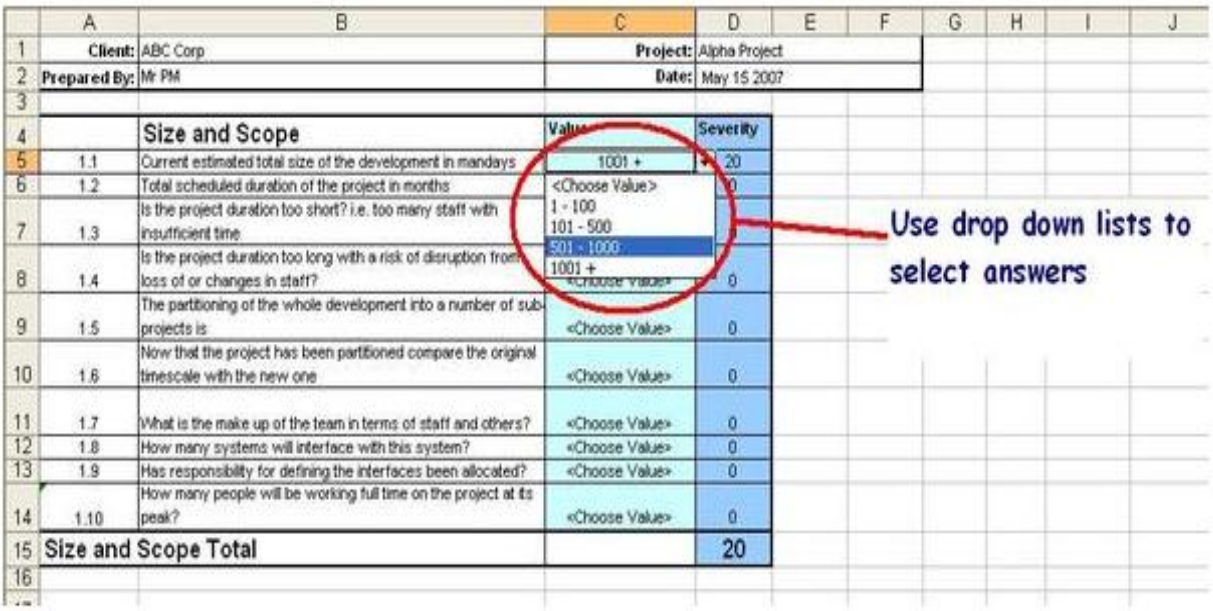


Figure 2.7: Application of a computer based questionnaire/survey with the Delphi method, Leading Answers (LA, 2007).

In the thesis, the interviewer's identification and viewpoints on commercial airport ownership risks were used in addition to the Delphi method to identify risks.

A checklist approach to risk identification requires a list of risk based on the resources of past projects related to the development in question. The checklist can be updated as new risks are identified for the project in question (KFPUM, 2012). An example of such a checklist would be a red flag items list of risk, which is usually created at the onset of project development, to identify risk and critical items within the project phase that could be affected by such risks. As the project advances, the risk list is updated for new risk issues. The list enables the application of the risk management process for identified risk while sharing information between project parties about the status and control of current risk issues occurring with project development (FHA, 2012).

In the application of assumption analysis, a project is reviewed for inaccuracies, inconsistencies and incompleteness during different phases, and from such occurrences, a listing of risk issues is developed (KFPUM, 2012). The diagramming technique utilizes a graphical and sequential representation of risk issues. Such diagramming occurs with three techniques (KFPUM, 2012).

The cause and effect diagram identifies risks causes and effects on project objectives. The second technique system, or process flow chart, utilizes diagrams to show interrelations between elements of a project and its phases through which the system determines factors of risk causation (KFPUM, 2012).

Influential diagrams show, graphically, the problem areas within a project and their associated risk, their occurrence within the project schedule, and their possible variables and, projected outcomes. The diagraming technique is utilized in Chapter 4 of this document.

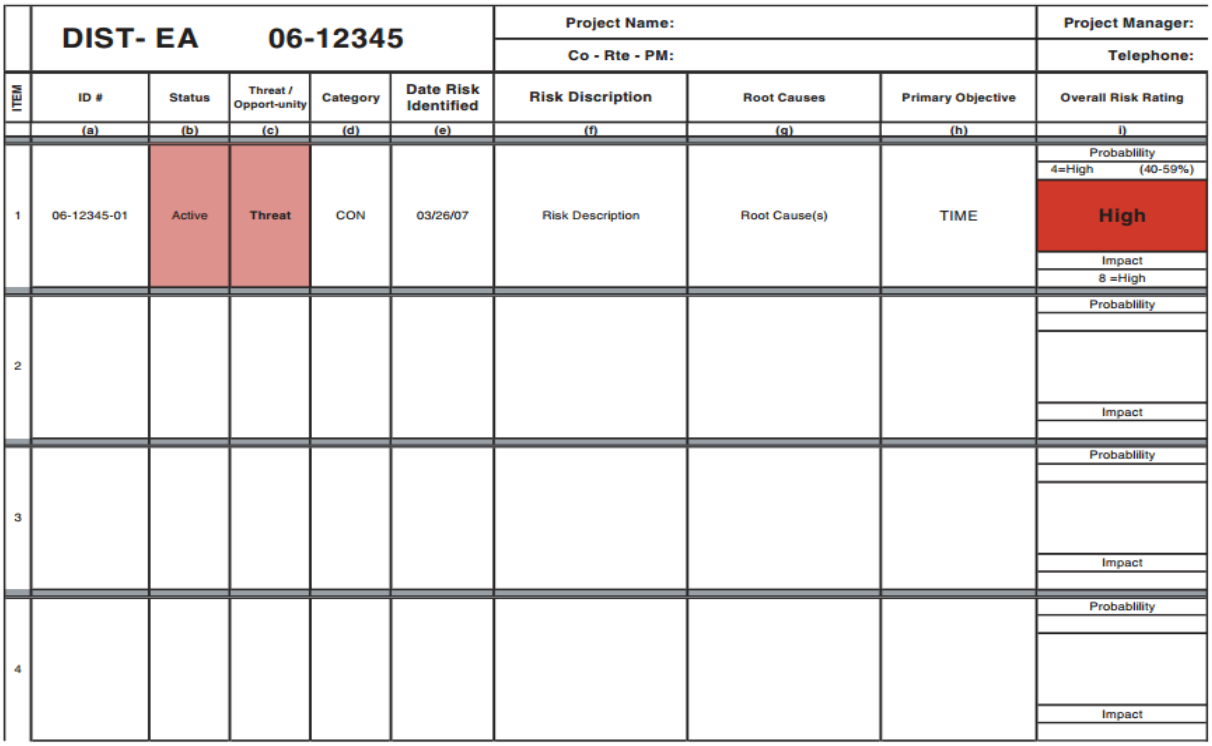
The risk register is a record of documents used to document the risk-management process. It is comprised of risk identification, a description of risk types, the root causes of risk types, potential responses to risk types and updated categories associated with risk organization (FHA, 2012).

The risk charter is an example of the risk register and is usually a part of the risk-management plan. As a document, it provides its user with risk identification (description, category and cause), the measure of magnitude associated with such risk, and the probability and impact of risk occurrence within the project. Risk register documents also allocate identified risks to parties within a given project, the risk effects on project parameters as well as the mitigation/control responses to deal with such risks. This risk identification tool is utilized for

large, complex projects that have a degree of significant uncertainty (FHA, 2012).An example of a risk register document can be seen in Figure 2.9. A typical risk charter list is comprised of the following headers (FHA, 2012):

- Risk description
- Status
- Date identified
- Project phase
- Functional assignment
- Risk trigger
- Probability of occurrence (% or decimal value)
- Impact ($ amounts or time delays)
- Response actions
- Responsibility (task manager)

A modified risk register is utilized in the research methodology section of this thesis for risk probability × impact assessment. Figure 2.8 shows the more advanced form of the risk register which is the risk charter.



	DIST- EA 06-12345					Project Name: Co - Rte - PM:			Project Manager: Telephone:
ITEM	ID #	Status	Threat / Opport-unity	Category	Date Risk Identified	Risk Discription	Root Causes	Primary Objective	Overall Risk Rating
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	i)
1	06-12345-01	Active	Threat	CON	03/26/07	Risk Description	Root Cause(s)	TIME	Probablility 4=High (40-59%) High Impact 8 =High
2									Probablility Impact
3									Probablility Impact
4									Probablility Impact

Figure 2.8: Caltrans' risk charter document (Molenaar et al, 2010).

2.7. Classification of Identified Risk in C.A.D

Once risk issues have been identified, it is important to classify risk accordingly to ensure the proper organization of risk issues according to areas of the project they affect. This way, proper analysis of the risk issues, allocation of risk to the intended parties involved, and the application of mitigation strategies and control systems to deal with risk can be done (Klemetti, 2006).

In the first of several approaches to risk classification, Klemetti looks at risk from the general viewpoint of four effect factors. The first effect factor is pure risk which pertains to risk types that are only known to produce the chance of loss within associated project objectives

(Klemetti, 2006). Pure risks are usually the only forms of risk that are insurable, and they relate to hazards and liabilities that occur during the course of a project (Investopedia, 2012). The second effect factor is financial risk which classifies the risk type based on losses and gains associated with various financial events that occur during the course of a project's development. Such risks are usually a function of debt and are utilized by a project and its associated parties to finance its development (Dictionary, 2012). The third classification is business risk which addresses the effects of risk on the parties associated with project development and project objectives. Business risks are influenced by factors that include, but are not limited to, input costs, competition, overall economic climate and government regulations (Investopedia, Business risk, 2009). The final risk effect factor is political risk which reviews the political environment around project development as well as its possible effects on an affected project and its determined project objectives (Klemetti, 2006). Such risks are known to become more of a factor as the time horizon of an investment gets longer (Investopedia, Political risk, 2009) . This general risk breakdown is seen in Table 2.2 on page 68.

In her dissertation *Risk Management in Construction Project Networks*, Klemetti (2006) reviews Miller and Lessard's risk classification system which is broken down into three major parts.

The first part reviews risk according to the state of the market during project development and looks at the demand, supply and financial purchasing power at hand during the course of project development (Klemetti, 2006).The second part classifies risk according to the completion of the project in question, reviewing the technical, construction and operational aspects of the project while doing so (Klemetti, 2006). The third and final part of the classification reviews institutional agencies and the effects they have on project completion.

These institutional agencies are regulatory (government) and relate to the permits, policies and procedures associated with the project and how government activities affect project completion. Social acceptability reviews how a project is perceived by the community, in which it lies, and sovereignty reviews how much independence or outside control a project's development possesses (Klemetti, 2006). Miller and Lessard's risk breakdown can be seen in Table 2.3 on page 68.

Klemetti also reviews Baloi and Price's classification of risk according to impact types which, as a classification method, pits risk factor categories against their opposites in an impact-style review. This classification is seen in Table 2.4 on page 69.

When classifying risk within construction projects, Finnerty's construction-project specific categories are analyzed by Klemetti. Here, construction risks are classification according to factors that affect project development during it subsequent phases (Klemetti, 2006). Finnerty's construction classification is seen in Table 2.5 on page 69.

The *Project Risk Management Handbook* reviews Caltrans' risk breakdown structure where risk is classified according to project phases of a construction project in which such a risk issue will occur (Caltrans, 2007). As a result, this type of classification enables the project owner to effectively assign risk duties to the parties involved with specific phases of project development. Caltrans risk breakdown structure is seen in Figure 2.9 on page 69.

Department of Energy (DOE) ,risk identification classification reviews risk according to four major categories: the project being developed, the technical risk associated with such a project, the external environment and risk associated with project development, and the internal

environment and risk within the project (Molenaar et al, 2010). This classification system can be seen in Figure 2.10 on page 70.

Each classification has attached factors that are affected by risk issues which enable users to associate determined risk types with the given classification to which they are attached.

Table 2.2: General risk classification (Klemetti, 2006).

Pure Risk
Financial Risk
Business Risk
Political Risk

Table 2.3: Miller and Lessard's risk classification (Klemetti, 2006

Market	***Completion***	***Institutional***
Demand	*Technical*	*Regulatory*
Financial	*Construction*	*Social acceptability*
Supply	*Operation*	*Sovereign*

Table 2.4: Baloi and Price's impact type classification (Klemetti, 2006).

Dynamic vs. Static
Corporate vs. Individual
Internal vs. External
Positive vs. Negative
Acceptable vs. unacceptable
Insurable vs. non –insurable

Table 2.5: Finnerty's construction: project-specific risk (Klemetti, 2006).

Technical	*Financial*
Social	*Natural*
Economic	*Commercial*
Construction	*Logistics*
Legal	*Political*

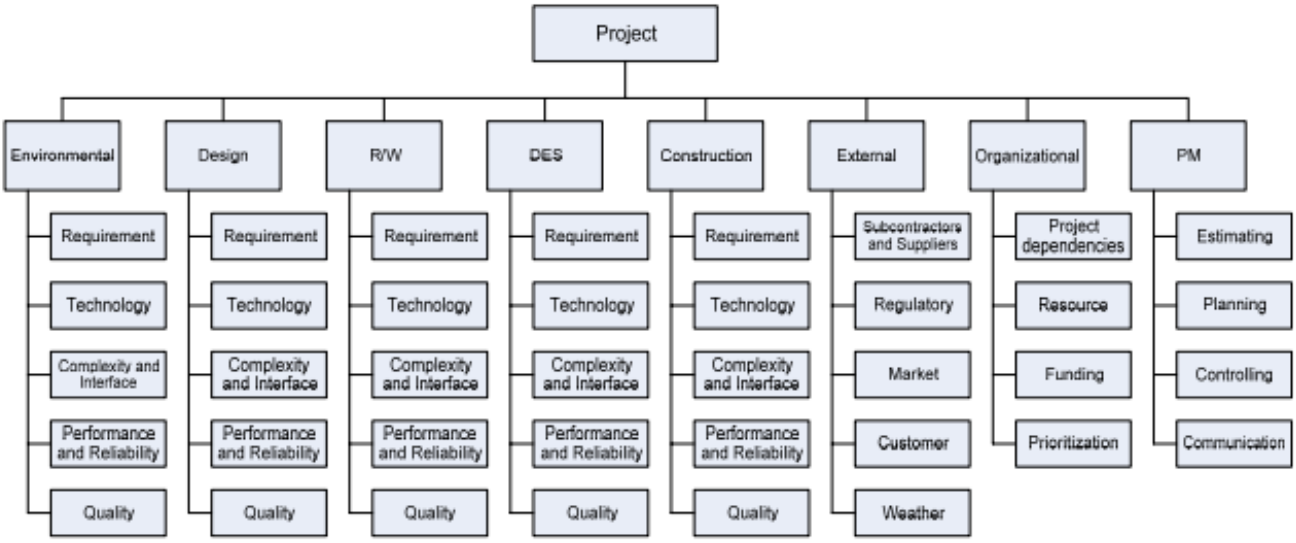


Figure 2.9: Caltrans' risk breakdown structure (Caltrans, 2007).

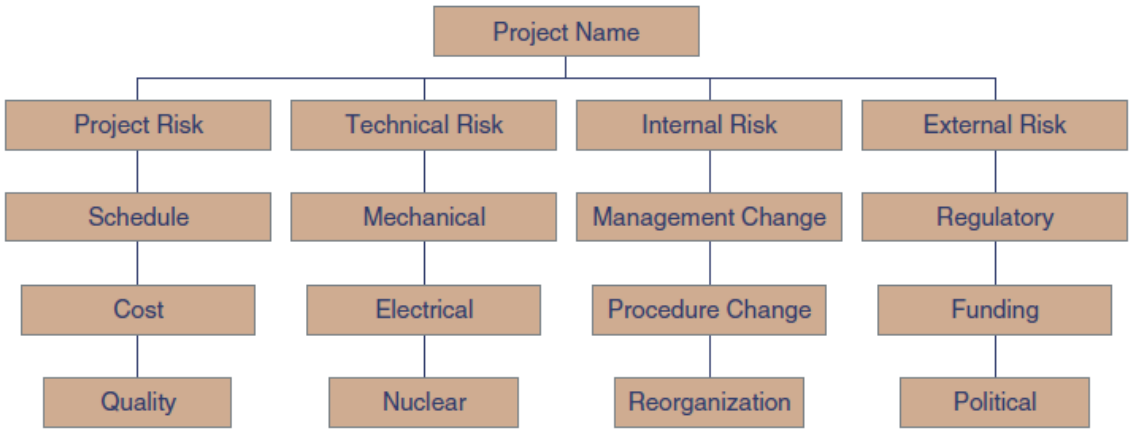


Figure 2.10: DOE risk identification classification (Molenaar et al, 2010).

2.8. Application of Risk Identification and Classification to the phases of C.A.D

With an understanding of the processes and tools associated with risk identification and risk categorization in the formal risk management plan, such knowledge can be applied to the

phases associated with commercial airport development to determine pertinent risks and classify them accordingly.

2.8.1. Commercial Airport Planning - Determining the project cycle for an airport development project

When planning for an airport's development, the owner and associated parties involved with project development should create a general structure to addresses the project development phases associated with the project in question and its associated risks as they occur. Such planning takes the form of a project cycle. Project cycles determine phase allocation for a given project. Project cycles are aimed at defining a project, planning for its subsequent development, executing established plans and delivering a project within identified project objectives (Gray, 2008). Figure 2.11 illustrates the stages associated with a project cycle.

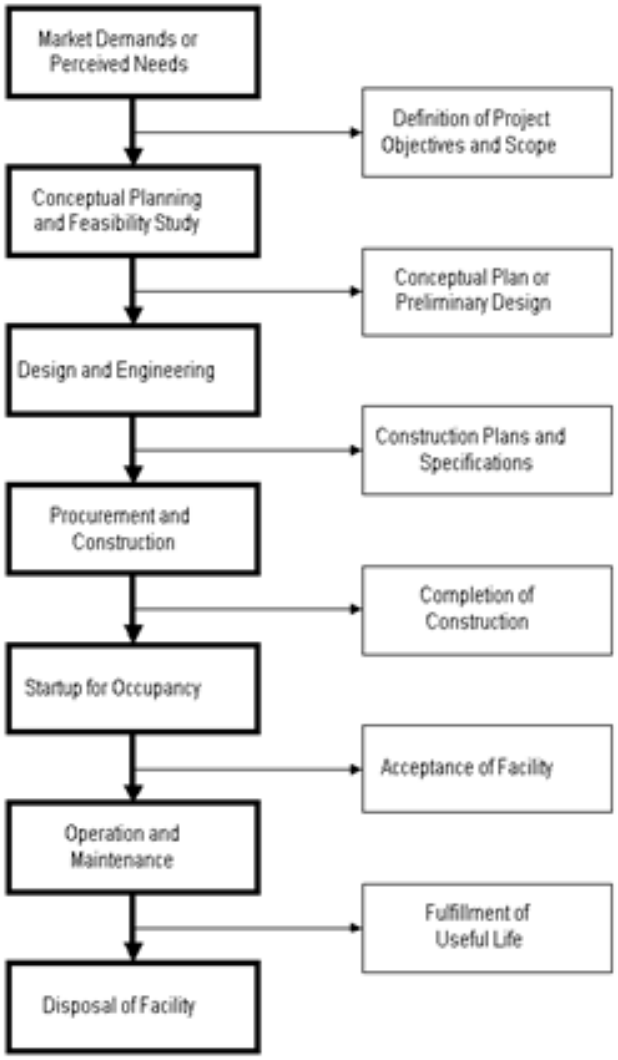


Figure 2.11: Project life cycle of a development facility (Hendrickson, 1998).

Figure 2.11 and its associated steps are utilized to review the development process for commercial-airport capital and maintenance projects as well as their associated risks.

Horonjeff et al. (1994) expressed the notion that airports had a wide range of interdependent activities with conflicting requirements and that a single activity, if not properly addressed, could limit the capacity of the entire facility. Therefore, it is important, when creating

a project cycle for commercial-airport development, for the developer to consider the project type (capital or maintenance) and structure the project cycle accordingly (Horonjeff et al, 1994).

For this thesis, a holistic project cycle, embracing both the capital and maintenance activities associated with airport ownership activities, was used to determine the risks affecting airport owners during the course of a commercial airport development cycle. This was seen in Sections 2.8.2 through 2.9.1.

2.8.2. Phase One: Project cycle application to C.A.D - Market demand and perceived needs

The first step in characteristic determination for an airport's development lies in the airport type to be developed. For this thesis, airport type to be developed would be commercial airports. The FAA, Airport Categories (2012) describes commercial airports as facilities that are publicly owned and have at least 2,500 passenger boarding's each given calendar year while receiving scheduled passenger services. The major types of commercial airport facilities are primary and non-primary airports. Primary airports are hubs that serve more than 10,000 passenger boarding's per year and count for a larger percentage of U.S. enplanement figures on a yearly basis. Hub sizes for such airports are large, medium, small and non-hub.

Table 2.6: FAA classification of commercial airports by enplanement figures (FAA, Airport Categories, 2012).

Airport Classifications		Hub Type: Percentage of Annual Passenger Boardings	Common Name
See Definitions of Airport Categories below for more information.			
Commercial Service: Publicly owned airports that have at least 2,500 passenger boarding's each calendar year and receive scheduled passenger service **§47102(7)**	**Primary:** Have more than 10,000 passenger boardings each year **§47102(11)**	**Large:** 1% or more	**Large Hub**
		Medium: At least 0.25%, but less than 1%	**Medium Hub**
		Small: At least 0.05%, but less than 0.25%	**Small Hub**
		Nonhub: More than 10,000, but less than 0.05%	**Non hub Primary**
	Nonprimary	**Nonhub:** At least 2,500 and no more than than 10,000	**Nonprimary Commercial Service**
Nonprimary (Except Commercial Service)		Not Applicable	**Reliever §47102(18)**

Non-primary airports serve no fewer than 2,500 passenger boarding's and no more than 10,000 passenger boarding's per year (FAA, Airport Categories, 2012). Table 2.5 shows the criteria set by the FAA for commercial-airport size determination while Figure 2.12 shows the top 20 commercial airports in the USA based on the criteria given in Table 2.6.

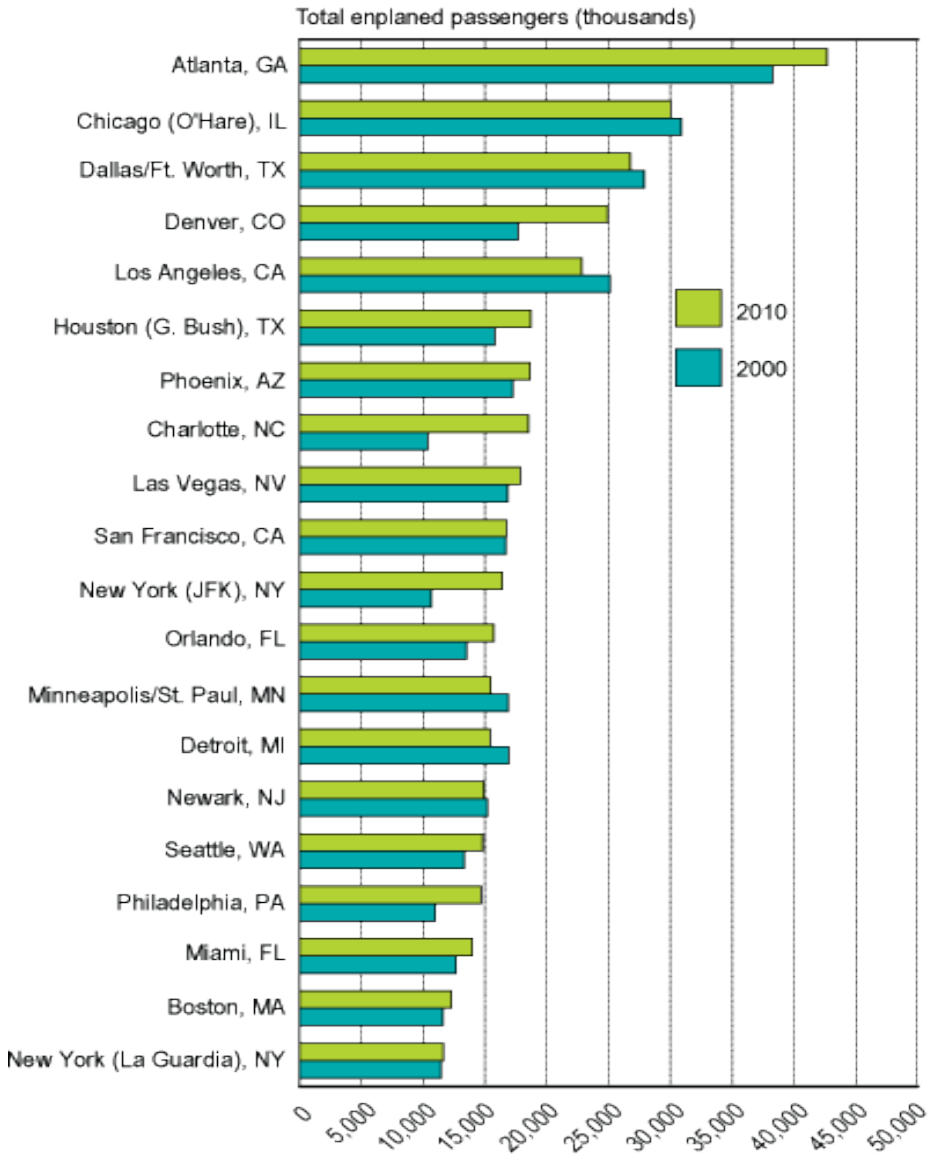


Figure 2.12: Research and Innovative Technology Administration (RITA): Utilization of airport enplanement figures to determine rank for the top 20 airports in the USA from 2000-2010 (RITA, 2012).

The project development type associated with the commercial airport facility in question should be reviewed next in this phase of project development. This project development type could either be capital or maintenance in nature.

Portland online (2004), in its review of capital projects, determines that capital projects for construction development are comprised of new construction, acquisition of existing development for redevelopment purposes, remodeling an existing facility, replacing parts of an existing facility or the capital improvement of an existing facility. Usually, such project costs must total at least $10,000 over the duration of project development (Portland, 2004). Maintenance airport projects routinely check existing development facilities and upgrade them as required. Such activities require the review of an existing structure's foundation and fixture conditions while applying updates through routine, scheduled or anticipated processes (Horonjeff et al, 1994).

2.8.2.1. Initial review of project parameters

Once the airport and development type are determined, it is required that the owner of an airport development has a general overview of certain parameters associated with the project in question. This way, structured decisions about the project approach can be made. The following paragraphs are brief descriptions of the parameters that need to be understood by the owner prior to project phase determination.

Project scope and size are utilized by the owner to determine the vertical or horizontal nature of the specific project in terms of financial cost and physical size (Touran, 2009). The complexity of an airport project is reviewed by the airport system being developed and its requirements in relation to the resources at hand. It is important to note that airports are a body of multiple systems with interdependent organs and airports must be planned, developed and maintained as such in order to ensure that all component parts work in sync (Touran, 2009). The types of funding available to the owner should be reviewed prior to embarking on the project to ensure that the financial parameters associated with project development can be met (Touran,

2009). This is discussed in more detail within the project cycle phase of commercial capital airport project development, which is reviewed for government funding, and approval for airport development projects. Associated security measures linked with project development should be reviewed to ensure safety for all parties involved with airport development, operation and use (Touran, 2009).

If an airport is in the operational phase during development or maintenance-related activities, the owner will have to juggle design/construction and airport operations to ensure that project objectives and airport operations are met (Touran, 2009). The revenue generating ability of the project in question should be reviewed by the owner to determine if resources pushed into project development will deliver the project in a timely fashion and maximize revenue from its future operations (Touran, 2009).

Finally, understanding the different stakeholders involved with a development project and mapping out their required duties during development phases ensure the success of any given commercial development project. Conflicting demands of project stakeholders for an airport's development can make it hard for the party in charge of the project to reach needed agreements, prolonging the project's design-and-development phase (Touran, 2009).

2.8.2.1.1. Specific review of select project parameters in project phase development

Utilizing risk identification and classification tools, the owner of the project in question should begin to compile an initial list of risks while going through the associated phases for commercial airport project development.

2.8.2.2. Market demand and perceived needs - Project description

The project description addresses project characteristics based on the scope of work and its corresponding elements within the project. As a tool, the project description is utilized by the owner to communicate project decisions to the parties involved with project development as well as to justify project decisions if issues arise during the project's development and operation phase (Rakich, 2011). A checklist for the project description is illustrated in Table 2.7.

Table 2.7: Project description checklist (Horonjeff et al, 1994).

1) Project Name	8)Project site dimensions or project limits
2) Project location	9) Security issues or concerns
3) Major features of work (Runway , apron , terminal , other)	10)Rate of return on capital investments / payback period (if applicable)
4) Estimated project budget	11)Major schedule milestones
5) Estimated project delivery method	12)Major project stakeholders
6) Required delivery date (if applicable)	13)Labor union status
7) Sources of project funding	14) Major challenges as applicable (risk included)

2.8.2.3. Project goal and objective determination

Identifying project goals requires noting the project needs and determining the parameters of a given project in terms of function, location, preliminary funding and timing targets (Nielson, 2007).

Project goals and objectives can be reviewed from seven different viewpoints. Consumer/ownership based goals address meeting the goals associated with the two listed parties (Wane County, 2012). Land use and zoning based goals focus on ensuring that the development plan for an airport facility complies with the regulations and zoning ordinances determined by government run organizations such as the FAA (Trinity, 2007) .

Development and design based goals are created to ensure that airport design and development parameters meet the owner's standards in accordance with the regulations set by aviation's governing bodies while also making room for future development (Trinity, 2007).

Safety based goals are created to ensure that the processes involved with airport development adhere to given standards set by the Occupational Safety and Health Association (OSHA) as well as the standards determined by airport owners and the parties involved with airport development (Trinity, 2007).

Operation and maintenance based goals are goals set to ensure the proper functioning, operation and maintenance of an airport facility during its post development phase. Such goals revolve around policies and procedures set by airport ownership and aviation's governing bodies (Wane County, 2012).

Policy and procedural based goals review set standards for development and operation by aviation's governing bodies, such as the FAA and ICAO, with which the airport facility is to keep in line (Wane County, 2012).

Finance and funding based goals review the development milestones that must be met by the financial budget afforded to the airport for development and maintenance. Such goals are subjective to the facilitators of such funding (aviation's governing bodies) and their requirements, a risk itself (Zou et al, 2009). Commercial and economic development goals are usually discussed in more detail within feasibility planning. It is important to set goals prior to feasibility planning to ensure that a major focus of the project is its capability to maximize profit and spur further development within the community where it is located. Internal and external

conflicts of interest by the parties involved with airport development are a major risk factor affecting such goals (WSDOT, 2012).

Once the project goals are determined, project objectives are reviewed based on the urgency of need by the airport facility in question. Such objectives are usually part of a larger master plan and represent policy and planning guidelines which identify the present and future needs of airport development and stakeholders, respectively (Wane County, 2012).The first project objective is general in nature, requiring the project's facilitating parties to determine, through policy and planning objective's the best way to meet the overall desires for an airport's development (Wane County, 2012). The objectives that follow soon after the general objective are specific in nature and address issues related to parts of the airport facility. Airside objectives cover policy and planning specific to development of airside facilities such as runways, holding pads, taxi systems, apron gate areas and exit taxiways. Terminal objectives cover policy and planning objectives specific to developing and enhancing features of the terminal facility and airline areas. Terminal objectives include, but are not limited to, passenger processing, security and passenger amenities (Wane County, 2012).

Financial objectives are utilized by a financial planner to review planning and policy associated with the fiscal responsibility of keeping airport facilities well equipped in terms of short-range and long range development planning. Financial objectives focus on activities such as project phasing for capital budgeting purposes and the financial allocation of resources to ensure such improvements are implemented at affordable levels (Wane County, 2012). Finally, security objectives are aimed at presenting policy and planning focused on the safety and protection of airport users and employees (FAA, Airport security , 1972).

2.8.2.3.1. Risks associated with C.A.D goals and objectives

The general risks associated with the development of goals and objectives associated with an airport's project type (capital or maintenance) and size determination are (1 conflict of interest between ownership and other involved parties while determining initial project parameters (Zou et al, 2009) and (2 project type and scope misrepresentation due to poor planning and feasibility related studies (Caltrans, 2007).

2.8.3. Project financing - C.A.D funding

Airport finance determination is utilized by most commercial aviation facilities for their funds' acquisition planning processes. With an idea about the governing bodies involved with the funding process, their associated fund determination processes and the percentages of funding they issue to commercial airport projects, airport ownership is able to determine what additional percentage of funds has to be acquired from internal and private sources to meet the project's financial objectives (Horonjeff et al, 1994). In the United States, government, or public, funding occurs at three levels, federal, state and local, which are all controlled by the FAA. The federal funding is controlled by the Airport Improvement Program (AIP) which provides grants to public agencies, owners and entities for the planning and development of public use airports included in the National Plan of Integrated Airport Systems (NPIAS) and State Aviation System Plan (SASP) (WSDOT, 2012) .

The AIP is responsible for providing grants to cover 75% of eligible costs associated with large to medium sized commercial airport facilities and 90-95% of eligible costs for smaller airport facilities (AIP, 2012). It is a requirement that all commercial airports pushing for AIP funding must be included on the National Plan of Integrated Airport Systems (NPIAS), a plan

utilized by the FAA at a nationwide scale to ensure that all public aviation facilities meet the requirements and standards set by the FAA (Horonjeff et al, 1994). An overview of AIP requirements for commercial airport facility development can be seen in Table 2.8 while examples of projects eligible and ineligible for AIP funding can be seen in Table 2.9.

Military Airport Programs (MAP) is a subset of the AIP funding process that provides money to retrofit former military airfields into public use commercial facilities with associated aviation operations. The eligibility and project requirements for MAP funding are similar to the general AIP provision with the addition of building rehabilitations that may be required, such as additional surface parking lots, fuel farms, hangars, utility systems, access roads and cargo buildings (Alexander-Adams, 2012).

The Facility and Equipment (F&E) fund is provided federally by the FAA through the Air Traffic Organization (ATO) and is responsible for funding provisions associated with navigational aids and air traffic control facilities (i.e.) air traffic control towers (etc.) ,associated with commercial and general aviation airports (WSDOT, 2012). Funding for the AIP is disbursed as an individual grant or a block grant that is issued to the SASP by the AIP for further disbursement at the state level. Such grant disbursement is issued to commercial airport facilities based on airport size which is governed by factors such as yearly enplanement figures, landed cargo weight and a national priority rating system that reviews funding requests based on project urgency and application priority (WSDOT, 2012).

Table 2.8: AIP funding eligibility requirements for airports (AIP, 2012).

The Airport must be publically owned	Sufficient funds must be made available for the portion of the project not paid for by the Federal government
The Airport can be privately owned but designated by FAA as a reliever	The project must be completed without undue delay
Privately owned but have scheduling service and at least 2,500 annual enplanements.	Airport must be included in the current version of the NPIAS
Project sponsorship requirements must be met	The project must involve more than $25,000 in AIP funding
Airport must be reasonable consistent with the plans of planning agencies for the development of the area in which airport is located.	The project is depicted on a current airport layout plan approved by the FAA

Table 2.9: Examples of Airport projects that are eligible and ineligible for AIP funding (AIP, 2012).

Eligible Projects	Ineligible Projects
Runway construction/rehabilitation	Maintenance equipment and vehicles
Taxiway construction/rehabilitation	Office and office equipment
Apron construction/rehabilitation	Fuel farms*
Airfield lighting	Landscaping
Airfield signage	Artworks
Airfield drainage	Aircraft hangars*
Land acquisition	Industrial park development
Weather observation stations (AWOS)	Marketing plans
NAVAIDs such as REILs and PAPIs	Training
Planning studies	Improvements for commercial enterprises
Environmental studies	Maintenance or repairs of buildings
Safety area improvements	
Airport layout plans (ALPs)	
Access roads only located on airport property	
Removing, lowering, moving, marking, and lighting hazards	
Glycol Recovery Trucks/Glycol Vacuum Trucks**(11/29/2007)	
Examples of Eligible Versus Ineligible AIP Projects	

State level funding is acquired based on commercial airport needs that meet state government requirements. The state government usually issues a “finding” document to approve a facility for funding. For facilities that are federally funded, costs not approved by the federal government are shared equally with the state. Projects that are not federally funded are eligible to

receive an 80% state fund provision for airside and landside airport developments and 50% for some planning projects (WSDOT, 2012).

The Advanced Loan Acquisition Program (ALAP), a part of state funding, makes funds available in the form of loans to owners of public use airports for land acquisition purposes. Such a loan is provided to ensure that all land development requirements are met by airport owners before funding approval is issued by the federal or state government (WSDOT, 2012). The loan also caters to projects in the development phase, including activities such as feasibility studies, land surveys, airport layout plan updates, environmental impact studies and legal services associated with land acquisition (WSDOT, 2012). For project development purposes, loans can also be acquired. The loans are issued by the state government based on 80% of the project's eligible cost, and they must be repaid in full 5 years after the loans are issued. The project owner is required to provide proof for the availability of 20% of the project development funds up front to be considered for such a loan. Interest wise, such loans are annual in nature and accrue 4% of the unpaid balance for the loan amount (WSDOT, 2012).

Other sources of funding available to the airport owner include customer facility charges collected by operational commercial airport facilities. Such fees are usually levied in taxes paid directly or indirectly to the airport facility.

General obligation bonds and revenue bonds are also a form of liquid assets sold to private investors involved in commercial airport development. Usually a pledge of payment from airport revenues in savings and revenue generated from the accumulation of profits in an operating commercial facility is offered to such investors (Gu.L et al, 2009). Table 2.10, Table 2.11 and Figure 2.13 are a breakdown of commercial airport facility development financial

expenditure allocations for an approved airport development project as provided by the ACI-NA report on commercial airport capital development costs (Gu.L et al, 2009).

Table 2.10: Committed commercial airport funding sources (Gu.L et al, 2009).

Airport Category	Bonds	PFC	AIP Enti.	AIP Dis.	State	Local	Cash/ Retain	TSA	CFC	Other	Total[1]
Large Hub	32.5%	22.8%	4.2%	13.7%	5.1%	12.0%	4.8%	1.3%	3.5%	0.2%	100.0%
Medium Hub	31.5%	23.8%	12.3%	14.6%	1.1%	3.6%	8.3%	2.6%	2.1%	0.2%	100.0%
Small Hub	3.5%	11.7%	26.4%	33.1%	8.1%	7.4%	7.6%	1.4%	0.4%	0.4%	100.0%
Summary	30.0%	21.7%	6.8%	15.4%	4.2%	9.9%	5.6%	1.5%	3.2%	1.7%	100.0%

Table 2.11: Abbreviation explanations for Table 2.9 and Figure 2.13 (Gu.L et al, 2009).

PFC = All three major government funding sources	Local = Local government
AIP Ent = AIP entitlement	State = State Government
AIP disc = AIP discretionary	Bonds = General obligation or Revenue bonds
CFC = Customer facility charge	Cash retained = Existing airport revenue

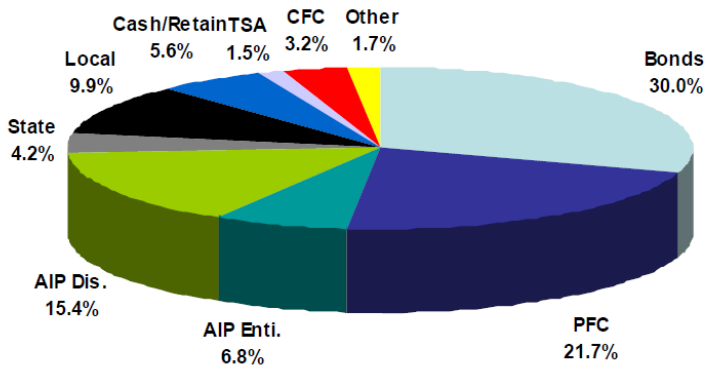


Figure 2.13: Pie chart showing committed commercial airport funding sources (Gu.L et al, 2009).

2.8.3.1. Risk associated with C.A.D funding and processes

The general risks associated with airport funding and its associated levels are (1 government intervention and bureaucracy in funding related processes (Zou et al, 2009), (2 project schedule affected by delays from numerous funding approval processes (Zou et al, 2009), (3 litigation issues associated with default payments on external funding options (WSDOT, 2012), (4 inadequate internal funding options (i.e., airport user fees, etc.) to cover airport facility development (Gu.L et al, 2009) and (5) debt accruement which cannot be effectively balanced by the project owner (WSDOT, 2012).

2.8.4. Phase two: Conceptual planning and feasibility studies - Project and Government associated planning procedures

Once funding alternatives have been reviewed, project development enters its planning phase which involves correlating the identified project objective phases with the policies and procedures provided by governing aviation agencies and the parties involved with project development (Horonjeff et al, 1994).

2.8.4.1. Project Inclusion in a five year airport plan (USA, C.A.D template)

Most commercial airport developments are required to be implemented with a five year airport improvement plan. The plan is utilized by the governing bodies to schedule individual airport projects that are eligible for federal and state assistance. The first two years of the system are utilized by government agencies to handle airport projects that have been formally petitioned, requiring airport owners who seek funding to apply for those funds 3-5 years before construction activities begin, depending on project complexity. The last three years are usually provided for airport projects that are tentative (not committed) in nature. As a program, the AIP is known to

suffer from fund fluctuations at the federal, state and local levels (WSDOT, 2012).Below in Table 2.12 is a step by step process in the way the five year airport program system works.

Table 2.12: Five year airport systems plan objectives (WSDOT, 2012).

How the five year airport program system works	
1) Reception of eligible airport development programs by Government agencies (FAA)	5) Formal petitions reviewed but not always guaranteed approval.
2) Prioritizing of airport projects utilizing a Federal and State ranking system based on needs, revenue resources, constraints and social, economic and environmental impacts.	6) Utilization of the SASP (State airport system plan) to push project into latter years of program.
3) Approval of highest priority programs.	7) Federal bureau responsible for running the program aids airport owner in petition process to ensure it is as complete and successful as it can be.
4) Possible delay of legitimate development based on a program's competitive nature.	

2.8.4.2. Five year airport program system process

The public hearing process is a state requirement for airport owners. At this forum, owners present conceptual/feasible ideas for airport development to the public and solicit input (WSDOT, 2012). Once a project has been presented to local community members for input purposes, a petition resolution is passed by the governing aviation bodies at the state level to petition the state department of transportation (DOT) for federal or state funding. The petition resolution requires submitting a petition package with legal documents to the state bureau for project approval and funding. It is important to note that petition package submission does not give the owner the right to begin airport development proceedings (WSDOT, 2012).Components of a petition package are seen in Table 2.13 below.

Table 2.13: Components of a petition package (WSDOT, 2012).

Components of a petition package	
1) Outline of pre-petition hearing proceedings	4) The petition resolution adopted by the governing bodies
2) Sketch of proposed work & project development	5) Copies of the agency agreement between the DOT and airport owner
3) A copy of the published legal notice of hearing and affidavit of publication	6) A stated need for the project

Once the petition package is submitted, the bureau responsible for aviation activities within the given state responds with an Eligibility Statement (ES). This statement reviews the work items identified in the petition package and determines whether the government will meet the needs of each given item. In situations where master plans and project feasibility studies are absent, the airport owner can submit a petition to request funding assistance for a plan of study to warrant project justification. Eligibility statement documentation includes the airport's inclusion in the SASP and NPIAS system of airports, a comprehensive master plan, feasibility studies, and a statement of need from the airport owner (WSDOT, 2012).

The State DOT produces a legal document, called the agency agreement, to be signed by the airport owner. The agreement gives the secretary in charge of State DOT activities the designated power to oversee all arrangements (financial, contractual and development) involved with the airport project in question. The duties of the DOT secretary, assisted by the airport owner, include 1) hiring consultants for differing project phases; 2) land acquisition; 3) application for federal aid, advertising for bids, and 4) awarding and administering construction contracts and a project's financial accounting (WSDOT, 2012).

The DOT secretary and the airport owner are then faced with the task of consultant selection. The consultant positions required for the commercial airport development are advertised in listed portions of the local media, and the selection process is based on interviews

conducted by consultant selection committee members who review consultants based on qualifications, experience and the expected workload of the development project (WSDOT, 2012).

Prior to design and development of the project, administrative rulings to govern the way the facility is developed and operated are provided through state laws. These laws ensure that the public is protected and that publically funded investments (i.e.) the airport project (etc.) are maintained in a safe, serviceable and financially sound way that provides value to public-infrastructure development (WSDOT, 2012).

2.8.4.3. Risk associated with project and government associated planning procedures

There were two general risks associated with project and government associated planning procedures: 1) project variation leading to associated disputes between project parties and ownership (Caltrans, 2007) and 2) planning procedures affected by government approval and associated processes (Zou et al, 2009).

2.8.5. Conceptual planning and feasibility studies - Project specific

Forecasting for airport development planning begins soon after the airport development planning phase and involves a calculated prediction of activity levels associated with the future of an existing or proposed airport development. It is from such an understanding that the airport project's planner is able to assess future airport performance from existing and improved facilities while recommending development programs consistent with the airport owner's objectives and policies. The planner estimates costs and associated revenue for such projects while supporting future capital improvement programs (Horonjeff et al, 1994). Consultants hired by the airport owner and DOT secretary are responsible for this activity phase (WSDOT, 2012).

Planning studies are utilized once the project is determined to be in accordance with federal and state system plans. Such studies refine the project scope to meet airport needs and to ensure that airport funding is utilized accordingly. Planning studies occur in three forms:1) airport layout plans, 2) feasibility studies and 3) master plans (Horonjeff et al, 1994). Figure 2.14 depicts that planning process utilized by most commercial airport management in the United states for long and short term airport facility project development .

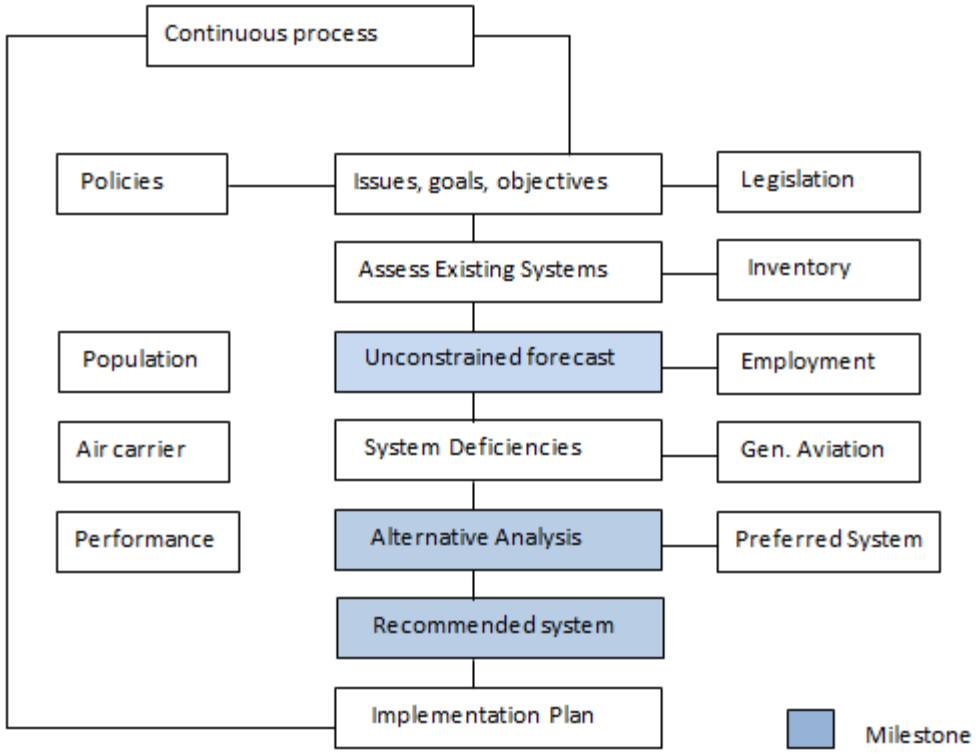


Figure 2.14: Airport system planning process: FAA (Horonjeff et al, 1994).

The FAA provides a step by step system to guide commercial airport planning. The first step in the guide to commercial airport planning is the development of an airport strategic business plan which is a holistic representation of present and future plans associated with an

airport's development. It is a clear guide to where a developing facility should and could be at differing points in its existence (Horonjeff et al, 1994).

It is important to note that the composite parts of the strategic business plan were addressed in previous sections of this document. Table 2.14 shows some requirements of a strategic business plan for a commercial airport development project.

Table 2.14: Component parts of the strategic business plan (WSDOT, 2012).

1) Mission and Vision Statements	5)Future development requirements of airport facility
2) Development goals	6)Funding strategies to aid in airport development
3) Financial goals	7)Implementation of strategic plan and recommendations for adjustment and changes
4) Measurement criteria for proposed present and future development	8)Alternative approaches to face possible challenges that may affect plan

Being included on national and state development plans (NPIAS and SASP) through application and approval by the governing aviation bureau (FAA) and its constituent parts provides the airport owner with the eligibility to apply for funding (Horonjeff et al, 1994). Once approved and included on the required aviation system plans, airport site investigations begin for new airport facilities. Such a practice is done to begin the process of fund acquisition (WSDOT, 2012).Table 2.15 shows the required process for a commercial airport site investigation.

Table 2.15: Content required for Airport site investigations (WSDOT, 2012).

Content required from Airport site investigations	
1) Site approval and related endorsements	6)Evaluation of site recommendations
2) Site selection report requirements	7)Public involvement
3) Aeronautical requirements	8)Coordination
4) Environmental requirements	9)Approval of airport site
5) Financial evaluation	10) Detailed site planning

Next, feasibility studies are utilized to define needs, identify and evaluate alternatives, and recommend the best solution associated with the commercial airport development in question (WSDOT, 2012). These feasibility studies utilize the airport's project plan which is a detailed plan about the proposed development being considered by an airport in the immediate future. Usually, such project plans include new runways, modification to existing runways, taxiway and exit provisions, the addition of gates, terminal building and facilities renovation, and the modification of ground facilities (Horonjeff et al, 1994).

Preliminary cost estimates, land requirements and project overviews are also included in airport feasibility studies with consultant selection for project planning done by the airport owner and DOT secretary (WSDOT, 2012). Master planning is then utilized to identify airport development both in the short term and long term. Such plans represent a development concept graphically, containing data and rationale upon which airport is being developed while supporting the modernization of an existing airport and the creation of new airports. As a guide, master plans also analyze airport growth and determine additional facilities needed by the commercial airport to accommodate future growth over a 20 year period (Horonjeff et al, 1994). Table 2.16 shows a review of the objectives required of a commercial airport master plan in the USA.

Table 2.16: Objectives of a commercial airport master plan (Horonjeff et al, 1994).

Objectives of an Airport Master Plan	
1) Airport physical facility development	5)Technical , economic and financial feasibility of airport development through investigation of alternative concepts
2) Development of land on an adjacent to the airport	6)Schedule and phasing priorities for improvement proposed to airport plan
3) Environment effects of airport construction / operations	7)Development of financial plans to support airport plan implementation schedule
4) Determination of airport access requirements	8) Development of a planning process to monitor airport and adjust master plan recommendations as situation warrants.

Airport layout plans (ALPs) are utilized in tandem with master plans to depict existing facilities and planned development for an airport. These plans are the prerequisite for the FAA to issue a grant for airport development. As a requirement of the FAA, ALP's need to be kept up to date at all times (Horonjeff et al, 1994). It is important to note that ALP costs, environmental studies and ALP updates are eligible for provision under planning grants provided by the AIP while ALP checklists provided by the FAA must be followed by the airport owner to ensure that the ALP is adequately prepared and updated (WSDOT, 2012).

Environmental issue determination requires the identification of possible negative impacts associated with project development on the area where project is located. To carry out the identification of environmental issues, an environmental assessment is utilized by consultants hired by airport owners and government bureau representatives. Environmental assessments involves coordinating the proposed project development with existing and planned patterns of development in a community by considering the effects that such development and its subsequent operations will have on people, ecological systems, water resources, air quality and other areas of community concern (Horonjeff et al, 1994). The intensity of an environmental impact study is based on project complexity, project controversy and project scale, with the

average time of assessment taking anywhere from a couple of months to years (Horonjeff et al, 1994). Table 2.17 provides examples of possible environmental studies that are carried out by commercial airports in the USA.

Table 2.17: Examples of Environmental Assessment Studies (Horonjeff et al, 1994).

Environmental Assessment studies (examples)	
1) Pollution factor studies (i.e.) Air and water quality.	3)Ecological studies (i.e.) Wetland and coastal zones
2) Social factor studies (i.e.) land development, displacement & relocation	4) Engineering and economic factors (i.e.) Flood hazards /cost of construction)

Impact statements come soon after assessment has been done, with State government agencies determining whether a project can commence based on findings from the environmental assessment. Environmental impact statements (EIS) are required by projects that pose a significant, negative impact to the environment where they reside. Such a project includes new airport developments, user carrier runways and projects with significant noise impact. An EIS requires a year for processing in addition to the EA approval for most project developments (WSDOT, 2012).

Agricultural impact statements (AIS) are usually required for projects that acquire more than 5 acres of farmland for the proposed development. The state aviation bureau partners with the departments governing agriculture, trade and consumer protection, providing departments of governing agriculture with information regarding farmland being utilized for development. The department, after careful consideration, issues an AIS allowing such development to occur. The average time to prepare the AIS differs from state to state (WSDOT, 2012). A hazardous material site assessment is required before the title to any property can be acquired. Such an assessment is done to determine contaminant locations and levels at the site. Early detection of

contaminants at the site enables the associated government agencies and airport owner to have possible site avoidance and remediation if required (Horonjeff et al, 1994).

Environmental public hearings are required for all airport projects needing EA or EIS permits. These hearings are a forum for the presentation of a project and its effects on the economic, social and environmental fabric of a community. Local residents, where a proposed development is to be built, can voice their opinions to representatives of the government agencies presiding over project development and the airport owner, receiving responsive answers as needed (WSDOT, 2012).

2.8.6. Phase 3: Design and Engineering - Design phase /plans and specifications

When the permits and approvals needed to embark on project development have been acquired, the airport owner hires consultants to prepare development plans and specifications. During the design process, frequent meetings are held among the designer, airport owner and government representatives. Such meetings act as a platform for the designer to share insight about project phase design, the development progress and the projected completion dates for given phases of the airport's design. The airport owner and government representatives can voice issues and concerns that they may have with the design work being developed during this forum. It is the design team's prerogative to be well briefed on the airport project on which it embarks and, as such, to determine what design approach to take towards developing a specific project (WSDOT, 2012).

The key word to remember when embarking on design is the need for development (Horonjeff et al, 1994). During the course of design development, airport design standards are utilized by the design team to keep the project within the standards and stipulations set by the

FAA and International Civil Aviation Organization (ICAO). For development in the USA, FAA design standards are followed. These design standards are published in advisory circulars and reviewed as the need arises (Horonjeff et al, 1994). At the international level, the ICAO provides guidance to airport facilities that have ICAO membership. Design stipulations for the ICAO are published in Annex 14 of the membership convention (Horonjeff et al, 1994). It is recommended by WSDOT (2012) that final plans and specifications be submitted to the governing bureau 60 days prior to bid opening dates. An airport owner's involvement in this phase is dependent on the project delivery method and contract stipulations utilized for the project (Rakich, 2011).Table 2.18 points out the different parts of the commercial airport that are usually developed or maintained as seen fit by airport management.

Table 2.18: Listing of airport parts available for development (Horonjeff et al, 1994).

Airport component parts available for design	
Landside	***Airport ground System*** 1) Circulation systems related to vehicle traffic flow within and outside airport facility (design within this category should include local and regional transport authorities) 2) Vehicular circulation parking and circulation systems.
Terminal building	***Terminal building*** 1) **Access interface**: Curb frontage (vehicular access to and from the terminal building), automobile parking facilities, vehicular road ways, service roadways and fire lanes. 2)**The processing system** :Air ticket counters , terminal service space ,inbound baggage space ,lobby ,public circulation space , outbound baggage space , Airport Administration and service area , Federal inspection , intraline and interline baggage space. 3) **The flight interface** : The concourse , the departure lounge ,passenger boarding devices , security facilities , the terminal service area
Airside	1) Taxi systems and exit way systems 2) Runway and runway configurations 3) Holding bays / holding pads / holding aprons / hangars 4) Airport lighting, marking and signage.
Airport System	1) Enroute airspace 2) Terminal airspace 3) Airfield surface systems

An airport user's conference is held during the early phases of planning and development as an FAA requirement for airport developments that are state related; all parties involved with the airport development are in attendance (WSDOT, 2012).The airport user conference familiarizes prospective and present airport tenants, air carriers, the airport manager and other interested parties with the project's scope, possible inconveniences caused by development

related activities and methods to prohibit project interference with existent airport operations (WSDOT, 2012).

2.8.7. Phase 4: Procurement and Construction

Land requirements are acquisition practices conducted by government representatives and the airport owner. Land requirement and acquisition as a process reviews the land needs for the airport project through land surveys. These surveys determine and measure land interest in relation to project development. The information acquired from the survey is used to create a project map showing proposed land acquisition areas. This land map is utilized for appraisal acquisition with land development practices (WSDOT, 2012).

Appraisals are utilized by the government representatives for the airport project and the airport owner to acquire land for project development. The appraisal is done by an independent review appraiser who is responsible for preparing appraisal and reviewing the appraisal process being utilized. The appraisal establishes the estimated purchasing prices for individual parcels of land or easements (WSDOT, 2012). With the estimated land prices determined, negotiation practices are utilized to purchase land where development will begin. Written offers, usually financial purchase prices, are presented to property owners at fair market value for the property to be purchased. The property owner usually has a given time to respond to the offer and prepare an appraisal of his own for the bureau and airport owner to review. The two appraisals created by the involved parties are then utilized to create a final settlement (cost agreement) for the land in question. If unhappy with the settlement, both parties can appeal in court after the negotiation period is closed (WSDOT, 2012). It is likely that the property owner who has been bought out will require relocation assistance. This entitlement is governed by policies, requirements and

claims as determined by U.S. federal and state laws. Such entitlements include relocation services, cost related payments for relocation related expenses, settlement payment for land acquired and the cost of replacement property (WSDOT, 2012). With the land acquired, airport construction and related activities can begin. The first step in the construction process is opening the project to bids from the general public. Opening project bids to the general public is done through general advertisements in the local media (Dagostino et al, 2010).Table 2.19 shows the required steps in the bidding process for most development projects including commercial airports .

Table 2.19: General steps in the bidding process (Dagostino et al, 2010).

General steps in the bidding process	
1) Invitation to bid	5) Specifications
2) Instruction to bidders	6) Alternates
3) Form of owner / contractor agreement	7) Addenda
4) Bid general conditions	8) Errors in specification

The bidding process is usually governed by the project delivery method utilized by the airport owner and the bureau representative involved with the bids presented in the form of project delivery systems (Touran, 2009).

The bidding process is separate from the contractual arrangement for financial compensation to be determined among the airport ownership, government bureau and contractor (Touran, 2009). There are three major types of project delivery systems utilized in airport development. The first one, design-bid-build, requires that the airport owner and bureau representative employ a design team to produce development drawings for the proposed project and to submit single or multiple packages of construction documents for bidding purposes. These documents are then utilized for competitive bidding. Once documents are submitted, the design

team's influence on the construction phase of project development is determined by the owner. These duties revolve around construction document administration, managing project changes and ensuring that general project development performance is in line with contract documents (Touran, 2009).Table 2.20 shows the characteristics of the DBB project development process that affects commercial airport management.

Table 2.20: DBB characteristics that affect commercial airport management (Touran, 2009).

DBB Characteristics that affect Airport owner	
1) Contractual separation between the designer and contractor. The owner must be able to ensure this and monitor accordingly	5) Procurement for such a method begins with construction
2) Ownership involvement and decisions are required in this method of project delivery. The owner becomes mediator between design and contractual parties involved.	6) Specifications must be adhered to by all parties involved in the project
3) Owner is responsible to the builder for design errors (*review Spearine doctrine*)	7) Method encourages low bid costs and numerous qualified bidders which encourages a high level of competition
4) Owner controls design and monitors construction quality compliance.	8) There is a sequential order of events in the development process. However fast tracking can be utilized at the involved parties discretion

The construction manager at risk method of project delivery provides the construction manager with the ability to oversee project development. The CMR representative engages in the project development process early (usually during the design phase of project development) and is hired at the same time the design team members are hired or prior to their involvement, dependent on the nature of the project at hand. Airport ownership has limited risk utilizing this method because the risk onus is borne by the CMR and project related construction cost (Touran, 2009). Table 2.21 shows the characteristics of the CMR project development process that affects commercial airport management.

Table 2.21: CMR characteristics that affect commercial airport management (Touran, 2009).

CMR Characteristics that affect the Airport owner	
1) Owner remains responsible to the builder for design errors	3) Daily involvement, resource application and control over construction effort are reduced for owner.
2) Owner retains control of design quality and direction	4) The CMR contractor is responsible for each subcontractor for coordination, cost and schedule.

The design build method utilizes a single consultant group for project design and construction purposes. Design consultants function as subcontractors to the DB party controller. Airport ownership bears limited risk with this delivery approach and must learn to relinquish control in design areas where changes and preferences could be imposed. However, design-related preferences can be provided by the airport owner with performance specifications when the contract is awarded (Touran, 2009). Airport ownership utilizing this method of project delivery should purchase special insurance that ensures that risks, such as design professional liability for error and omission, are transferred to the DB party. Table 2.22 shows the characteristics of the DB project development process that affects commercial airport management.

Table 2.22: DB characteristics that affect commercial airport management (Touran, 2009).

DB Characteristics that affect the Airport owner	
1) Specification for project are performance based rather than prescriptive	4) Limited competition for such contracts due to high bid cost
2) Minimal daily owner involvement, resources and decisions are required as compared to the DBB & CMR.	5) GMP (Guaranteed maximum price) needs to bet by airport owner and government representatives with room for adjustments (Progressive GMP) .This must be determined by the end of development design phase.
3) Transfer of responsibility and most risk from the owner to the DB party for project entirety	

Once bids are in and the project delivery method has been determined, the FAA issues grant offers for project development based on general bid figures, detailed cost estimates for the planned project and appraisal costs for the land purchase. The government aviation bureau, working with the airport owner, accepts the grant offer issued by the FAA (WSDOT, 2012).

In situations where development costs exceed grant offers, the aviation bureau, working in tandem with the airport owner, requests a grant amendment. The FAA amends grants based on completed project work and the project's financial closing. Such grant amendments puts the airport owner in a position to rely on state and local government funds to complete a project that exceeds grant offers. Once a project is complete, the FAA will reimburse parties that footed development costs that exceeded the grant offer amount if grant amendment is approved (WSDOT, 2012).

Prior to construction, the government aviation bureau, working with the airport owner, reviews and approves the performance payment bond and contract documents that were signed by the contractors and consultants who won bids and were offered contracts. At this stage, project funding has been secured, and a notice to proceed is issued (WSDOT, 2012). In the pre-

construction process, construction and engineering consultants are hired to carry out stipulated activities (resident engineering, construction management and testing services).

A pre-construction conference, with the airport owner, aviation bureau representatives and hired consultants, is held and utilized as a platform for engineering consultants and contractor to discuss the following items: 1) how current airport operations, security and safety practices will be implemented during the course of construction; 2) federal policies and requirements to follow during the construction process and 3) the coordination of construction planning and work schedules (i.e.) carrying out construction activities during the airport facility's low productivity period if the facility is already in operation (etc.). The meeting also provides a forum for questions and suggestions from all parties involved with the airport development process (WSDOT, 2012).

During the construction phase, the construction engineers, architects and contractors follow stipulated duties issued in contracts and project delivery system documents. As needed, these professionals act as the liaisons between the airport owner and the parties working on the site. Government bureaus also stop for periodic inspections during the project to ensure that the services provided by parties involved with project development are adequately meeting project standards, objectives and goals (WSDOT, 2012).

2.8.8. Risk associated with C.A.D - Capital development processes

For activities associated with capital development, 16 general risks that would be of issue to airport ownership were identified. They were 1) local community opposition to project development (Zou et al, 2009), 2) the occurrence of disputes between airport ownership and aviation's governing bodies about policy requirements for development (WSDOT, 2012), 3)

litigation issues arising from negligence of safety related processes on site during construction phases of development (Donell, 2012), 4) permitting related processes (i.e.) environmental impact statement approval pre development (etc.) that slow down the project development process (WSDOT, 2012), 5) project schedule affected by review time for project development in aviation bureau review agencies (Zou et al, 2009), 6) hired consultants unable to meet project requirements and standards (Caltrans, 2007), 7) cyber threat related issues (Tummala, 1999), 8) monitoring equipment and communication during capital development (Tummala, 1999), 9) disaster preparedness (Tummala, 1999), 10) security threat for the existing facility posed by airport development (Donell, 2012), 11) project design constructability issues affecting the project's cost (Touran, 2009), 12) utilization of unfavorable project delivery methods that negatively affect project finances (Touran, 2009), 13) land development issues (eminent domain proceedings or sacred burial grounds) that stall project development (Caltrans, 2007), 14) contract related disputes (Touran, 2009), 15) the negative effects of "Acts of God" on project development (Tummala, 1999) and 16) the negative effect of construction activities on current airport operations (Touran, 2009).

2.8.9. Phase 5: Start up and occupancy - Acceptance of facility

Final inspections are done by the airport owner, bureau representatives and head consultants for final acceptance of a project and final payment purposes. In the USA, faulty workmanship or material issues noticed within a one year period of project completion are the responsibility of the contractor in charge of project construction and development (WSDOT, 2012). The bureau with jurisdiction where the project lies determines the project's final completion.

The bureau is faced with maintaining a project's financial records and disbursing funds as required during the project. Other completion duties for the bureau include 1) requisition for final contract billings from the forms involved in budget development; 2) financial settlements with the FAA, airport owner and state according to participant percentage; 3) financial settlement for the airport owner after he supplies a final financial statement and 4) closing the financial record for the department's financial system (WSDOT, 2012). An airport owner's responsibility post completion of the project is subject to the operation and maintenance of the airport facility. Financial aid directed towards maintenance activities are provided by the airport owner. However, in the USA, if work is warrantied for one year and if maintenance is needed within that duration, the airport owner has the right to report maintenance issue to the state aviation bureau where project resides and to solicit government aid (WSDOT, 2012).

2.9. Phase 6: Operation and maintenance - Fulfillment of useful life

The FAA and associated aviation bureau agencies within state jurisdictions issue compliance policies for the airport ownership during the facility's operation phase to ensure that facilities are adequately maintained for peak performance. The WSDOT manual (Section 00-00.01) presents a rundown of the guidelines for maintaining commercial airports as required by the FAA (WSDOT, Airport Maintenance Manual, 2009).

Standard procedure requires that airport ownership review annual airport activities based on seasonality. For maintenance activities that occur on an ongoing basis, the process to review and update is required for operations that keep the airport functional (WSDOT, Airport Maintenance Manual, 2009).A listing of standard procedures is seen in Table 2.23 below.

Table 2.23: Ongoing airport review and update activities (WSDOT, Airport Maintenance Manual, 2009).

Standard procedures (Airport maintenance)	
Review and update activities (general)	1) Airport website and facilities directory 2) Aviation operational handbook 3) Airport security plans 4) Property management documents (airport leases ,special use agreements , easements) 5) Airport caretaker programs 6) Contractor and supply vendor agreements 7) Maintenance plans and supervisors
Review and update activities (supply controls)	8) Acquiring maintenance materials & organizing for the following year (scope / budget / order) 9) Ordering materials required for airport operations for following year
Review and update activities (Administration)	10) Establishing maintenance program for upcoming year 11) Identification of capital projects for next year.
Review and update activities (Operations)	12) Conduct general maintenance 13) Maintenance activities on aviation equipment 14) Landscape removal activities

Seasonal review and update activities are required in regions that are prone to seasonal change. Seasonal review activities require the performance of maintenance activities at specific periods of the year when they can be done (WSDOT, Airport Maintenance Manual, 2009).For US commercial airports, examples of seasonal maintenance activities can be seen in Table 2.24.

Table 2.24: Seasonal Airport review and update activities (WSDOT, Airport Maintenance Manual, 2009).

Seasonal activities - Standard procedure (Airport maintenance)	
Spring season (March / April / May)	1) Airfield inspection s 2) Airport caretaker orientation seminars 3) Inspections and repair of applicable irrigation and potable water systems 4) Landscape related operations 5) Airport scheduled maintenance & construction activities (should be planned in the winter months)
Summer season (June / July / August)	6) Landscape related activities 7) Airfield inspections 8) Scheduled maintenance activities 9) Scheduled construction activities
Fall season (September / October / November)	10) Planning of landscape related activities 11) If airport is seasonally opened a courtesy call to Aviation bureau (FAA) determining closing date should be issued. 12) Identification of capital improvement and planning projects for inclusion in AIP program for the following year.

For airports that open and close seasonally, determining the activities of importance for airport operations is a requirement. A state bureau representative is assigned to inspect airport facilities prior to their opening to ensure that all maintenance requirements are met as well as prior to airport closure to determine the necessary maintenance activities that are required for the following year. The period in which inspection occurs prior to airport operations and closure is determined by the bureau in charge of the jurisdiction where the airport resides (WSDOT, Airport Maintenance Manual, 2009). Regular inspections, at least three times a year, for airports in full operation during the year are usually conducted by the bureau in control of the jurisdiction where the airport lies. For all inspection types, a maintenance inspection form must be completed by the inspector, and a copy is returned to the airport owner for review and filing (WSDOT, Airport Maintenance Manual, 2009).A listing of maintenance inspections is seen in Table 2.25.

Table 2.25: Airport maintenance inspection requirements (WSDOT, Airport Maintenance Manual, 2009).

Maintenance inspection requirements - (Seasonal airports)	
Aviation facilities *Inspection checks that review -*	1) Runways / Aircraft landing areas / light and markers around runway & taxiway / Aircraft fueling area / Airport signage /structures , facilities &equipment / Aircraft loading area /Fences , gates & locks /Camera's/Utilities.
Recreational facilities *Inspection checks that review -*	2) Sanitary facilities / Trash disposal facilities / Ground vehicle parking area / Non - aviation related signage
Maintenance facilities *Inspection checks that review -*	3) Irrigation systems /Airport access roads / onsite equipment /equipment storage buildings

Airport ownership is given guidelines from the bureau that must be followed during the course of airport operations, and these guidelines fall in line with all possible maintenance activities that can be done at an airport facility. These maintenance guidelines govern airfield maintenance and review conditions, standards, policies and procedures associated with the airfield, including runways, taxiways and exits (WSDOT, Airport Maintenance Manual, 2009).An example of runway maintenance items that have set maintenance guidelines are seen in Table 2.26.

Table 2.26: Examples of runway items with set maintenance guidelines (WSDOT, Airport Maintenance Manual, 2009).

Runway Maintenance items that have set guidelines	
1) Runway maintenance procedures based on runway material type (gravel / turfed / paved)	4)Airport signage
2) Runway pavement marking	5) Aircraft parking locations
3) Runway lighting & lights	6) Segmented circle and wind cone maintenance

Individuals in charge of airport maintenance guides review conditions, standards, policies and procedures associated with airport features, such as airport signage, access road maintenance, and fencing and gate maintenance (WSDOT, Airport Maintenance Manual, 2009).

Vegetative control guidelines govern the maintenance of all vegetation related exposure at the airport facility. Examples of such guidelines are seen in Table 2.27.

Table 2.27: Examples of items that adhere to vegetation control maintenance guidelines (WSDOT, 2009).

Vegetative maintenance practices that have set guidelines	
Herbicide use	
General moving and trimming around the following :	1) Runway , runway edge , runway lights , NAVAID ,helipads , taxiways
General vegetation control around the following :	2) Runway safety areas, runway approach areas, aircraft parking areas, airport access drives, automobile parking area, building facilities.

The obstruction identification and removal process is the last practice discussed in the maintenance review section. The process requires the active scanning of the airport facility and beyond (review FAA - part 77), especially the runway (Horonjeff et al, 1994). The obstruction identification and removal process identifies objects that could hinder airside operations associated with aircrafts and vehicles, and removes them accordingly. The process, in itself, is more capital development in nature than maintenance and requires that airport ownership review the capital-development process to handle such issues (WSDOT, 2012).

2.9.1. Risk associated with C.A.D - Maintenance activities

There were seven general risks identified for the maintenance related activities. The risks are as follows: 1) the aviation bureau's inspection procedures affect the project's maintenance schedule and associated objectives (WSDOT, Airport Maintenance Manual, 2009), 2) the possibility of cyber threats (Tummala, 1999), 3) unidentified maintenance issues affecting the current maintenance process (WSDOT, Airport Maintenance Manual, 2009), 4) fund provision by aviation bureau limits scope of maintenance project (WSDOT, 2012), 5) negative effects of maintenance activities on airport operations (Touran, 2009) , 6) monitoring equipment and

communication during maintenance activities (Tummala, 1999) and 7) disaster preparedness issues (Tummala, 1999) .

From the risks outlined in the literature review for differing phases associated with commercial airport, capital and maintenance project development and the utilization of the Delphi method for data collection, a survey questionnaire was developed, which is described in the subsequent chapter. This survey collected expert opinion that can be used to validate and rank the risks presented in this Literature review.

CHAPTER 3. RESEARCH METHODOLOGY

3.1. Introduction

Utilizing Figure 2.4 as a process for risk management in this thesis, steps 5 and 6 in the formal risk-management plan (review Figure 2.4 in Section 2.4) which covers the risk identification and assessment process are continued in this chapter (Burtonshaw-Gunn, 2009).

A total of 32 major risks were identified for the Literature review in Chapter 2 through processes discussed in Section 2.6.1. The validity of such risks and their associated assessment should be determined in order to ensure that they are successfully mitigated and controlled.

The Delphi method reviews the survey and interview method of risk identification and assessment, requiring the review of listed risks by professionals in the area of study where risk is being assessed (KFPUM, 2012). The responses solicited from the surveys and interviews provide validity to the already listed risk and determine a ranking associated with the severity of the risks for the associated project objectives (Zou et al, 2009)

3.2. Delphi Method - Survey production

Survey production, as seen in Figure 3.1 was broken down into four different sections. Section 1 presented survey participants with a general description of the data being presented, the analysis process of the data after survey completion and the goals expected of the research study linked to the survey.

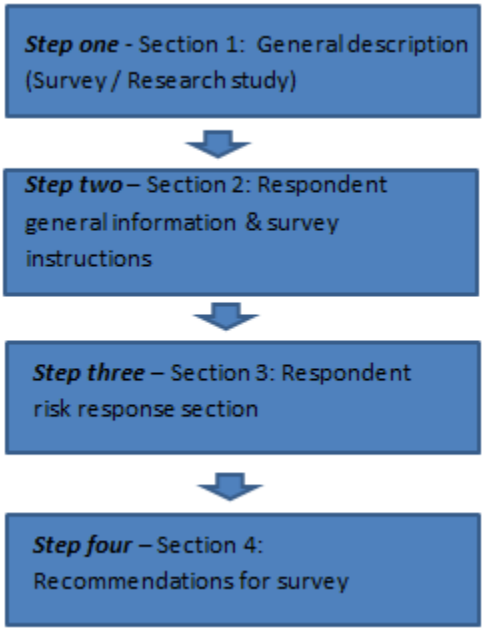


Figure 3.1: Survey production

Section 2 required respondents to provide general information about themselves and the commercial airport they represented. Size for the airports where representatives were contacted to fill out the survey was predetermined prior to survey dissemination because the respondents were mostly in the USA. This information was acquired from FAA data sources (FAA, Airport Categories, 2012).Once this information was provided, a step by step basis to fill out the survey was given to respondents. The step by step approach to filling out the survey ensured that respondents understood survey requirements and avoided issues that would arise from incomplete or unclear responses on returned surveys (Zou et al, 2009).

Section 3 of the survey provided respondents with a total of 32 major risks that affect airport ownership at the different development phases associated with commercial-airport capital and maintenance projects. Respondents were asked to review and to indicate the likelihood of risk occurrence as well as the airport owner's level of involvement with risk based on a scale

from A-E. Within the scale, A = near certainty, B = highly likely, C = likely, D = unlikely and E = remote. Respondents were also asked to review and indicate risk's impact on the phase of project development where they were based on a scale of A = very high, B= high, C = medium, D = low and E = very low.

Risks provided for this survey were classified according to the project objectives they would affect utilizing the DOE risk identification classification provided in Section 2.7 of the thesis (Molenaar et al, 2010). However, respondents were provided with a listing of project objectives (cost, quality, environment, safety and time) and asked to complete the corresponding section provided, with the project objectives they felt risk affected in relation to airport ownership activities associated with the project development phases (Zou et al, 2009). The risks provided were sourced from Caltrans (2007), WSDOT (2012), Gabel (2010), Tummala (1999), FAA (2012), Touran (2009), (Gu.L et al, 2009) and (Zou et al, 2009).

Section 4 presented respondents with an avenue to provide possible recommendations and feedback about the survey they completed. That way, future surveys associated with risk ranking at commercial airport facilities could be improved based on their feedback. In addition, financial information regarding capital and maintenance projects that survey respondents had started in the past and with which they were currently involved was solicited. This information will be used for future phases of the formal risk management plan to assess the impact of risk values (negative or positive) on a range of existing commercial airport project costs.

The 32 risks provided in this section were put in 5 given phases. These phases followed the chronological sequencing in which events associated with airport-capital development and maintenance occurs. The phases were sourced from WSDOT (2012), FAA (2012), Horonjeff et

al (1994) and Hendrickson (1998). A listing of these risks as well as their associated categories and phases can be seen in the Appendix E.

Of the 32 risks listed, it was determined that airport ownership and the associated stakeholders bore 18 directly while airport owners in tandem with consultants hired for the project's maintenance or development bore 14.

Prior to distributing the questionnaire, a pilot study was conducted to determine the survey's validity, the intelligence behind the risk list issued for ranking purposes and the survey's clarity. Two members of academia at North Dakota State University and a field engineer with prior experience in capital commercial airport development were involved in this process.

3.2.1. Sample size determination

According to the FAA, there are a total of 387 primary airports and 124 non-primary airports in the USA (FAA, Primary Airports, 2012). Within the primary airport categorization, there are 4 distinct categories (large hubs, medium hubs, small hubs and non-hubs), and for the non-primary airport hub, there are two categories (non-primary and reliever).Utilizing sample-size criteria and corresponding factors (confidence level, degree of variability and level of precision) as well as a simplified formula for proportions utilized by Yamane, the number of respondents required from the available population sizes associated with U.S. commercial airports was determined (Glen.D, 1992).

$$n = \frac{N}{1 + N(e)^2} \qquad \text{(Eq 3.1)}$$

N = Available population size, $(e)^2$ = level of precision and n = sample size determination

The available population sizes (N) for U.S. commercial airports were based on FAA airport type listings that focused on hub type (FAA, Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports, 2012). The level of precision value used (5%) was the range in which most true value populations (respondents) fell (Glen.D, 1992). Utilizing the formula for proportions in Equation 3.1, the values given in Table 3.1 were determined for sample-size responses from the different U.S. commercial airport types and sizes.

Table 3.1: Sample size survey distribution for U.S. commercial airports.

Commercial airport type	Number in the United states (Population size available) = N	(e) 2 Level of precision	n = sample size determination	Number of samples actually sent
Primary - Large Hub	29	0.05	17	20
Primary – Medium Hub	20	0.05	19	20
Primary – Small hub	21	0.05	21	21
Primary – Non Hub	21	0.05	35	21
Non primary – Non Hub	18	0.05	30	18
Total			122	100

Reviewing the above mentioned sample size information, it was important to note that response variations from airport respondents affected the proposed sample size determination number required. Statistical distribution only required a sample size (n) of 30 surveys from a large data response set to be utilized as a lower bound for large-sample inference about the mean of a quantifiable variable (Agresti et al , 2012). Therefore, it was justifiable to obtain survey responses that fell lower than the expected sample size requirement of 122, or the actual 100 samples proposed for collection.

3.2.2. Survey dissemination

Once the pilot study was completed and final adjustments were made, the survey was distributed to 100 commercial, hub airports in the USA.

With more of an emphasis placed on the Midwestern region of the USA, more specifically North Dakota, the correspondence success rate for the survey was based, primarily, on the response rates for the 6 major primary-hub airports in North Dakota and then a review of other U.S. airport responses. Table 3.2 shows survey three parameters.

Table 3.2: Survey three parameters

Survey three : Parameters	
Survey Size : pages	9
Number of risks documented	32
Survey dispensed	Yes
Email number sent (1st try)	100
Email number sent (2nd try)	100
Email number sent (3rd try)	105
Phone call number	100
Phone call number (2nd try)	67
Phone call number (3rd try)	71

Survey related dissemination was done from February 20, 2013, to April 12, 2013. It is important to note, however, that survey three was not the first form of the survey produced. Prior to this survey, two other versions were produced.

The first of the three was a trial run survey produced to determine the type of risks that would be applicable for the survey respondents who completed the survey. The survey's parameters can be seen in Table 3.3.

Table 3.3: Survey one parameters

Survey one : Parameters	
Survey size : pages	15
Number of risks documented	164
Survey dispensed	No
Survey revised	Yes

Due to complexity issues, this test run survey was further improved with the introduction of the phase determination for the project cycle of airport capital and maintenance projects as well as classification objectives under which identified risks could be placed. These phases and classification headers were sourced from WSDOT (2012), FAA (2012) and Horonjeff et al. (1994).

In addition to commercial hubs in the USA, this survey was also sent to other regions of the world. This step was done with the intention of covering any possible survey-respondent deficits that may have occurred in the USA and for opening the avenue to compare survey results cross continentally. A breakdown of the survey statistics can be seen in Table 3.4.

Table 3.4: Survey two parameters

Survey two: Parameters	
Survey Size : pages	23
Number of risks documented	130
Survey dispensed :	Yes
Email number sent :	245
Survey revised	Yes

Table 3.5: Survey two statistics

Survey two : Statistics		
Country	***Type***	***Participation goal***
USA	Non Hub : Releiver	18
	Primary : Non - Hub	21
	Primary : Small Hub	21
	Primary : Medium Hub	20
	Primary Hub : Large	20
Total:		100
Other regions of the world		
United Kingdom	Primary Hub:	10
Germany	Primary Hub :	21
France	Primary Hub :	21
Canada	Primary Hub :	50
China	Primary Hub :	30
Japan	Primary Hub :	10
Barbados	Primary Hub :	1
South Africa	Primary Hub :	2
Total		145
USA + other regions of the world		245

Survey two, however, was considered complex and time consuming by the respondents who were contacted to complete it. Its statistic is reviewed in Table 3.5. Survey two's complexity finally led to its revision and the dissemination of survey three. The two dispensed surveys can be reviewed in Appendices D and E respectively.

3.2.3. Survey respondents

After a 3 month waiting period, 9 responses were received for the final survey, most of which were fully completed by the respondents. The return rate for the airports in North Dakota was 50% because 3 of the 6 primary-hub airports returned the survey. This return rate represented a valid response rate which is acceptable according to Moser and Kalton's assertion which presumes that the results of a postal survey can be considered unbiased if the response rate is more than 30% (Moser et al, 1971) .

Another requirement for the 9 data responses was their ability to cover all airport size criteria listed by the FAA for commercial airports in the USA (Refer to Table 2.4 in Section 2.8.2). This way, an unbiased comparison of all commercial airport types could be done with survey analysis of the respondents' answers, despite minimal response numbers. A breakdown of the respondents by airport type can be seen in Table 3.6, and a percentage comparison can be seen in Figure 3.2.

Table 3.6: Survey respondents by airport enplanement numbers.

CATEGORY - AIRPORT SIZE	FREQUENCY	%
Primary Hubs:		
Large Primary Airport	1	11.11111111
Medium Primary Airport	1	11.11111111
Small Airport	3	33.33333333
Non Hub	3	33.33333333
Other:		
Reliever Airport	1	11.11111111
Total	9	100

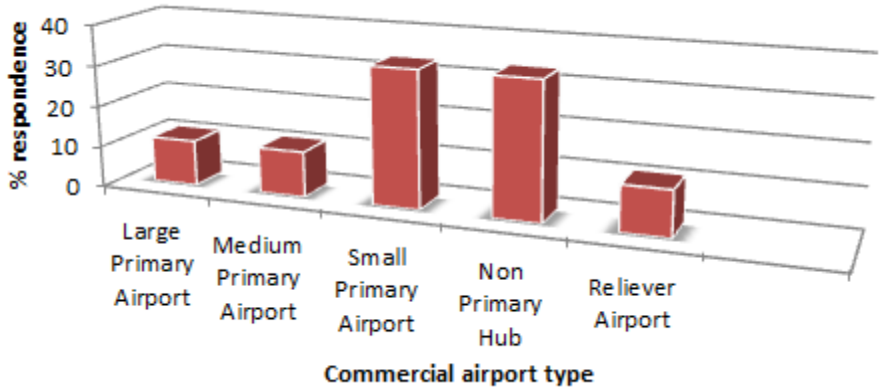


Figure 3.2: Percentage comparison of survey respondents by airport

Of the 9 respondents who completed the survey, most held positions in airport administration. Respondents included 3 airport directors, 1 deputy airport director, 1 airport

manager, 1 project development manager, 1 construction manager, 1 program coordinator and 1 executive director. Their positions and knowledge in the realm of commercial-airport ownership activities associated with capital and maintenance development projects prepared them to rank the risk related questions posed to them in the survey and validated each respondent's answers. The survey respondent's breakdown is seen in the pie chart in Figure 3.3.

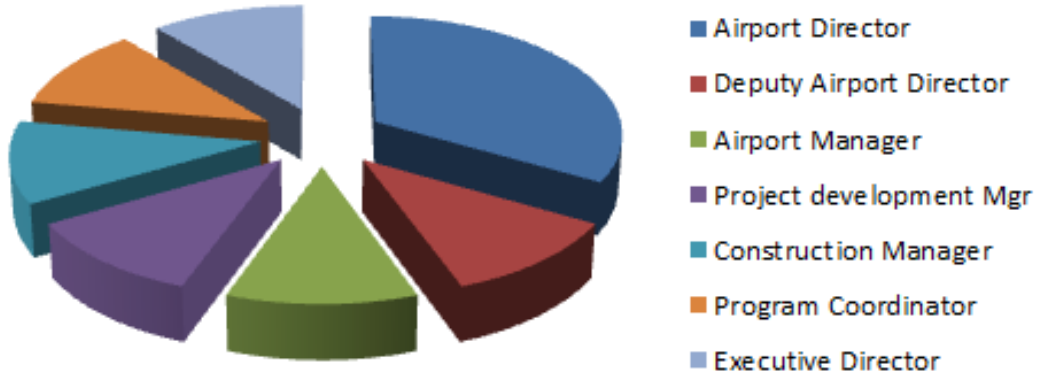


Figure 3.3: Survey respondents' role at their respective airports.

Also reviewing the initial emphasis of the survey analysis, which was correspondence from airports in the Midwest, with an emphasis within the state of North Dakota, a comparison was made from the responses of these Midwestern airports in relation to airports from other regions of the USA.

It was found that, despite the pool of promised respondents from 8 airports in the West region, where 52 airports were available (FAA, Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports, 2012), only 4 respondents were acquired. This percentage return rate is 50%, which is still valid according to Moser and Kalton's assertion (Moser et al, 1971).

The other participating region was the Southwest region, which had 42 primary commercial airports (FAA, Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports, 2012) and promised survey correspondence of 17; there was a final return of 2. According to Moser and Kalton's assertion, the Southwest region could not be compared with the Midwest and Western region due to its biased return rate of 11.76% (Moser et al, 1971). Figure 3.4 shows responses by region for the 9 respondents.

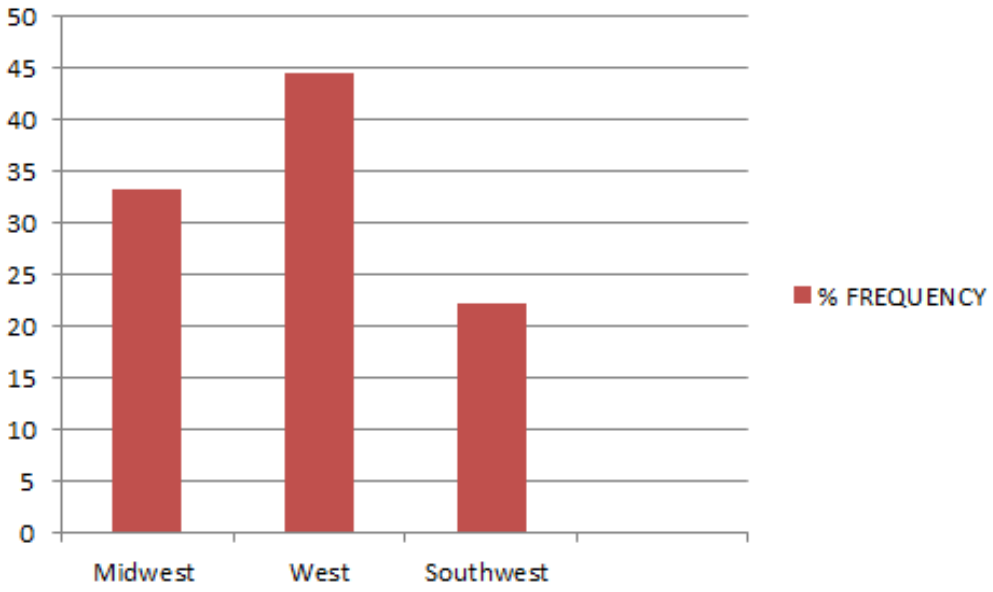


Figure 3.4: Survey respondents by region in the USA.

3.2.3.1. Validity of the survey data

The response size for the survey data was significantly smaller than expected by respondents based on the following three reasons:

First, the survey size was a factor because 32 risks factors were presented on a 9 page document with each risk rated according to 4 given criteria. (See Section 3.2.) The survey was time consuming but this was required to ensure that survey was optimally completed to provide

the needed data. Second, the survey was required to be completed by top level administration at U.S. airports. Acquisition of personal information, such as email addresses or phone numbers, was a tricky process. Third, airport administrators were reluctant to fill out the survey once they received it because of the information content they were required to provide.

Although the small sample may weaken the survey's effectiveness overall, the analysis from the sample is supported with current case studies from ongoing capital and maintenance airport projects in future phases of the formal risk management plan that will be associated with this research. The survey analysis can be applied to these case studies to validate the importance of airport ownership's risk management. Also, the survey response rates for the Midwestern region, with regard to North Dakota, as well as the West region as a whole are validated based on Moser and Kalton's assertion (See Section 3.23) and, as a result, can be utilized effectively for such regions (Moser et al, 1971).

3.3. Analyzing the data

The following processes in the proceeding sections were utilized to analyze the feedback acquired from the survey respondents of commercial airport facilities in the United States.

3.3.1. Utilizing the Probability impact matrix to determine risk assessment values

From the feedback obtained from the survey respondents, data is grouped into two types. These two groupings are 1) the likelihood for the occurrence of each risk listed in the survey and 2) the level of impact that each risk has on the project objectives and phases for which it is listed. Project objectives affected by each risk include cost, time quality, environment and safety (Zou et al, 2009).

From the scale provided for ranking likelihood and impact (See Section 3.2.), we attach probability ranges that are converted to individual decimal numbers. For the impact and likelihood related probability ranges used in this thesis, values from a sample probability impact matrix utilized in the NCHRP report 658 (Molenaar et al, 2010) were acquired and converted to single decimal numbers utilizing the equation in Equation 3.2.

$$\text{Individual probabiltiy number} = \frac{(Xmax + X\min)}{2} \div 100\% \qquad \text{(Eq 3.2)}$$

$x_{max} =$ Highest percentage value in the range while $x_{min} =$ Lowest percentage value in the range.

The values for risk impacts on the phase listed were acquired from the cost impact, schedule impact and scope impact ranges that are highlighted in blue in Table 3.4 while values for the likelihood of the risk issue occurring were acquired from the probability ranges highlighted in red on Table 3.7.

Table 3.7: Sample probability impact matrix (Molenaar et al, 2010).

	Very Low	Low	Moderate	High	Very High
Cost Impact	Insignificant cost increase	<5% cost increase	5-10% cost increase	10-20% cost increase	>20% cost increase
Schedule Impact	Insignificant slippage	<5% project slippage	5-10 % project slippage	10-20% project slippage	>20% project slippage
Scope Impact	Change is barely noticeable	Minor areas are affected	Change requires TBPOC approval	Change not acceptable to TBPOC	Material termination of project
Probability	1–19%	20–39%	40–59%	60–79%	80–99%

The final values, once converted to single decimal figures, are given in Tables 3.8 and 3.9 for impact and probability (likelihood).

Table 3.8: Probability (likelihood) individual numbers (Molenaar et al, 2010).

Assessment	**Likelihood/probability**	**Individual probability number (Approx.)**	**Alphabetical numeration**
Near Certainty	80-99%	0.9	**A**
Highly Likely	60-79%	0.7	**B**
Likely	40-59%	0.5	**C**
Unlikely	20-39%	0.3	**D**
Remote	1-19%	0.1	**E**

Table 3.9: Impact of individual numbers (Molenaar et al, 2010).

Assessment	**Risk Impact/ consequence**	**Individual probability number (Approx.)**	**Alphabetical numeration**
Very High	20-100%	0.6	**A**
High	10-20%	0.15	**B**
Medium	5-10%	0.075	**C**
Low	0-5%	0.025	**D**
Very Low	0	0	**E**

These figures are then multiplied against themselves in a 5 × 5 matrix formation to produce 25 given outcomes for a given probability (likelihood) × impact combination utilizing the assessment guide provide by the DOE in NCHRP report 658 (Molenaar et al, 2010). Figure

3.6 shows the combination process for impact and likelihood values for Tables 3.8 and 3.9. The probability impact matrix is indicated through the lettering in Figure 3.5.

	A	A x e	A x d	A x c	A x b	A x a
	B	B x e	B x d	B x c	B x d	B x a
Likelihood	C	C x e	C x d	C x c	C x b	C x a
	D	D x e	D x d	D x c	D x b	D x a
	E	E x e	E x d	E x c	E x b	E x a
		e	d	c	b	a
			Impact / Consequence			

Figure 3.5: Combination process for probability (likelihood) × impact values using letter substitutions

Once the order of the 5×5 matrix has been determined, a color coded assessment guide for the values ascertained by the combination process is provided. This guide's goal is to give an assessment of the 25 different risk values in the 5 ×5 matrix and to present a means of action for each value based on the color code region where it falls (Molenaar et al, 2010).

	A	M	M	H	H	H
	B	L	M	M	H	H
Likelihood	C	L	L	M	M	H
	D	L	L	L	M	M
	E	L	L	L	L	M
		e	d	c	b	a
			Impact / Consequence			

Figure 3.6: Color coded Probability × Impact matrix assessment guide (Molenaar et al, 2010).

Figure 3.6 shows a typical probability × impact assessment guide. The colors utilized in the guide represent the severity of the risk being analyzed. The highest of the three values, which

is red, is allocated 6 spots in the upper right hand corner of the matrix. In terms of assessment, red is analyzed as the region for high unacceptable risks which are liable to cause a disruption to any given activity when they occur within during the course of project development. Such risks require priority management attention (Molenaar et al, 2010).

The values that fall within the yellow range are the moderate risk values. They are allocated 9 spots within the 25 value matrix and occupy the midsection of the matrix. These risks are moderate impact risks that may cause some disruption to activities where they occur. They require additional management attention to ensure that the damage they cause is limited and not as detrimental to project development as high-value risks (Molenaar et al, 2010). The lowest of the three color value ranges is green. It is allocated 10 spots within the 25value matrix and occupies the mid and lower left hand corner of the matrix. Values that fall within this range pose minimum consequence to the activities where they occur. They, therefore, require minimum oversight in the form of monitoring to ensure that they remain low during the course of project development (Molenaar et al, 2010).

With an understanding of the combination process and the assessment guide for the values obtained by combining probability (likelihood) × impact, the 5 ×5 matrix in Figure 3.7 was developed and utilized as a guide to allocate risk-severity assessment based on the survey participants' responses.

	Likelihood(range)	Ind .Prob. No.					
Very High	80 - 99 %	0.9	0	0.0225	0.0675	0.135	0.54
High	60 - 79 %	0.7	0	0.0175	0.0525	0.105	0.42
Medium	40 - 59 %	0.5	0	0.0125	0.0375	0.075	0.3
Low	20 - 39 %	0.3	0	0.0075	0.0225	0.045	0.18
Very Low	1 - 19 %	0.1	0	0.0025	0.0075	0.015	0.06
		Ind. Prob No.	0	0.025	0.075	0.15	0.6
		Impact range	Insignificant	0-5%	5-10%	10-20%	20%-100%
			Very Low	Low	Medium	High	Very High

Figure 3.7: Probability × Impact matrix assessment guide used for survey respondents.

Because the survey utilized project objectives in addition to the probability (likelihood) × impact combination, the inclusion of project objective values in the probability impact matrix had to occur. The inclusion of project objective values was possible through the utilization of an equation that raised the impact value for each risk (refer to Table 3.32) to the number of project objectives that affected the risk. It is important to note that the Equation 3 in Figure 3.9 was utilized to determine the index score for all given risks within each individual survey response.

$$r_{ic}^{b} = \alpha_{ic}\beta_{ic}^{b} \quad \text{(Eq 3.3)}$$

In Equation (3.3), r_{ic}^{b}= risk index score acquired from survey respondent *c* for the impact of risk *i* on project objective b; *i* = ordinal number of risk, $i \in (1, 32)$; *b*= ordinal number of project objectives, $b \in (1, 5)$; *c* = ordinal number of valid feedback to risk *i*, $c \in (1, n)$; n = total number of valid feedbacks to risk *i;* α_{ic} = likelihood of risk occurrence *i* , determined by respondent *c ;* β_{ic}^{b} = level of risk impact *i* on project objective *b* , determined by respondent *c* (Zou et al, 2009).

Equation 3.3 was applied through the multiplication of the probability and impact individual numbers based on survey respondents' determination of the ranges in which such values fell based on. In a hypothetical example utilizing Figure 3.10, we could say that

respondent *X* decided to go with risk F, determining that its impact was high and that its likelihood of occurring was high .In the probability impact matrix such values would be picked from the matrix as shown by the blue highlights in Figure 3.8.

	Likelihood(range)	Ind .Prob. No.					
Very High	80 - 99 %	0.9	0	0.0225	0.0675	0.135	0.54
High	60 - 79 %	0.7	0	0.0175	0.0525	0.105	0.42
Medium	40 - 59 %	0.5	0	0.0125	0.0375	0.075	0.3
Low	20 - 39 %	0.3	0	0.0075	0.0225	0.045	0.18
Very Low	1 - 19 %	0.1	0	0.0025	0.0075	0.015	0.06
		Ind. Prob No.	0	0.025	0.075	0.15	0.6
		Impact range	Insignificant	0-5%	5-10%	10-20%	20%-100%
			Very Low	Low	Medium	High	Very High

Figure 3.8: Picking Values from the Probability-Impact matrix

In a regular probability matrix, the two values would have been multiplied together ($r_{ic}^{b} = \alpha_{ic}\,\beta_{ic}$ = 0.7 × 0.15 = **0.105**), and the risk assessment value would have been given as high based on the assessment guide given in Figure 3.7. However, this reading would not consider the number of project objectives the respondent felt the risk affected.

Let us assume that respondent X stated that the project objectives (cost, time and quality) were affected by risk F, raising the impact value by b, where b is the number of objectives affected by the risk; the new impact would be β_{ic}^{b} . This new value is the impact value assessed for the risk by respondent X, raised to the power of the project objectives affected. The final risk-index score for risk F would be $r_{ic}^{b} = \alpha_{ic}\beta_{ic}^{b}$ =0.7 ×0.15 ^3= 0.7 ×0.003375 = 0.0023625 (Zou et al, 2009).

Looking for the new index score on the risk matrix guide in Figure 3.7, we can determine the range in which the new index score falls. This principle was applied to all individual risks within each returned survey document to determine an individual risk index score. Table 3.10 shows a cross section of the 9 survey participants and the individual index figures acquired from each risk utilizing the equation in Equation 3.3.

Table 3.10: Cross section of survey participants' individual risk index scores.

		AIRPORT REPRESENTATIVES								
Phase	Risk No	D	B	A	G	F	H	C	E	I
1	1	0.00675	0.000000	0.0002109	0.00021	0.0075	0.00038	0.00169	0.09072	0.0075
1	2	0.069984	0.000000	0.069984	0.00394	4.69E-06	0.001688	0.1512	0.09072	0.002813
2	3		0.015750	0.01575	0.324	0.0075	0.000211	0.075	0.1512	0.18
2	4	0.108	0.015750	0.0028125	0.00394	0.0075	0.075	0.075	0.0016875	0.18
2	5	0.001013	0.000000	0.0075	0	0	0	0.0075	0.0028125	0.0375
2	6	0.001013	0.002813	0.0016875	0.01125	0	0.002363	0.0075	0.0016875	0.54
2	7	0.001013	0.000000	0.0001875	0.00019	0	0.01575	0.0075	0.0016875	0.54
3	8	0.0000007	0.000211	1.17E-07	0.00169	0.000188	0.01125	0.00169	0.00012656	0.000211
3	9	0.0000012	0.015750	4.69E-06	0.324	0.001688	0.001688	0.075	0.0016875	0.002813
4	10	0.00675	0.000000	0.075	0.105	0.0225	0.001688	5.32E-05	0.0016875	0.0125
4	11	0.01125	0.002813	1.58E-05	0.0375	0	0.075	0.0075	1.56E-06	0.000313
4	12	0.000338	0.000011	0.54	0.00019	0.000188	0.01125	0.00019	0.00012656	0.003938
4	13	0.001688	0.001688	0.0016875	0.324	0.001688	0.252	0.18	0.01125	0.1512
4	14	0.001688	0.000000	4.69E-06	6.3E-05		0.0375			0.0375
4	15	0.002813	0.193649	0.0375	0.01575	0	0.00675	0.0375	0.0028125	0.000127
4	16	0.00000	0.002813	0.0025	0.00169	0	0.001688	0.0225	4.69E-06	0.0075
4	17	0.00000	0.002813	4.69E-06	0	0	0.000188	0.252	0.00021094	0.0375
4	18	0.00002	0.000042	0.0001875	0	0	0.0225	0		0.0375
4	19	0.00001	0.000042	0.0000625	0	1.56E-06	0.001688	0	0.0001875	0.01575
4	20	0.03888	0.001688	0.01575	0.00019	0.001688	0.001688	0.42	0.00675	0.105
4	21	0.00675	0.000563	0.0028125	0	0	0.000127	0.0375	0.00012656	4.69E-06
4	22	0.0233280	0.000063	0.0039375	0.00281	0.001688	0.002813	0.0375	4.69E-06	0.105
4	23	0.0016875	0.000563	4.69E-06	2.36E-03	0.000127	1.58E-05	0.00021	0.00012656	0.001688
4	24	0.2332800	0.000563	0.0003544	4.69E-06	0	0.000211	4.69E-06	0.000210938	0.000354
4	25	0.0002531	0.003038	0.0023625	0.00019	0.000127	0.002363	0.01575	0.00025313	0.1944
5	26	0.0028125	0.002813	0.0075	0.00019	0	0.002813	0.00281	0.0016875	0.0375
5	27	0.0028125	0.000000	0.0016875	0.00019	0	0.000188	0.00019	0.0016875	0.0375
5	28	0.0002531	0.000563	4.69E-06	4.69E-06	0.000211	0.000127	0.00021	1.58E-05	0.1512
5	29	0.1166400	0.002250	0.0028125	4.69E-06	0	0.000127	0.0375	0.00012656	0.000188
5	30	0.0000095	0.000000	0.0075	0.00281	4.69E-06	0.000188	0.0375	0.0016875	0.324
5	31	0.0010125	0.000000	0.0001875	0.00281	0.001688	0.002813	0.105	0.00035438	0.105
5	32	0.0000000	0.000211	0.0001875	0.00019	0	0.002813		0.00012656	0.105

CHAPTER 4. RESULTS AND DISCUSSION

4.1. Comparison of survey respondents based on individual survey risk index scores

Based on the individual index scores acquired from utilizing Equation 3. 3, a general comparison of the 9 airport respondents was done to see how they rated the individual risk's combination values when compared to each other. These risk combination values were based on the assessment guide diagram provided in Figure 3.6. This general comparison did not consider airport size or location by region. These general comparisons are given in preceding sections.

Of the 32 risks provided for respondents to complete, the following bar chart diagram (Figure 4.1) shows how participant responses for the 32 risks compare statistically from high risk to low risk assessment.

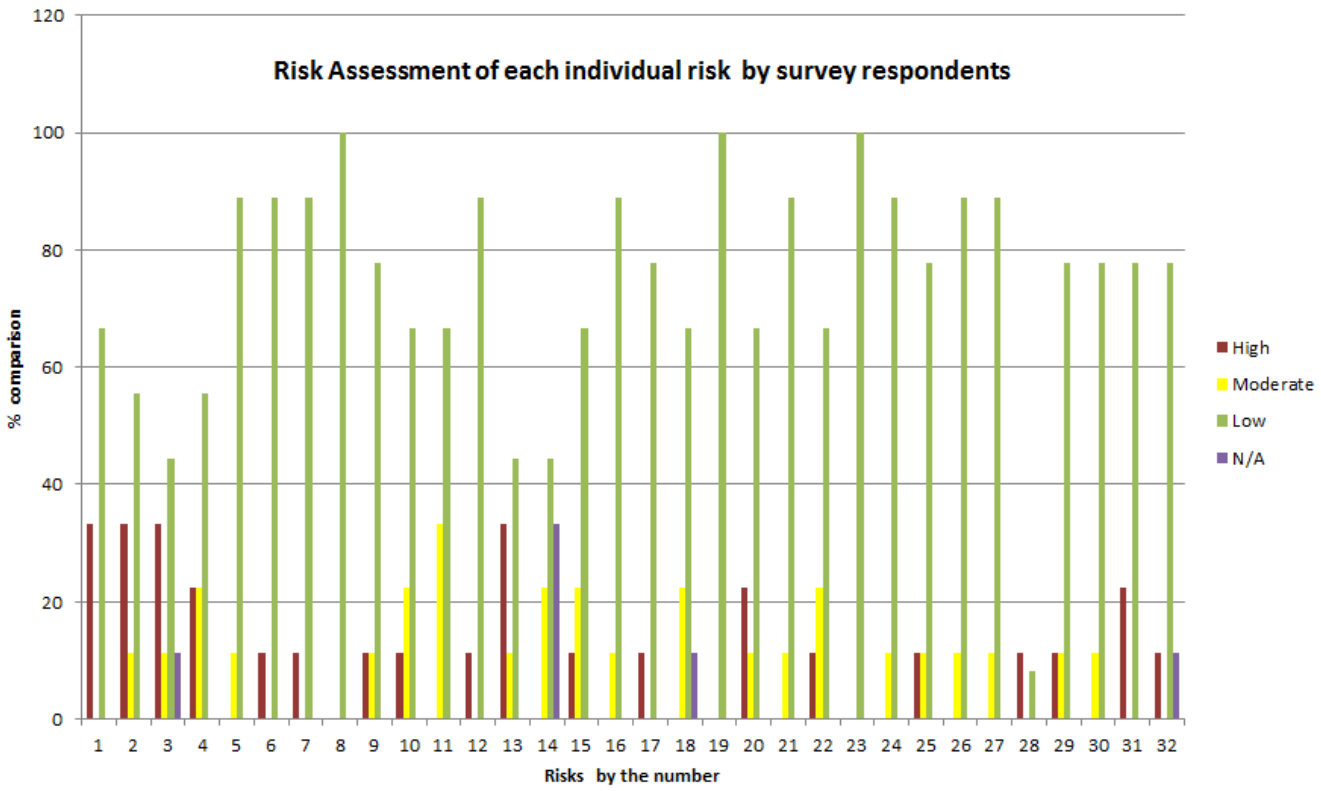


Figure 4.1: Survey respondents' comparison of risk assessment by individual risks

Notable areas within the bar chart analysis include risks 8, 19 and 23, where all 9 respondents considered the impact on airport owner associated activities posed by such risks as low. These risks were risk 8, project variations leading to associated disputes between project parties and ownership (Phase 3); risk 19, security threat on facilities posed by airport development (Phase 4), and risk 23, contract related disputes (Phase 4).

It is understandable to note that risk 8 may have little to no bearing on the airport owner based on the fact that project development, whether capital or maintenance in nature, is approved by government aviation agencies such as the FAA and programs such as the AIP and SASP, prior to funding and development (Horonjeff et al, 1994). These agencies and programs also ensure that project development is in line with set parameters, and the government agencies are responsible for hiring consultants (project parties) involved with project design prior to development. An airport owner's involvement with such a phase would be based on government agency intervention (WSDOT, 2012), the project delivery method being utilized and the contract stipulations associated with the project (Touran, 2009).

Risk 19, dealing with the security threat to facilities during airport development, is an issue generally covered by the Transportation Security Agency (TSA) which is run by the U.S. Department of Homeland Security (FAA, Airport security , 1972). However the FAA Advisory Circular 107–1 assigns the responsibility for airport security to the airport operator. Airport security is tied to security plans put in place by the airport administration to carry out airport employee checks and screens for the facility and to ensure safety for the airport premises (FAA, Airport security , 1972). Part 107 says that airport operators are required to establish master security plans for all operation areas of a commercial airport except for those which are occupied or controlled exclusively by certificate holders that are required to have a security program under

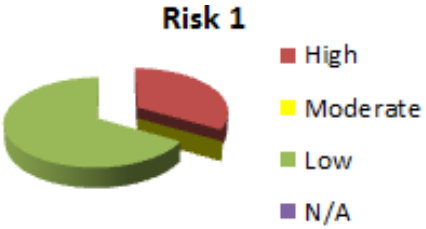
FAR 121.538 (FAA, Airport security , 1972). Such certificate holders would be aircraft carriers that are responsible for conducting gate and aircraft checks for security purposes (FAA, Airport security , 1972).

Risk 23, dealing with contract related disputes, would be of minimal issue to the airport manager at a commercial airport because governing aviation agencies, such as the FAA, in tandem with SASP policies and procedures would be responsible for dealing with a majority of contract related issues prior to project development. Although the airport manager is involved to some degree, this involvement is minimal at the most (WSDOT, 2012).

Risks 1, 2, 3 and 13, as seen in Figure 4.2, were considered by all 9 respondents as the ones with the highest risk assessment values, despite being considered as having comparatively low to low assessment percentage values.

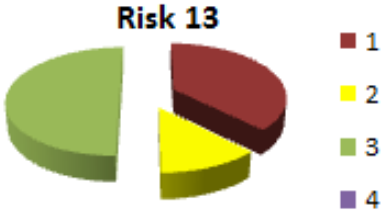
These risks are as follows: risk 1, conflict of interest between ownership and other involved parties while determining initial project parameters (phase 1); risk 2, project type and scope misrepresentation due to poor planning and feasibility related studies (phase 1); risk 3, government intervention and bureaucracy with the funding related processes (phase 2), and risk 13, permitting related processes (i.e., environmental impact statement approval pre-development, etc.) that slow down project development process (phase 4).

Risk 1 would be considered as relatively high for most airport owners. When reviewed on the basis of the project objectives affected by risk 1, 20 responses were received. From these responses, 8 were time related, 5 were cost related, 5 were quality related, and 1 was safety related and 1 was environment related. The following analysis was then deduced.



Risk one
High assessment : 33.33%
Low assessment : 66.67%

Risk two
High assessment : 33.33%
Low assessment : 55.55%



Risk three
High assessment : 33.33%
Low assessment : 44.44%

Risk thirteen
High assessment : 33.33%
Low Assessment : 44.44%

Figure 4.2: Comparison of high to low risk assessments by individual risk respondents

Risk 1 would be considered as relatively high for most airport owners. When reviewed on the basis of the project objectives affected by risk 1, 20 responses were received. From these responses, 8 were time related, 5 were cost related, 5 were quality related, and 1 was safety related and 1 was environment related. The following analysis was then deduced.

Airport owners considered this risk as high based on the notion that they are not solely responsible for all procedures associated with determining the initial project parameters of a capital or maintenance project's development. Procedures determining initial project parameters are is also partially in the hands of other project stakeholders and predominantly in the hands of the FAA and its subsequent government planning agencies (Refer to Section 2.8.4 and its subsections). Government programs appointed by the FAA, such as the AIP and SASP, have a greater say in defining initial project parameters due to their control over project funding approval, funding allocation and the implementation of policies and procedures that need to be met by initial project parameters before a project can proceed (WSDOT, 2012). Delays associated with government policies and procedures affect funding acquisition and project commencement, both of which are cost and time related. The push to meet a project's schedule when it is affected by government agency delay can compromise the quality and safety of project work during the course of project development.

Risk 2, project type and scope misrepresentation due to poor planning and feasibility related studies, is considered a relatively high risk by the airport owner based on the project's cost and time objectives that could be affected during the course of project development. Of the 26 project-objective responses indicated as being affected by risk 2, cost and time had the highest response by survey respondents. These frequencies were 7 and 8, respectively, for cost and time.

In terms of project type and scope misrepresentation, approval processes for initial planning and funding processes with government agencies would be affected based on such mistakes (WSDOT, 2012). This risk would also cost the airport owner financially in terms of rectifying noted mistakes and could hinder the process of getting the project included on the 5 year airport plan by governing aviation agencies (WSDOT, 2012). This risk could also lead to

the issuing of a halt to the "finding" documents (Refer to Section 2.8.3) issued by government agencies, delaying the disbursement of funding for airport development (WSDOT, 2012). In terms of time, the effects of such an error would also affect the proposed "Notice to proceed" date for project development, causing a shift in the proposed start and finish dates. This effect on project schedule will have trickle down effects on construction and airport operation activities associated with the project (Touran, 2009) .

Risk 3, government intervention and bureaucracy with funding related processes, was considered relatively high by airport owners based on the process required to attain funding to embark on capital or maintenance development. (Refer to Section 2.8.3.).Like all government related activities, there are protocols, policies and procedures that airport owners are required to follow to acquire funding from the FAA (WSDOT, 2012). These protocols, however, may have a noted effect on the project objectives of time and cost that are associated with project development as stated by survey respondents. Of the 15 responses about project objectives affected by risk 3, 6 were cost related; 7 were time related and 2 were quality related.

In terms of schedule, airport ownership's timeline for a given project's development may be affected by the time taken to acquire funding from the FAA through its government agency programs (Refer to Section 2.8.3). The affected schedule could alter other activities tied to the funding allocation processes and slow down the rate at which project development is completed. In terms of cost related issues, the FAA determines what percentage of funding it allocates to certain airport facilities for project development purposes (Refer to Section 2.8.3). This funding, however, is subject to change based on federal government budget adjustments associated with aviation (cuts/gains) for the fiscal year or changes in policies and procedures about which the airport owner may not be aware (DOT, 2012).

Risk 13, permitting related processes (i.e., environmental impact statement approval predevelopment, etc.) that slow down the project development process, was considered a relatively high risk for airport owners who, in terms of project objectives, rated this risk as affecting cost and time related objectives. Of the 21 responses for project objectives affected by risk 13, 8 were cost related; 9 were time related; 3 were environment related; and 1 was quality related. Most airport owners require approval for site development and related processes to ensure that funding and the green light to continue project development are given (WSDOT, 2012). An inability to follow policies and procedures set by the FAA to acquire such approval may delay the funding or result in the outright disqualification of a project to receive funding, affecting the commencement of project development (DOT, 2012). In terms of environment, opposition to project development on the existing facility's site or a new site picked for airport development by local community members, as a result of the project's perceived environmental impact (noise pollution, chemical pollution or air pollution), could be an issue for the airport manager (Horonjeff et al, 1994).

4.1.2. General comparison of project objectives by survey respondents

When comparing the evaluation of the 32 risks, as determined by respondents, we can infer that, when it comes to project objectives ,of the 528 listed as affected by the risks, 198 were associated with cost; 203 were associated with time; 55 were associated with quality; 47 were associated with safety; and 25 were associated with environment. Figure 4.21 shows an area diagram comparing the project objectives affected by the 32 risks based on their frequency of occurrence. Of the 5 objectives listed, time and cost were the most frequent project objectives affected by the 32 risks that affected airport management. In terms of the project objective cost, it is affected in part, due to the fixed budget acquired from governing aviation bodies to aid in

airport development (FAA, What is AIP, 2012), the limited liquid reserves at the airport manager's disposal (Gu.L et al, 2009) and the ease with which debt can be incurred when dealing with such risks with a limited budget (WSDOT, 2012).

Quality and safety were least indicated by airport owners in terms of frequency than time and cost. The limited indication of these objectives is due in part to the restricted nature of the airport owner's involvement with such activities, which is tied to contracts and project delivery methods that are enforced by governing aviation agencies prior to project construction. (Refer to Section 2.8.7.)

Environment related project objectives were less indicated by survey respondents. The risks associated with these objectives dealt more with impact assessment studies and environmental hearings to acquire permits for funding and development. Such studies would be assigned to consultants employed by the government agencies involved with the airport development process with minimal participation from airport ownership (WSDOT, 2012).Figure 4.3 shows an area diagram comparison of the 9 survey respondents and their frequency of project objective indication within the survey filled out.

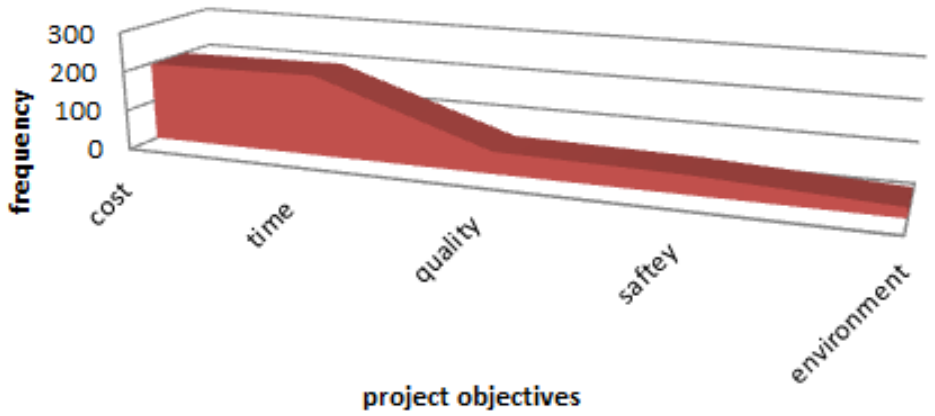


Figure 4.3: Area diagram comparison: frequency of project objectives associated with 32 risks

4.1.3. Analysis of final risk assessment for general respondents

In terms of the total compilation of risk combinations by all participants in the survey, there were a total of 285 assessment scores when reviewing all 32 risks from each respondent's viewpoint. Of the 258 responses, 29 responses were ranked as high assessment risks; 29 responses were ranked as medium assessment risks; 220 were ranked as low assessment risks; and 3 were ranked as not available. The overall analysis of this risk combination can be seen in Figure 4.4.

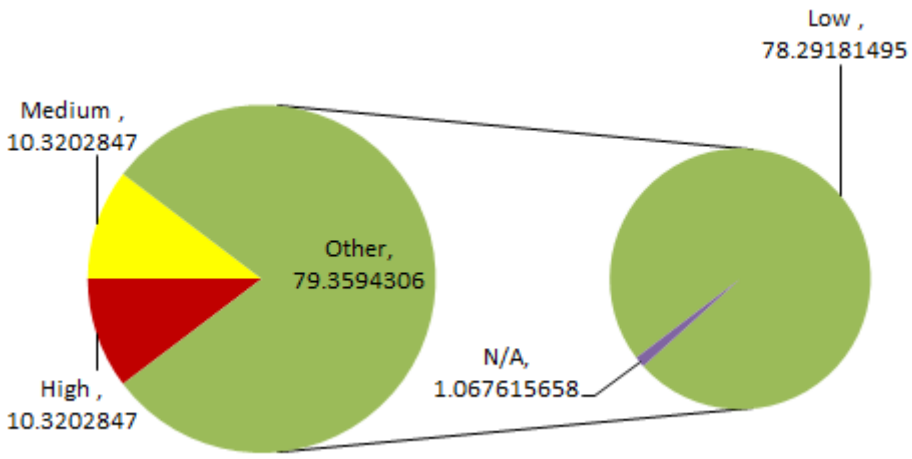


Figure 4.4: Analysis of overall risk combination assessments for all 32 risks.

Despite the majority of the risk combination assessments being low, it is important to note that this risk assessment was a summation of all possible viewpoints expressed by the respondents and did not necessarily mean that all 32 risks have a relatively low ranking. One goal for this thesis is to weed out irrelevant risks and to keep a core of risk that ware proven to affect airport ownership activities. The process of acquiring a relevant core of risks is done in later sections where the Top 10 risk lists, by project objectives, are developed. From these lists, a

final Top 20 risk list is developed, encompassing all project objectives associated with the commercial airport development's project cycle.

4.2. Comparison of survey recipients based on region and airport size

Comparison was done between primary non-hub respondents and primary small hub respondents because they were the larger groups of survey respondents. All primary non hub respondents came from the Midwestern region of the USA, specifically North Dakota. Most of the primary small hub respondents came from the Western region of the USA; however, they were spread out by state when compared to the primary non hubs that were concentrated in one area. Only one small hub participant came from the Southwest area of the USA. However, this small hub participant could still be put in the Western region for analysis based on its location within its given state. Table 4.1 shows the respondent breakdown by region, state and airport type.

Table 4.1: Respondent breakdown for analytical comparison by region, state and airport

Region	*State*	Airport Type
Midwest	North Dakota	Primary Non- Hub
Midwest	North Dakota	Primary Non- Hub
MidWest	North Dakota	Primary Non- Hub
West Region	Montana	Primary Small Hub
South West	Arkansas	Primary Small Hub
West Region	Texas	Primary Small Hub

4.2.1. Comparison of primary non-hub respondents by individual survey risk index scores

The 3 primary non-hub respondents in the Midwestern region of the USA reviewed all 32 risks individually. In terms of notable findings, 2 of the 3 respondents indicated that risk 1, conflict of interest between ownership and other involved parties while determining initial project parameters (phase 1), was the highest assessed probability impact combination risk of the 32 and would be the most troubling to airport owner's activities; one person indicated that this risk was a low assessment risk. Of the 6 project objectives indicated as being affected by this risk, 2 were cost related; 3 were time related; and 1 was quality related. The response to these project objectives by respondents indicated that airport ownership would have to deal with a majority of finance and project schedule impacts in phase one if this risk occurred. Due to the similarity of the general comparison of individual index scores and the primary non-hub for this risk, the reasoning for such a high assessment can be inferred from Section 4.1.2.

Risk 9, planning procedures affected by government approval and associated processes (phase 3), was indicated as a medium assessment risk by 2 of the 3 primary non-hub respondents while 1 respondent indicated assessment for this risk as low. This analysis is different from general comparisons of all airport respondents where risk 9 was considered low by a majority of the respondents (66.7%) who filled out the survey. It is also important to note that no medium assessment risks were indicated in the general comparisons of all survey participants' individual index scores. Of the 6 project objectives indicated as affected by risk 9, one was cost related; 2 were time related; 2 were quality related; and 1 was safety related. The survey response indicated that the airport manager would be more concerned about project quality and schedule related impact issues if this risk were to occur in phase 3 of project development. (Refer to Appendix E). Cost would still be a big issue as well because it is directly tied to the quality of project

development and the project development completion rate in terms of time. Safety would be more associated with phases 4 and 5 dealing with the actual capital development and maintenance process done by consultants and hired contractors. Safety would, therefore, be an area of minimal impact assessment for airport owners whose involvement with such an objective is determined by project delivery method and contracts (Touran, 2009).

Respondents from primary non-hub would consider risk 9 as moderately affecting airport owner activities. Such valuation of risk 9 is, in part, due to the fact that most planning for airport expansion, maintenance and development hinges on finances and time. With the AIP, a governing aviation agency footing 90%-95% of eligible costs for project capital developments FAA (2012), an airport owner would need to have determined, prior to embarking on planning procedures for project development, whether the proposed project meets the standards set by the FAA through the SASP while adhering to policies and procedures set by the AIP when putting the project up for funding requests (WSDOT, 2012). Attached to this percentage cost determination is figuring out what percentage of the project cost the airport owner has to provide because the AIP does not fund a project in its entirety (FAA, What is AIP, 2012). A lengthy approval processes could result in the loss of alternative financial options that are available to fund the percentage of project that is not funded by the AIP. (Section 2.8.3) The project development could also be disqualified for not meeting standards during the course of the government's approval processes, setting back the project schedule and affecting new project costs if a deadline must be met (WSDOT, 2012).

Risk 15, project schedule affected by review time for project development by aviation governing bodies review agencies (phase 4), varied among all 3 respondents in the primary non-hub section. Of the 3 participants, 1 considered the risk assessment for risk 15 as high; 1

considered it as moderate; and the last respondent considered it as low. In terms of the 5 project objectives indicated as being affected by risk 15, two respondents indicated cost as an objective affected by this risk while 3 respondents indicated time as an objective that was affected.

The variations in response associated with risk 15 could be linked to the context in which the risk was reviewed or the phase location upon which the risk was deemed to have an effect. These variations are many, but here are a few postulations.

The context of risk 15 could be linked to the initial project schedule prepared for the project cycle prior to its development phase (Refer to Section 2.8.1.).In this case, the risk would be considered as low, having occurred in an earlier phase. If risk 15 were reviewed in terms of airport owners involvement with a given project development schedule during the course of the project's capital or maintenance activities (Refer to Appendix E.), then risk 15 may be considered moderate or high due to contractual stipulations and project delivery methods tying the airport owner in terms of liability (Touran, 2009).

4.2.2. General comparison of project objectives by primary non-hub respondents

Comparing the evaluations for the 32 risks as determined by primary non-hub respondents, we can infer that, when it comes to 167 project objectives indicated as affected by the risks; 64 were cost related; 62 were time related; 14 were quality related; 20 were safety related; and 7 were environment related. Utilizing the area diagram in Figure 4.5, a comparison of the project objectives affected by the 32 risks based on their frequency of occurrence is shown.

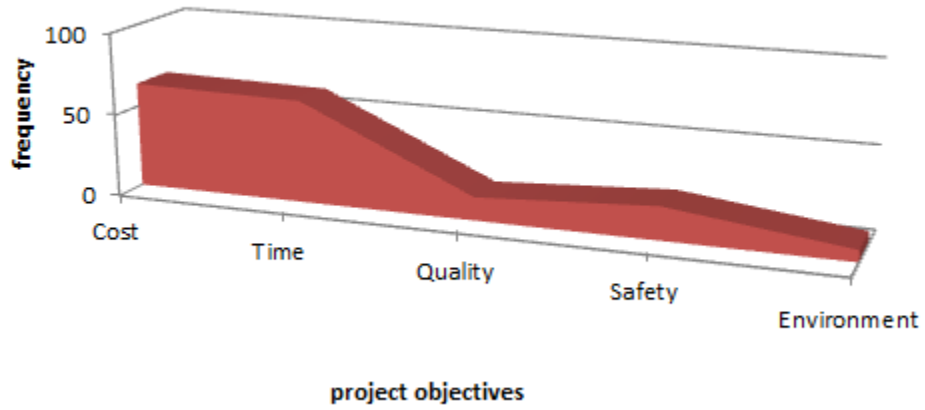


Figure 4.5: Area diagram comparison: frequency of project objectives associated with 32 risks for primary non-hub respondents.

In order to better analyze these data, comparing the percentage responses for individual project objectives from the general individual participants and primary non-hub participants was done. This way, despite differing data response numbers for both categories, a level data figure (%) could be used to determine differences and to make inferences. For inferences similar to general individual participation, percentage differences between general individual participants and primary non-hub respondents should fall within the range of 0.1%-1.4%, which is the minimal value change for general respondents (0.528-7.392 responses) and for primary non-hub respondents (0.167-2.338 responses).Anything above a 1.4% difference will change the inference for the given project objective being analyzed.

Of the 5 objectives listed, time and cost were the most frequent project objectives affected by the 32 risks as responded to by survey participants. For cost objective analysis, due to similarities for the response outcome on a percentage scale between primary non-hub respondents and general individual respondents (37.5% for general survey respondents and

38.32% for primary non-hub respondents, a noted difference of 0.8%), the same inference drawn from Section 3.1 is applicable to primary non-hub respondents.

For time objective analysis, due to similarities in response outcomes on a percentage scale between primary non-hub respondents and general individual respondents (37.125% for primary non-hub respondents and 38.447% for general respondents, a difference of 1.32%), the same inference drawn in Section 4.2.2 can be utilized for time as well.

In terms of the safety project objectives affected by the 32 risks, primary non-hub participants registered more responses percentagewise at 11.97% compared to general individual participants who registered safety objectives at 8.902%. This result is a difference of 3.06%.

Safety issues for primary non-hub airport management are considered as a more important objective for non-hubs based on size related issues. Small, medium and large primary hubs are better equipped to handle capital development and maintenance issues due to the size capability (i.e.) a terminal shutdown at a large airport is just one of many; others can be utilized during the course of construction or a hazard related issue; (etc.); non-hub airports do not have such luxury and, as such, have to enhance the safety of a project development area within their facilities to protect passengers and employees. However, damages that do occur at such airports and are safety related are covered by builders' risk insurance for construction and liability for personnel and passenger related issues, leaving the airport manager to deal with a minimal amount of financial compensation payments if damages do occur during the course of project development (Dobberstein, 2013).

In terms of environmental project objectives affected by the 32 risks, primary non-hub respondents registered the effects of the 32 risks on the objective at 4.192% compared to the

general respondents who registered at 4.73%. This finding is a difference of 0.538%, which is a minimal value difference; therefore, the same reasoning for such a low value in relation to risk effects on an airport manager's activities can be inferred from Section 4.1.2.

Quality project objectives for general project respondents were registered as being impacted to a greater extent by the 32 listed risks. A value of 10.41% of the total percentage of project objectives was registered by general respondents in relation to 8.38% registered by primary non-hub respondents, a difference of 2.03%.

Primary non-hub airport owners, although focused on the quality of project development associated with their facilities, have their participation to a project's construction and delivery methods tied to contracts and stipulations with contractors and governing agencies (Touran, 2009). Size and financing are also factors to consider when noting non-hub airport owners' responses to quality (FAA, NPIAS , 2012). Such facilities are usually not large scale, and issues of quality, if noted by management, can be rectified a lot quicker due to the limited scope, complexity and finances of such projects (Touran, 2009). Refer to Section 2.8.2.1 for more information.

4.2.3. Analysis of final risk assessment for primary non-hub respondents

In terms of the total compilation of risk combinations for primary non-hub participants, there were a total of 95 responses reviewing the 32 risks. Of the 95 responses, 15 responses for the risks were ranked as high assessment risks; 13 responses were ranked as medium assessment risks; and 67 responses were ranked as low assessment risks. Refer to Section 4.1.3 for an analysis related conclusion.

When compared to the general survey participants, primary non-hub respondents indicated that percentagewise, the 32 risks had a greater influence on airport-owner activities with 15.79% of their responses going to high assessment risks compared to 11.24% for general respondents. For medium assessment-risk indication, primary non-hub airports assessed a greater amount of the risks as being medium risks, affecting airport owner activities with 13.684% of their responses going to medium assessment risk compared to general respondents at 11.24%. In terms of low risk assessment, general respondents assessed more of the 32 risks as low risk at 85.27% compared to primary non-hub respondents who assessed 70.526% of the risks as low risks. This analysis is seen in Figure 4.6.

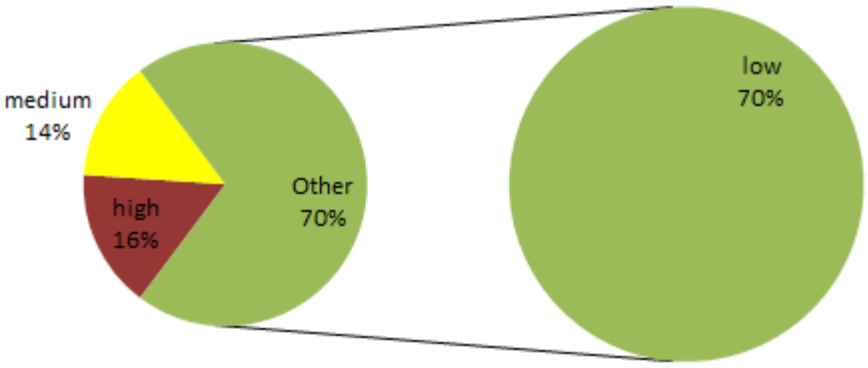


Figure 4.6: Analysis of overall risk combination assessment by primary non-hub respondents. (Note: Percentages have been rounded to the nearest whole number.)

4.3. Comparison of primary small-hub respondents by individual survey -Risk index scores

From the review of responses from the three primary small-airport hubs, the following findings were inferred. Risk 2, project type and scope misrepresentation due to poor planning and feasibility related studies (phase 1), was considered as high for all three airport respondents

in terms of probability impact assessment. This response rate was different from primary non-hub respondents who indicated risk 1 as the risk of highest assessment in terms of affecting airport-owner activities. (Refer to Section 4.2.1). Of the 9 project objectives indicated as being affected by this risk, 3 were cost related; 2 were time related; 2 were quality related; 1 was safety related; and 1 was environmental related.

Risk 2 would be considered as a high assessment risk for primary small-hub airport owners based mostly on funding related issues, time disruption associated with such an error and the quality of the developed project once finished. Consultants are usually responsible for determining the project type and scope representation (WSDOT, 2012), but primary small-hub airport owners, project stakeholders and government aviation agencies are responsible for bearing a majority of the issues associated with discrepancies in such documentation (WSDOT, 2012). In terms of funding, a determination of variation from what is considered standard for policies and procedures associated with an airport's type and scope representation, as referred to by the FAA in its NPIAS (FAA, NPIAS , 2012), could halt the approval process for the airport development in question and could hinder the funding required by airport ownership (WSDOT, 2012). However, there may be scenarios where such project misrepresentation may be approved and funding provided for project development. During the course of development, complexity issues associated with a project may arise, requiring further time and finances to resolve (Touran, 2009). If not rectified during the development phase, such type and scope issues could affect the quality of the final development product while being a safety hazard to passengers and employees during a project's operational phase (Touran, 2009). An example of such a risk issue would be the Denver International Airport baggage claim in 1995 (Consulting, 2008).

Risk 22, land development issues (eminent domain/sacred burial grounds) stalling the project development process (phase 4), was considered a medium assessment risk by 2 of the 3 survey respondents while 1 respondent considered the risk as low. This medium risk assessment was different from the general survey response where 66.7% of the respondents considered risk 22 as a low assessment risk and primary non-hub respondents who considered risk 9 as the risk that was of moderate impact assessment to airport owners' activities.

Of the 8 responses about project objectives affected by risk 22, small primary-hub respondents indicated that 2 were cost related, 2 were time related, 2 were environment related, and 1 was safety related and 1 was quality related.

Risk 22 would be an environment, time and cost issue for primary small-hub airport owners based on the processes associated with such land development issues if they do occur. For example, if a sacred burial ground were found beneath the site scheduled for project development, an immediate halt to project development occurs, affecting the project schedule. The process of attaining permits from government agencies to continue development begins again, and this process, in itself, is time and cost incurring (Caltrans, 2007). Other legal issues could arise from local community members' opposition to development on such sites and may lead to government agencies ruling that such a site cannot be utilized for the proposed development (Caltrans, 2007). Risk 22 sets the airport owner back financially and postpones the project schedule as a new site is located for future development (WSDOT, 2012). The situation would be similar for eminent domain issues (Refer to Section 2.8.7) and environmental impact issues (Refer to Section 2.8.5.) that may affect surrounding development within an airport's development range (Horonjeff et al, 1994).

Risk 3, government intervention and bureaucracy with funding related processes (phase 2); risk 4, project schedule affected by delays from numerous funding approval processes (phase 2); risk 13, permitting related processes (i.e., environmental impact statement approval pre-development, etc.) that slow down the project development process (phase 4) risk 20, project design constructability issues affecting project cost (phase 4); and risk 29, funding provisions for certain aspects of maintenance by governing aviation bodies limiting the scope of the maintenance project (phase 5), all had varying responses from the 3 small-hub airport respondents based on risk assessment. The responses were spread out for all the risks in such a manner that, of the 3 respondents, 1 respondent would base the risk as high, another as medium and the last as low for the 5 previously stated risks. For primary non-hub airports, only one risk, risk 15, had such a varied response. Table 4.2 is a listing of the project objectives that were affected by these risks.

Table 4.2: Risk numbers for primary small-hub airports with varied responses and the associated project objectives they affect.

	Project objectives affected				
Risk No	Cost	Time	Quality	Environment	Saftey
Risk 3	1	1	1		
Risk 4	2	3	2		
Risk 13	3	3			
Risk 20	2	2	1	1	1
Risk 29	2	2			1
Total count	10	11	4	1	2

From Table 4.2, it is clear that cost and time are the project objectives that are affected the most by the project risks indicated by small-hub respondents with varied responses to risk assessment.

4.3.1. Reasoning behind varied responses for risks from primary small-hub respondents

Risks 3, 4 and 13 had varied assessment due, in part, to the respondents' interaction with the governing aviation body in their respective states as well as the associated funding approval and permitting processes which may differ by state (WSDOT, 2012). For some small-hub respondents, it may have been tougher to acquire the 90%-95% reserved by the FAA for capital projects or associated eligible costs determined by the FAA for maintenance related projects (FAA, What is AIP, 2012). It may also be difficult to attain the necessary permission needed to continue with project development when it is required (WSDOT, 2012). Waiting for these funds or the associated permitting processes could also have slowed the project-development time for such projects, affecting airport owners negatively and vice versa (Caltrans, 2007).

Risk 20 had varied assessment from all three respondents. Medium and low risk assessment for risk 20 revolve around a contract or project delivery method that benefits the airport owner, which is usually decided in tandem with the governing aviation body overseeing the project development process (WSDOT, 2012). Such contractual agreements are determined prior to project construction. (Refer to Section 2.8.7.) A high risk assessment revolves around contract clauses related to project development that tie airport owners to liabilities that occur from errors and omissions in the work associated with the project-delivery method. (Refer to Section 2.8.7.) Such clauses can result in the airport owner having to pay more than required for liability related issues associated with project construction (Refer to Section 2.8.7.) and result in the delay of project development (Touran, 2009).

Risk 29 is maintenance related, and the FAA is adamant about its stance on not providing the cost for ineligible development projects (FAA, What is AIP, 2012). Such ineligible projects

(Refer to Table 2.7) may be ones that the airport owner deems as important for maintenance upkeep of the existing facility. Ineligible project costs may require that the airport owner look elsewhere (internal and external funding sources) for funding to embark on such projects (Gu.L et al, 2009). Looking for other sources of funding sets the airport manager up for potential risk associated with such funding ventures (Refer to Section 2.8.3.1.). In such a scenario, risk assessment would be high because risk 29 would affect the cost and time related objectives associated with project maintenance and development. If the risk were assessed as low, it would be tied to the fact that external and internal financing sources are available to meet the needs of maintenance projects, and as such, risks associated with time and cost related project objectives are minimal.

4.3.2. General comparison of project objectives by primary small-hub respondents

In terms of a general comparison of the risk objectives indicated as being affected by the 32 risks, by primary small-hub respondents, Figure 4.7 shows a comparison of the risk in terms of percentage figures.

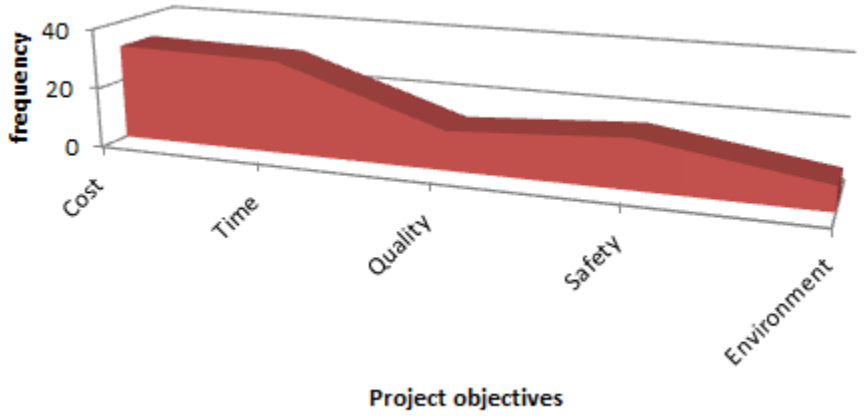


Figure 4.7: Area diagram comparison: frequency of project objectives associated with 32 risks for primary small-hub respondents.

Cost and time are the objectives that are most important to the small primary-hub airport owner, as with primary non-hub and general survey participants, when analyzing the 32 risks. Both project objectives stand at 31.84% and 30.85%, respectively. These objectives are closely followed by safety and quality at 16.42% and 12.94%, which are little higher for small primary-hub airports when compared to primary non-hub airports. (See the following paragraphs for the analysis.) Environment is the last of the five objectives for small primary hubs at 7.96%.Compared to primary non-hub airports, this percentage difference is still significantly higher.

When comparing the 32 risks, as determined by primary small-hub respondents, we can infer that, of the 201 responses to objectives affected by the 32 risks, 64 were cost related (31.8407%), compared to primary non-hub airports where the response percentage for cost was 38.32%, a difference of 6.48%.

In a comparison with primary non-hub airports, primary small hubs would still have cost-related issues associated with the 32 stated risks but would be better equipped, in terms of available internal and external funding options (Gu.L et al, 2009), to deal with the financial issues associated with such risks. A huge factor for these cost related issues would be airport size and enplanement figures (FAA, Airport Categories, 2012). As such, cost objectives are not as much of an issue for primary small-hubs because their impact is minimal in terms of percentage when compared to primary non-hubs. Primary small-hub and primary non-hub airports still go through the issue of government related funding processes and have to deal with the risks associated with such processes because the bulk of funding for such development comes from the AIP (WSDOT, 2012).

Sixty two responses were about time objectives as indicated by primary small-hub respondents. This response is 30.85% of the 201 total responses. When compared to the primary non-hub respondents' percentage value of 37.125%, there is a difference of 6.275%. This comparison indicates how primary non-hub respondents felt that time was a factor that affected them more when faced with the 32 risks. This was in comparison was not as detrimental to the primary small hubs respondents

This difference in time objective responses between the two airports may be based solely on funding acquisition to embark on a project's development and schedules for when the project development should be completed (Touran, 2009). Project permits and funding-approval processes for the governing aviation bodies may have affected the project development schedule for respondents at primary non-hubs to a greater degree than primary small-hub airport respondents. (Refer to Sections 2.8.3 - 2.8.7.) Also, running airports that were smaller in size than the small-hub respondents and having fewer internal and external funding options (Customer Facility Charges or Bond options) available to them, non-hub airport owners need to meet a strict budget set on a project's schedule timeline in order to avoid issues with cost overruns and debt incurrence (Gu.L et al, 2009).

Twenty six responses were indicated for quality as a project objective affected by the 32 risks by primary small-hub respondents (12.94% of the 201 responses given). When compared to primary non-hub percentages for quality (8.38%), a difference of 4.56% was noted. This percentage difference would indicate that primary small-hub respondents felt that quality was a major factor to consider when it came to airport owner activities associated with project development.

Quality objectives would be linked more specifically to the design development and construction phase of project development (WSDOT, 2012). These phases are controlled by contracts, project delivery methods and liabilities (Touran, 2009).The airport owners' input for these phases is based on 1) the governing aviation body with which the airport is working (WSDOT, 2012), 2) the nature of the project delivery methods and contracts being signed, 3) the liabilities assigned with each given document that affect the airport owner (Rakich, 2011) .

The primary small-hub airport owner would face more risk, quality wise, than the primary non-hub owner for the following reasons: 1) minimal activity and input during the development phase (See Section 2.8.5.) where consultants and the governing aviation agencies determine outcomes (WSDOT, 2012), 2) a project delivery method that ties project development liabilities to the airport owner and 3) more complex and sizeable projects in terms of scope (Rakich, 2011).

Projects of such nature, especially at the primary small-hub scale, would cost more to rectify in terms of poor quality when compared to a primary non-hub where the projects are at a smaller scale due to facility size (DOT, 2012).

Thirty-three responses about safety being a project objective affected by the 32 risks were given by the primary small-hub respondents (16.42% of the total 201 responses). When compared to non-hub respondents at 11.97%, a difference of 4.45% was noted. This percentage difference would indicate that primary small-hub airport owners were affected, to a greater degree, by safety related risks than primary non-hub owners were.

A reason for this percentage difference in safety objectives between primary small-hub and non-hub airports could be the magnitude of the project at the given small-hub facility

(Rakich, 2011) as well as the level of insurance the airport owner has to cater to building development issues; airport operation issues (i.e., builders' risk insurance and passenger-injury liability insurance) (Dobberstein, 2013); and OSHA-related policies, procedures, and claims in tandem with the FAA for airport employees (Donell, 2012). With fixed liability coverage for development and operation issues (Dobberstein, 2013) and the likelihood that accidents associated with project development may occur at such facilities (Donell, 2012), small airport owners might be worried that safety related objectives may not be met due to financial limitations.

There were 16 responses from small-hub airport administrators in relation to environmental objectives being affected by the 32 risks (7.96% of the 201 total project objective responses). When compared to primary non-hub respondents (4.192 %,) there was a noted difference of 3.768%, indicating that primary small-hub respondents felt that environmental objectives were of higher priority to affect airport-owner activities than primary non-hub airport owners.

Reasons for the difference in percentage value for environmental objectives for these two airport sizes may be down to permitting related policies and procedures that have negative effects on the project development cost and schedule (WSDOT, 2012), land availability issues for such development that may alter the project development schedule and cost (Horonjeff et al, 1994), and local community opposition to a project's development based on its proposed effect on the development area which affects the project's schedule and cost (Horonjeff et al, 1994). We also have to remember that larger scale projects associated with primary small hubs, in comparison with primary non-hub developments, have a greater impact on the environment where they are developed (Horonjeff et al, 1994). If commercial airports are not planned in a

manner compatible with the environment where they are located, two important characteristics of urban economics will be affected: 1) the need for the airport to meet transportation needs and 2) the continuing demand for community expansion (Horonjeff et al, 1994).

4.3.3. Analysis of the final risk assessment for primary small-hub respondents

Of the 96 assessment scores given for the 32 risks by the 3 respondents in the primary small-hub airport category, the following analysis was inferred: the respondents assessed 13 responses (13.54% of the assessment) associated with the 32 risks as high assessment risks. Medium assessment risks were given for 18 of the 96 responses (18.75% of the total assessment given) and low risk assessment was given to 65 responses associated with the 32 risks (67.71% of the total assessment given). This percentage analysis is seen in Figure 4.8.

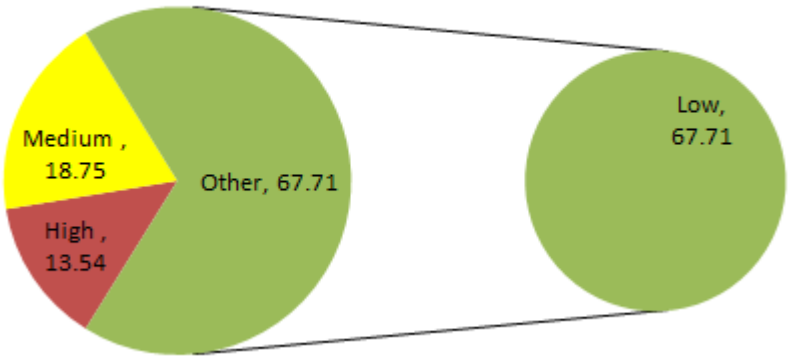


Figure 4.8: Analysis of the overall risk combination assessment for primary small-hub respondents.

Comparing primary non-hubs and primary small-hubs in terms of the percentage risk-assessment figures, it is was noted that primary non-hub airport owners considered a larger portion (15.79%) of the assessment for the 32 risks as high compared to 13.54% as indicated by primary small hubs. Smaller-hub owners considered a larger portion (18.75%) of the 32 risks as

medium risks compared to 13.68% assessed by primary non-hub respondents. In terms of low risk-assessment percentages, both primary non-hubs and primary small hub owners consider a larger portion of the risk assessments directed toward the 32 risks as low. The non-hub percentage was greater (70.52 %) compared to primary small-hub percentages (67.71%).

4.4. Ranking the 32 risks by risk assessment for the general survey respondents

With analysis done for commercial airports based on general response, region and primary hub type, Section 3.3.1, Equation 3.3 and Table 3.10 with values for each individual respondent from the survey are further utilized to rank the 32 risks listed in the survey.

It is important to note that a final ranking of the 32 risks given in Table 3.10 by each respondent is required to determine the highest valued risks based on project objectives. From this ranking, an avenue for which to begin to mitigate for such risk can be presented (Zou et al, 2009).

4.4.1. Ranking of 32 risks based on general responses

Utilizing Equation 3.3 in Section 3.3.1, we are able to acquire an overall risk score for all given risks associated with each given airport facility response as seen in Table 3.10. However, taking this equation a step further to look for the median score of all 9 respondents provides a valid final score from which all 32 risks can be assessed and ranked accordingly. Equation 4.1 shows the $\text{probability} \times \text{impact}^{\text{project objectives}}$ equation utilized to obtain the mean final risk-index scores for each risk. Equation 4.2 shows the mean summation of the final risk index scores for all 9 responses as they equate to each individual risk. (See Equation 3.3 for an initial explanation of the Equation 4.1).

$$r_i^b = \sum_{c=1}^{n} r_{ic}^b = \frac{1}{n}\sum_{c=1}^{n} \alpha_{ic}\, \beta_{ic}^b \qquad \text{(Eq 4.1)}$$

In the new equation, r_i^b = the significance index score for risk *i* based on project objective *b.*

$$(\text{ significance index score }) = \frac{\sum (r_i^b)_k}{9} \quad (\text{ Eq 4.2})$$

k= Ordinal number of responses from 1-9

The summation of these index score values is divided by the total summation of the respondents to provide the final index score. Equations 4.1 and 4.2 were applied to all 9 respondents based on the individual index score each respondent assessed for each individual risk, and a median index score was derived. This median index score was the final index score for all 9 responses and was used as the index score to assess ranking (Zou et al, 2009).

The final index scores acquired from the median score of all 9 respondents in relation to the 32 risks were then ranked in descending order from the highest value to the lowest. In addition to the ranked risk an individual risk assessment value was given to each final risk index score based on the probability × impact matrix values provided in Figure 3.8. The final ranking for the 32 risks is Table 4.3.

Table 4.3: The 32 risks ranked by respondents

Phase	Risk No	Summation of responses	No of responses	Mean	P X I Effect	Risk Rank
1	1	0.114959064	9	0.012773229	Low	21st
1	2	3.90E-01	9	0.04337	Medium	9th
2	3	0.769410938	9	0.085490104	High	2nd
2	4	0.4696875	9	0.0521875	Medium	7th
2	5	0.056325	9	0.006258333	Low	26th
2	6	0.5683125	9	0.063145833	High	4th
2	7	0.566325	9	0.062925	High	5th
3	8	1.54E-02	9	0.001707	Low	31st
3	9	4.23E-01	9	0.046959	Medium	8th
4	10	2.25E-01	9	0.025020	Medium	14th
4	11	1.34E-01	9	0.014932	Low	20th
4	12	0.556225001	9	0.061803	High	6th
4	13	0.9252	9	0.102800	High	1st
4	14	7.68E-02	9	0.008528	Low	23rd
4	15	0.29690073	9	0.032989	Medium	11th
4	16	3.87E-02	9	0.004299	Low	29th
4	17	2.93E-01	9	0.032524	Medium	12th
4	18	0.06025	9	0.006695	Low	24th
4	19	1.77E-02	9	0.001971	Low	30th
4	20	0.59163	9	0.065737	High	3rd
4	21	0.04788	9	0.005320	Low	27th
4	22	1.77E-01	9	0.019683	Medium	17th
4	23	6.78E-03	9	0.000754	Low	32nd
4	24	2.35E-01	9	0.026109	Medium	13th
4	25	0.2187328	9	0.024304	Medium	16th
5	26	0.0581250	9	0.006458	Low	25th
5	27	0.0442500	9	0.004917	Low	28th
5	28	1.53E-01	9	0.016954	Medium	19th
5	29	1.60E-01	9	0.017739	Medium	18th
5	30	3.74E-01	9	0.041522	Medium	10th
5	31	0.2188669	9	0.024319	Medium	15th
5	32	0.1085250	9	0.012058	Low	22nd

4.4.2. Analysis of the final risk ranking table for the 32 risks

There were 6 risks listed as high priority risk assessments. These risks made up 18.75% of the final ranking responses. They were risks 3, 6, 7, 12, 13 and 20, respectively, and are seen in Table 4.4.

Table 4.4: High assessment risks affecting airport ownership activities by ranking.

High assessment risks from the final ranking process
3) Government intervention and bureaucracy in funding related processes.
6) Inadequate internal funding options (ie) airport user fees & (etc) to cover airport facility development
7) Debt accruement which cannot be effectively balanced by the owner of the project
12) Litigation issues arising from negligence of safety related processes on site during construction phase of development.
13) Permitting related processes (i.e.) Environmental impact statement approval pre development (etc.) that slow down project development process.
20) Project design constructability issues afecting project cost

The top ranking risk for the final risk table was risk 13, with an assessment value of 0.102800. This risk was driven predominantly by governing aviation body processes and procedures for site permitting related processes (WSDOT, 2012).

The least ranking high assessment risk was risk 12, with an assessment value of 0.061803. This risk is predominantly driven in the construction phase of project development and is linked to FAA and OSHA related safety guidelines that must be followed during the course of project development by both airport and construction staff (Donell, 2012). This risk also takes contract stipulations, clauses and project-delivery methods into account as well as their noted effect on airport ownership (Touran, 2009).

There were 12 risks listed as medium priority risk assessments. These risks made up 37.5% of the final risk ranking responses. They were risks 2, 4, 9, 10, 15, 17, 22, 24, 25, 28, 29, 30 and 31, respectively, and are seen in Table 4.5.

Table 4.5: Medium assessment risks affecting airport ownership activities by ranking.

Medium assessment risk from the final ranking process
2) Project type and scope misrepresentation due to poor planning and feasibility related studies.
4) Project schedule affected by delays from numerous funding approval processes.
9) Planning procedures affected by government approval & associated processes .
10) Local community opposition to project development
15) Project schedule affected by review time for project development in aviation governing bodies review agencies
17) Monitoring equipment and communication during capital project development
22) Land development issues (eminent domain /sacred burial grounds) stall project devlopment process
24) The negative effects of " Acts of God " on project development
25) Construction activities negatively affect current airport operations
28) Unidentified maintenance issues affecting the current maintenance process
29) Funding provision for certain aspects of maintenance by governing aviation bodies limiting scope of maintenance project
30) Negative effects of maintenance activities on airport operations
31) Monitoring equipment and communication during maintenance activities

Of the 12 risks, risk 4 was the highest ranked medium assessment risk, with a value of 0.0521875. This risk was driven by government policies, procedures and approval processes for fund related acquisition (WSDOT, 2012).

The lowest ranking medium assessment risk was risk 28, with a value of 0.016954. This risk was driven by consultant related error (Gabel, 2010).

There are 14 risks listed as low assessment risks. These risks make up 43.75% of the final risk ranking response. They are risks 1, 5, 8, 11, 14, 16, 18, 19, 21, 23, 26, 27 and 32, respectively, and are seen in Table 4.6.

Table 4.6: Low assessment risks affecting airport ownership activities by ranking.

Low assessment risk from the final ranking process
1) Conflict of interest between ownership and other involved parties whilst determining initial project parameters
5) Litigation issues associated with default payments on external funding options (loans / bonds)
8) Project varaitions leading to associated disputes between project parties & ownership
11) Occurrence of dispute between ownership and aviation governing bodies over policy requirements for development
14) Cyber threat related issues
16) Consultant staff hired unable to meet project requirememts and standards
18) Disasater preparation issues
19) Security threat on facilities posed by airport development
21)Utilization of unfavorable project delivery methods that negatively affect airport owernship finances
23) Contract related disputes
26) Inspection procedures of aviation governing bodies affect maintenance schedule of project and its associated objectives.
27) The possibility of cyber threats
32) Disaster preparation issues

The highest of the low risk assessment risks was risk 11, with an index score of 0.014932. As a risk, it would be considered relatively minimal because policy and procedural requirements for airport development project approvals are determined by the FAA (DOT, 2012). An airport owner would have little to no say in matters concerning the requirements to meet in terms of project development (WSDOT, 2012).

The lowest of the low risk assessment risks was risk 23, with an index score of 0.000745. Contracts are determined in tandem with the FAA, airport owner and potential consultants prior to the design development and construction phases (WSDOT, 2012). The contract type and project delivery method usually determine who bears the liabilities associated with the project in these given phases (Touran, 2009). Therefore, the airport owner would have a contingency beforehand to support liabilities if there were any associated with project development (Hart, 2007).

4.4.3. Conclusion of the analysis for the final risk ranking table for the 32 risks

The rankings for high, medium and low assessment risks ignore the risk impact on a particular project objective because significance scores for each individual risk are usually offset by their low level of impact on other project objectives (Zou et al, 2009). Utilizing a risk ranking based on the identified risks significance index score on individual project objectives will identify key risks that affect project objectives and provide a comprehensive list of the risks (Zou et al, 2009).This approach is taken for the next section, and the top 10 risks for each project objective are determined in Section 4.5.

4.5. Determining the Top 10 risks associated with each project objective

The process for determining the top 10 risks for each project objective is an addition to the final risk-assessment and ranking process. In this process, Equation 4.1 is reemployed and modified with the multiplication of the frequency (g) associated with the project objective being analyzed. Equation 4.3 is the modified project objective index (MPI). It is important to note that the frequency (g) changes as the specific project objective indicated as affected by risk changes; therefore, the value for Equation 4.3 changes with each risk.

$$MPI = r_i^b \times \mathrm{g} \qquad \text{(Eq 4.3)}$$

An example would be a cost project objective determination for risk 13 on the final risk-assessment table (review Table 4.3, under the mean column). This value is 0.102800. Multiply this value by the frequency (g) of the project objective for cost that is indicated as being affected by risk 13 by respondent. This value would be 6. These two values stated are multiplied to give the modified project objective index score (MPI) for cost. This value is 0.6168. Once computed,

this value is then multiplied by the relative frequency or the project objective index. The project objective frequency index in this application is the total number of times an individual project objective was recorded over a summation of the total number of project objectives indicated. The project objective frequency index application is given in Equation 4.4.

$$f_i = \frac{\sum_{i=1}^{32} n_{i,j}}{\sum N i_j} \quad \text{(Eq 4.4)}$$

Where f_i= relative frequency of the project objective, n_i = the number of times and event occurs, $\sum N\ i_j$ = the total number of project objectives assessed by respondents, j = the project objective being assessed, $\sum_{i=1}^{32} n_i, j$ = the subtotal of the specific project objective assessed by respondents for all 32 risks.

Equation 4.4: Relative frequency of the project objective being analyzed (Zou et al, 2009).

An example would be a scenario to determine the relative frequency for the project's objective cost affected by the 32 risks as indicated by the participants; final survey responses. Cost was frequented 198 times; in Equation 4.4 this would be$\sum_{i=1}^{32} n_i, j$. The total number of project objectives indicated as being affected by the 32 risks (cost, time, quality, environment and safety) is 528; In Equation 4.4 this is$\sum N\ i_j$. f_i(Relative frequency) .For the project objective cost this would be equal to $\frac{198}{528}$ = 0.331104. It is important to note that f_i is a constant for all risks being analyzed for effects with regard to a particular project object. Therefore, the frequency index number (f_i) for the cost indicated above would be used to multiply the modified project objective index for cost that changes for each individual risk associated with the 32 final

risk assessment values. Equation 4.5 is a multiplication of MPI and f_i to determine the final index score (FIS) associated with a particular risk number.

$$FIS = MPI \times f_i \quad \text{(Eq 4.5)}$$

Where *FIS* = final index score, MPI = modified project-objective index and f_i = frequency index

Equation 4.5: Final project objective index scores

For the example stated, we can infer that the final significance index score for the cost objectives affected by risk 13 in the final risk assessment table is $0.102800 \times 0.6168 \times 0.331104 = 0.2042248$.

This same process was used for the 5 different project objectives affected by the 32 risks given by respondents to acquire 32 different values as associated with each given project objective. From the 32 values allocated to the 5 different project-objective categories, the top 10 values were ascertained by ranking. Tables 4.50-4.54 show the Top 10 risks developed for each project objective affected by the 32 risks by following the procedure listed in Section 3.5.A listing of the Top 10 risk by each given project objective can be seen in Table 4.7 – 4.11 below.

Table 4.7: Top 10 Cost related risks that affect airport ownership activities

PHASE	Top Ten Ranked Cost Related Risks	Index scores
4	1) Permitting related processes that slow down project development process.	0.204224749
2	2) Government intervention and bureaucracy in funding related processes prior to project development .	0.14153044
4	3) Project design constructability issues afecting project cost	0.130593913
2	4) Inadequate internal funding options (ie) airport user fees & (etc) to cover airport facility development	0.125446906
2	5) Debt accruement which cannot be effectively balanced by the owner of the project	0.125008194
4	6) Litigation issues arising from negligence of safety related processes on site during construction phase of development.	0.122778763
1	7) Project type and scope misrepresentation due to poor planning and feasibility related studies.	0.100519814
2	8) Project schedule affected by delays from numerous funding approval processes.	0.086397366
3	9) Planning procedures affected by government approval & associated processes .	0.077741465
5	10) Negative effects of maintenance activities on airport operations	0.068741112

Table 4.8: Top 10 Time related risks that affect airport ownership activities

PHASE	Top Ten Ranked Time Related Risks	Index scores
4	1) Permitting related processes that slow down project development process.	0.316187879
2	2) Government intervention and bureaucracy in funding related processes.	0.197210127
4	3) Project design constructability issues afecting project cost	0.176916294
2	4) Project schedule affected by delays from numerous funding approval processes.	0.160516098
2	5) Inadequate internal funding options (ie) airport user fees & (etc) to cover airport facility development	0.145665956
2	6) Debt accruement which cannot be effectively balanced by the owner of the project	0.145156534
4	7) Litigation issues arising from negligence of safety related processes on site during construction phase of development.	0.142567772
1	8) Project type and scope misrepresentation due to poor planning and feasibility related studies.	0.13339567
3	9) Planning procedures affected by government approval & associated processes .	0.108325843
5	10) Negative effects of maintenance activities on airport operations	0.095784648

Table 4.9: Top 10 Quality related risks affect airport ownership activities

PHASE	Top Ten Ranked Quality Related Risks	Index scores
1	1) Project type and scope misrepresentation due to poor planning and feasibility related studies.	0.022588553
2	2) Government intervention and bureaucracy in funding related processes.	0.017810438
4	3) Project design constructability issues afecting project cost	0.013695139
2	4) Inadequate internal funding options (ie) airport user fees & (etc) to cover airport facility development	0.013155382
2	5) Project schedule affected by delays from numerous funding approval processes.	0.010872396
2	6) Consultant staff hired unable to meet project requirememts and standards	0.001343503
1	7) Planning procedures affected by government approval & associated processes .	0.009783122
1	8) Conflict of interest between ownership and other involved parties whilst determining initial project parameters	0.006652724
4	9) Litigation issues arising from negligence of safety related processes on site during construction phase of development.	0.006437789
4	10) Disasater preparation issues	0.000697367

Table 4.10: Top 10 Safety related risks that affect airport ownership activities

PHASE	Top Ten Safety Related Risks	Index scores
2	1) Litigation issues arising from negligence of safety related processes on site during construction phase of development.	0.01650415
4	2) Construction activities negatively affect current airport operations	0.00865357
3	3) Planning procedures affected by government approval & associated processes .	0.00836012
1	4) Project type and scope misrepresentation due to poor planning and feasibility related studies.	0.00772118
4	5) Project design constructability issues affecting project cost	0.00585156
4	6) Monitoring equipment and communication during capital project development	0.00579026
4	7) The negative effects of " Acts of God " on project development	0.00464822
5	8) Monitoring equipment and communication during maintenance activities	0.00432944
4&5	9) Disaster preparation issues	0.00429437
4	10) Local community opposition to project development	0.00222714

Table 4.11: Top 10 Environment related risks that affect airport ownership activities

PHASE	Top Ten Environment risks	Index scores
4	1) Permitting related processes that slow down project development process.	0.014602273
1	2) Project type and scope misrepresentation due to poor planning and feasibility related studies.	0.00410701
4	3) Local community opposition to project development	0.003553948
4	4) Project design constructability issues affecting project cost	0.003112532
4	5) Land development issues (eminent domain /sacred burial grounds) stall project devlopment process	0.002795852
5	6) Negative effects of maintenance activities on airport operations	0.001966023
4	7)Monitoring equipment and communication during capital project development	0.001539964
4	8) Occurrence of dispute between ownership and aviation governing bodies over policy requirements for development	0.00144061
4	9)The negative effects of " Acts of God " on project development	0.001236229
5	10) Funding provision for certain aspects of maintenance by governing aviation bodies limiting scope of maintenance project	0.000839898

In total, it was determined that 51 risks were responsible for affecting all 5 project-objective categories associated with airport owner activities. We acquire 51 as the number for the 5 project objective categories based on the repetition of risk 9 in the Top 10 safety related risks affecting airport ownership (Refer to Table 4.10).This risk occurred in the capital and maintenance activity phases of commercial development.

4.5.1. Top 10 project objective risks and their impact on the phases in which they occur

Prior to survey dissemination, the 32 risks were organized according to the phases in which it was believed that such risks would occur. These phases were listed from phase 1-5, and risks associated with each phase were listed in descending order of rank. The phases followed the order in which the project cycle for a commercial-airport development or maintenance project would occur. (Refer to Sections 2.8.1-2.9.1.) Sources such as WSDOT (2012), Horonjeff et al. (1994) and (FAA, Primary Airports, 2012) were utilized to determine the appropriate phases of the project cycle. Table 4.12 shows the phases utilized to organize the 32 risks.

Table 4.12: Phases utilized in organizing the 32 risks.

Project Cycle for Commercial Airport Project Develoment (Capital & Maintenance)
Risk (Phase one) Airport project type & Project size determination
Risk (Phase two) Airport Funding Levels (Federal / State / Local)
Risk (Phase three) Project & Government associated planning procedures (Project description / Goals & objectives / Strategic planning)
Risk (Phase four) Activities associated with commercial capital projects
Risk (Phase five) Maintenance development : Activities associated with Commercial airport maintenance projects

With the Top 10 project objective risks per category determined, it is now possible to see the phases where such risks occur. This way, the airport owner is able to foresee what project objectives are affected by these Top 10 risks based on phase location. By reviewing each top 10 project-objective risk category, the following analysis was inferred.

In the top 10 risk category affecting cost project objectives associated with airport owner activities, 10% of such risks occurred in phase 1, 40% occurred in phase 2; 10% occurred in phase 3; 30% occurred in phase four; and 10% occurred in phase five. Of the five phases, the cost objectives for phases two and four were affected the most by the Top 10 risks associated

with the cost project objectives. These phases are phase 2, airport funding levels (federal/state/local), and 4, commercial capital project activities. Phases one, three and four were affected the least by these risks. This analysis can be seen in Figure 4.9.

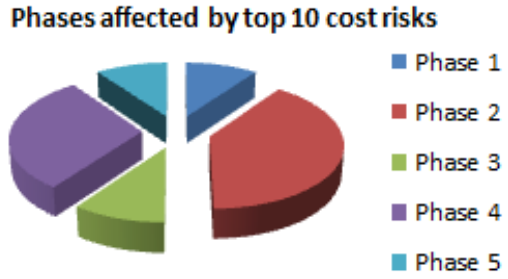


Figure 4.9: A breakdown of the phases where the Top 10 risks affecting cost project objectives occur.

In the Top 10 risk category affecting the time objectives associated with airport owner activities, distribution of risks among differing phases (in %) was exactly the same as that of cost in the previous paragraph. Phases 2 and 4 were affected the most by the Top 10 risks associated with time objectives. These phases were phase 2, project type and size determination, and phase 4, airport funding levels (federal/state/local), while phases one, three and four were affected the least by these risks. This analysis is seen graphically in Figure 4.10.

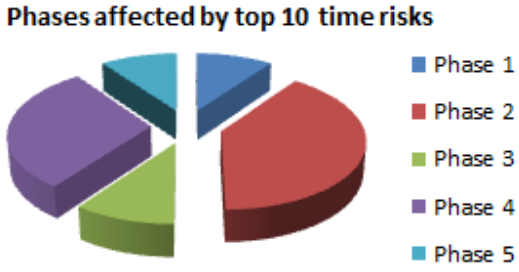


Figure 4.10: A breakdown of the phases where the Top 10 risks affecting time project objectives occur.

For the Top 10 risks affecting the quality objectives associated with airport owner activities, 30% of the risks occurred in phase one; 40% occurred in phase two; 0% occurred in phase three; 30% occurred in phase four; and 0% occurred in phase five. Different from cost and time, the quality objectives affected by the Top 10 quality risks occurred more in phases one, three and four of an airport's project development. These phases are associated with, phase 1, project size and scope determination; phase 3, project and government associated planning procedures; and phase 4, commercial capital project activities. This analysis is graphically seen in Figure 4.11.

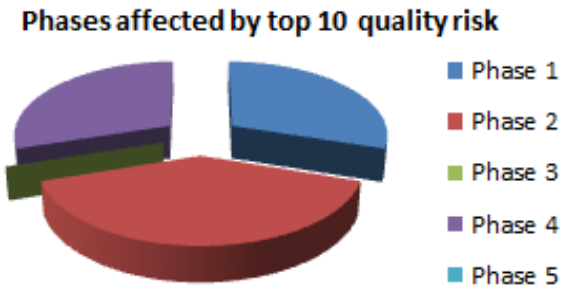


Figure 4.11: A breakdown of the phases where the Top 10 risks affecting project quality objectives occur.

For the Top 10 risks affecting the safety objectives associated with airport-owner activities, 10% of the risks occurred in phase one, 10% in phase two, 10% in phase three, 60% in phase four and 20% in phase five. The majority of the Top 10 risks associated with affecting the quality objectives associated with project development occurred in phases four and five. These phases were as follows: 4) commercial capital project activities and 5) maintenance development: activities associated with commercial airport maintenance projects. Other phases were affected to a lesser extent by the safety objectives and associated risks. The comparison above is represented graphically in Figure 4.12.

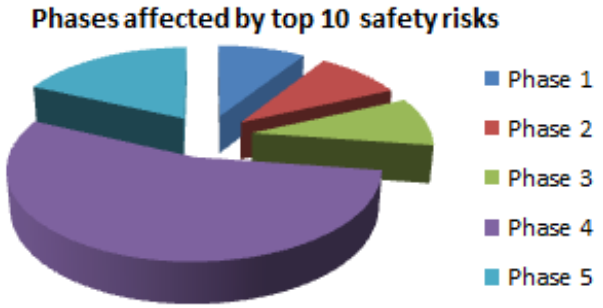


Figure 4.12: A breakdown of the phases where the Top 10 risks affecting project safety objectives occur.

The last of the five Top 10 risk categories that affect project objectives associated with ownership activities is environment. When reviewed in terms of this objective being affected by the Top 10 risks in the category, 10% of these risks occurred in phase one, 10% in phase two, 10% in phase three, 60% in phase four and 20% in phase five. The majority of the risks that affect environmental objectives associated with airport owner activities occurred in phases four and five. These phases were as follows: 4) commercial capital project activities and 5) maintenance development: activities associated with commercial airport maintenance projects. Phases one through three were affected similarly by the Top 10 environmental risks but were minimally less than the occurrence of the environmental risks in phases four and five. This analysis can be seen graphically in Figure 4.13.

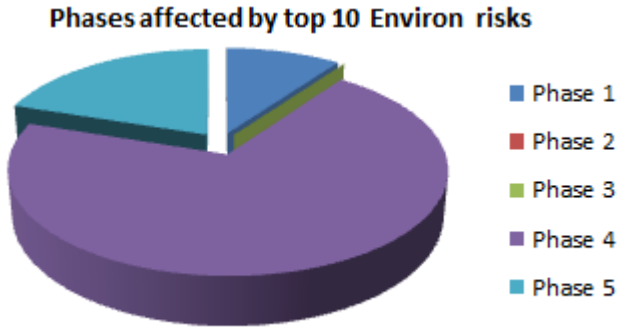


Figure 4.13: A breakdown of the phases where the Top 10 risks affecting environment objectives occur.

4.5.2. General analysis of the Top 10 Project objective risks and their emphasis on C.A.D phases

From the data represented above, we can infer that, in phase one, 13.725% of the 51 risks linked to affecting the 5 project objectives occurred. In phase two, 25.49% of the 51 risks occur; in phase three, this is slightly less with 5.88%. In phase four, 43.13% of the 51 risks occur while 11.76% occur in phase five. This analysis is noted graphically in Figure 4.14.

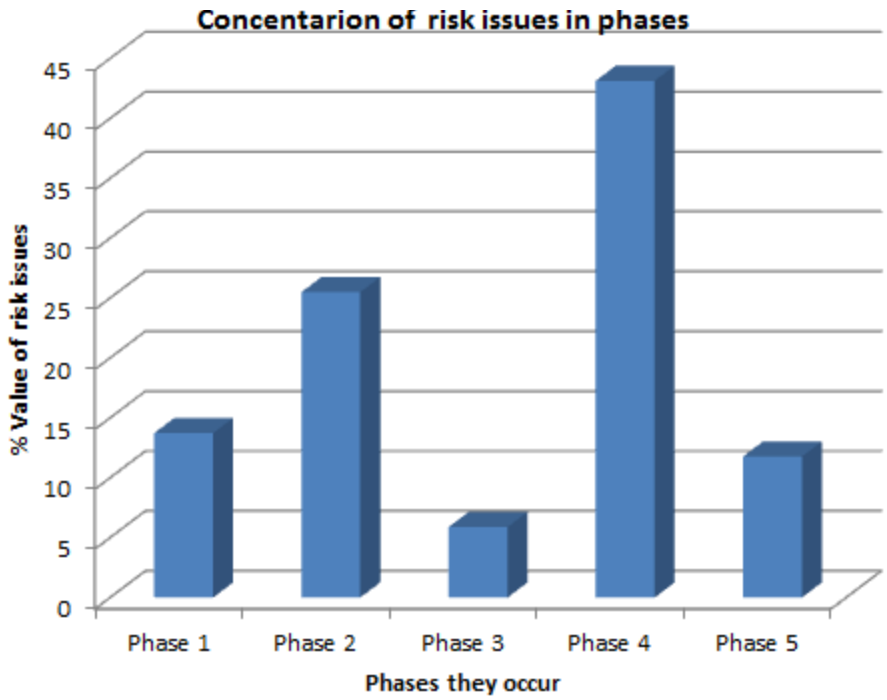


Figure 4.14: A graphical comparison of the 51 risks determined as affecting the 5 key project objectives.

Despite phase four being the area with the most risk concentration, the objectives indicated as being affected the most were environmental or safety related. These objectives had the smallest number of indications when compared to other project objectives affected by the 51 risks. Safety pulled in 47/528 general responses (8.90%), and environment pulled in 25/528 responses (4.73%). However, phase four tied in with capital project development activities, and

safety and environmental objectives were a big issue with permitting and construction-related processes within this phase (WSDOT, 2012). It is safe to say that, despite their relatively low indication within the general project objectives, these two categories were affected to a larger degree by risk in phase four than any of the other objectives when associated with airport-ownership activities.

Most of the objectives affected in phase two were time, quality and cost related. Despite being lower in project objective concentration (%) affected by risk than phase 4, the survey users' responses showed that cost objectives indicated as affected pulled in 192/528 of general responses for project objectives (37.5%), that time pulled in 203/528 responses (38.45%) and that quality pulled in 55/528 responses (10.42%). However, phase two, airport funding levels in relation to airport owner activities was where cost; time and quality objectives associated with airport owner activities were affected the most. (Refer to Section 2.8.3.)

In phase one, the project objective affected the most by the 51 listed Top 10 risks was quality. This was despite the general responses of survey participants where it was listed 55/528 times (10.42%) as being affected by the 32 general risks.

Phase one deals with airport type and size determination, and the project objective quality is affected by the risk , project type and scope misrepresentation due to poor planning and feasibility related studies (Caltrans, 2007).This has its effects on the overall project cycle associated with project development. An example of this risk can be seen in the Denver International Airport baggage handling system where an underestimation of project complexity, a change in the initial project strategy, and the decision to proceed with the strategy change by airport management and its associated project management team caused the final project to

suffer from a plethora of quality related deficiencies and affected capital cost. The airport opening was delayed by 16 months and cost the city of Denver $1.1 million a day in loan costs to maintain the empty airport. The maintenance issues associated with the handling system continued during the airport's operational phase where $1 million per month was spent on maintaining the system until its eventual abandonment by the airport in 2005 (Consulting, 2008).

In phase three, the project objectives affected by the 51, Top 10 risks were safety, cost and time. These objectives were even in response rates when reviewed according to the Top 10 risks for each project objective category.

Phase three, project and government-associated planning procedures (project description/goals/strategic planning) is controlled predominantly by the governing aviation agencies (WSDOT, 2012). These governing agencies, as well as their policies, procedures and final verdicts, affect funding disbursement, project schedules and associated project safety plans with available funding for disbursement (Horonjeff et al, 1994). As such, these agencies will be having noted effect on an airport's management activities.

4.6. Producing a Top 20 key risk list for a project cycle in C.A.D development

Reviewing the top 10 risks in for each project objective category, it was clear that there were some repetitions in risk within each category (i.e.) project type and scope misrepresentation due to poor planning and feasibility studies (phase 1) was indicated in all 5, Top 10 risks affecting each individual project objective, despite its rank varying due to changes in its index score based on each represented project objective. In order to avoid repetition and to produce a final, filtered list of risks that affect all objectives to a larger extent, a Top 20 key risk list was

developed. This Top 20 list took into account the following objective: 1) the frequency of risk in all given Top 5 project objective categories. This Top 20 key risk list can be seen in Table 4.13.

Table 4.13: Frequency of occurrence for the Top 10 risks listed by project objective categories

PHASE	Frequency list of top 10 risks associated with the 5 different project objectives	Frequency
4	Permitting related processes that slow down project development process.	3
2	Government intervention and bureaucracy in funding related processes.	3
4	Project design constructability issues affecting project cost	5
2	Inadequate internal funding options (ie) airport user fees & (etc) to cover airport facility development	3
2	Debt accruement which cannot be effectively balanced by the owner of the project	2
4	Litigation issues arising from negligence of safety related processes on site during construction phase of development.	4
1	Project type and scope misrepresentation due to poor planning and feasibility related studies.	5
2	Project schedule affected by delays from numerous funding approval processes.	3
1	Planning procedures affected by government approval & associated processes .	4
5	Negative effects of maintenance activities on airport operations	3
4&5	Disasater preparation issues	2
4	The negative effects of " Acts of God " on project development	2
4	Local community opposition to project development	2
5	Monitoring equipment and communication during maintenance activities	2
1	Conflict of interest between ownership and other involved parties whilst determining initial project parameters	0
4	Land development issues (eminent domain /sacred burial grounds) stall project devlopment process	0
4	Occurrence of dispute between ownership and aviation governing bodies over policy requirements for development	0
4	The negative effects of " Acts of God " on project development	0
4	Construction activities negatively affect current airport operations	0
2	Consultant staff hired unable to meet project requirememts and standards	0

2) A mean value FIS indicated in Equation 4.6.

$$FIS_{(mean)} = \frac{\sum FIS}{g_{top10}} \quad \text{(Eq 4.6)}$$

Where $FIS_{(mean)}$ = the mean value of the highest frequency Top 10 risk index scores, $\sum FIS$ = the summation of all index scores associated with frequented risk, g_{top} = the number of times frequented risk occurred in the Top 10 risks associated with the 5 different project objectives.

3) For risk indicated in Table 4.13 with no given value, their original FIS scores are utilized for ranking purposes.

Table 4.14 shows the final Top 20 risks affecting airport owner activities based on these risks new index scores.

Table 4.14: FIS (Mean) index numbers for the Top 20 risks affecting project objectives associated with airport owner activities.

PHASE	Frequency list of top 10 risks associated with the 5 different project objectives	Frequency	sum of FIS	FIS (Mean)
4	Permitting related processes that slow down project development process.	3	0.56698316	0.188994388
2	Government intervention and bureaucracy in funding related processes.	3	0.3767182	0.125572734
4	Project design constructability issues affecting project cost	5	0.34893077	0.069786153
2	Inadequate internal funding options (ie) airport user fees & (etc) to cover airport facility development	3	0.30185524	0.100618412
2	Debt accruement which cannot be effectively balanced by the owner of the project	2	0.28917074	0.14458537
4	Litigation issues arising from negligence of safety related processes on site during construction phase of development.	4	0.30647579	0.076618947
1	Project type and scope misrepresentation due to poor planning and feasibility related studies.	5	0.28132628	0.056265255
2	Project schedule affected by delays from numerous funding approval processes.	3	0.27090349	0.090301164
1	Planning procedures affected by government approval & associated processes .	4	0.2154135	0.053853375
5	Negative effects of maintenance activities on airport operations	3	0.17717365	0.059057882
4&5	Disasater preparation issues	2	0.01054393	0.005271964
4&5	The negative effects of " Acts of God " on project development	2	0.00589735	0.002948673
4	Local community opposition to project development	2	0.00565129	0.002825644
4	Monitoring equipment and communication during capital development activities	2	0.00734629	0.003673146
1	Conflict of interest between ownership and other involved parties whilst determining initial project parameters	1	0.00590389	0.00590389
5	8) Monitoring equipment and communication during maintenance activities	1	0.00439432	0.004394316
4	Land development issues (eminent domain /sacred burial grounds) stall project devlopment process	1	0.00266748	0.002667484
4	Occurrence of dispute between ownership and aviation governing bodies over policy requirements for development	1	0.00134914	0.001349136
4	Construction activities negatively affect current airport operations	1	0.00878325	0.008783248
2	Consultant staff hired unable to meet project requirememts and standards	1	0.01191773	0.01191773

It is important to note that 6 risks in the top 20 did not possess a frequency; therefore, their original FIS final index score (FIS) is utilized for ranking purposes. These risks are highlighted in red in Table 4.14.

Once all 20 index numbers were acquired, ranking the top 20 risks was implemented. Table 4.15 shows the final risk rank table for the Top 20 risks associated with all project objectives that affect airport owner activities.

Table 4.15: Final ranked Top 20 risks with their associated abbreviations and index scores.

PHASES	Final Top 20 Key Risks that affect Commercial Airport Ownership / Administration project objectives	Abbreviation	Index Score
4	1) Permitting related processes (i.e.) Environmental impact statement approval pre development (etc.) that slow down proje	PRP	0.188994388
2	2) Debt accruement which cannot be effectively balanced by the owner of the project	DAB	0.14458537
2	3) Government intervention and bureaucracy in funding related processes.	GIBF	0.125572727
2	4) Inadequate internal funding options (ie) airport user fees & (etc) to cover airport facility development	IIFP	0.100618412
2	5) Project schedule affected by delays from numerous funding approval processes.	PSDFP	0.09031164
4	6) Litigation issues arising from negligence of safety related processes on site during construction phase of development.	LINSP	0.076618947
4	7) Project design constructability issues afecting project cost	PDCPC	0.069786153
5	8) Negative effects of maintenance activities on airport operations	NMAAO	0.059057882
1	9) Project type and scope misrepresentation due to poor planning and feasibility related studies.	PTSMPF	0.056265255
3	10) Planning procedures affected by government approval & associated processes .	PPGAP	0.053853375
2	11) Consultant staff hired unable to meet project requirememts and standards	CSURD	0.01191773
4	12)Construction activities negatively affect current airport operations	CANCAP	0.008783248
1	13) Conflict of interest between ownership and other involved parties whilst determining initial project parameters	CIOIP	0.00590389
4&5	14) Disasater preparation issues	DPI	0.005271964
5	15) Monitoring equipment and communication during maintenance activities	MECMPD	0.004394316
4	16) Monitoring equipment and communication during capital project development	MECCPD	0.003673146
4&5	17) The negative effects of " Acts of God " on project development	NAGPD	0.002948673
4	18) Local community opposition to project development	LCOPD	0.002825644
4	19) Land development issues (eminent domain /sacred burial grounds) stall project devlopment process	LDIPDP	0.002667484
4	20) Occurrence of dispute between ownership and aviation governing bodies over policy requirements for development	ODOGB	0.001349136

4.6.1. Analysis of the Top 20 key risks for a project cycle associated with C.A.D

From Table 4.15, we can review the FIS' of the available risks and determine that the range of scores associated with risks fall within 0.19-0.001349; utilizing the risk assessment matrix in Figure 3.81 acquired from Gabel (2010), we can infer that this range is from high assessment to low assessment risks. Table 4.16 shows the breakdown of risk assessment by color, where red indicates high assessment risk (0.54-0.0675), yellow indicates medium assessment risk (0.18-0.0175) and green indicates low assessment risk (0.015-0).

Table 4.16: Risk assessment for the Top 20 risks.

PHASES	Final Top 20 Key Risks that affect Commercial Airport Ownership / Administration project objectives	Abbreviation	Index Score
4	1) Permitting related processes (i.e.) Environmental impact statement approval pre development (etc.) that slow down proje	PRP	0.188994388
2	2) Debt accruement which cannot be effectively balanced by the owner of the project	DAB	0.14458537
2	3) Government intervention and bureaucracy in funding related processes.	GIBF	0.125572727
2	4) Inadequate internal funding options (ie) airport user fees & (etc) to cover airport facility development	IIFP	0.100618412
2	5) Project schedule affected by delays from numerous funding approval processes.	PSDFP	0.09031164
4	6) Litigation issues arising from negligence of safety related processes on site during construction phase of development.	LINSP	0.076618947
4	7) Project design constructability issues afecting project cost	PDCPC	0.069786153
5	8) Negative effects of maintenance activities on airport operations	NMAAO	0.059057882
1	9) Project type and scope misrepresentation due to poor planning and feasibility related studies.	PTSMPF	0.056265255
3	10) Planning procedures affected by government approval & associated processes .	PPGAP	0.053853375
2	11) Consultant staff hired unable to meet project requirememts and standards	CSURD	0.01191773
4	12)Construction activities negatively affect current airport operations	CANCAP	0.008783248
1	13) Conflict of interest between ownership and other involved parties whilst determining initial project parameters	CIOIP	0.00590389
4&5	14) Disasater preparation issues	DPI	0.005271964
5	15) Monitoring equipment and communication during maintenance activities	MECMPD	0.004394316
4	16) Monitoring equipment and communication during capital project development	MECCPD	0.003673146
4&5	17) The negative effects of " Acts of God " on project development	NAGPD	0.002948673
4	18) Local community opposition to project development	LCOPD	0.002825644
4	19) Land development issues (eminent domain /sacred burial grounds) stall project devlopment process	LDIPDP	0.002667484
4	20) Occurrence of dispute between ownership and aviation governing bodies over policy requirements for development	ODOGB	0.001349136

In order to better validate the Top 20 key risks affecting all phases of project development associated with airport owner activities, a comparison of these risks in relation to the Top 10 risks for each project objective category was done utilizing the radial diagram in Figure 4.15. A similar approach was utilized by Zou et al. (2009) in the study about the identification of key risks for construction projects: lifecycle and stakeholders' perspective (Zou et al, 2009).

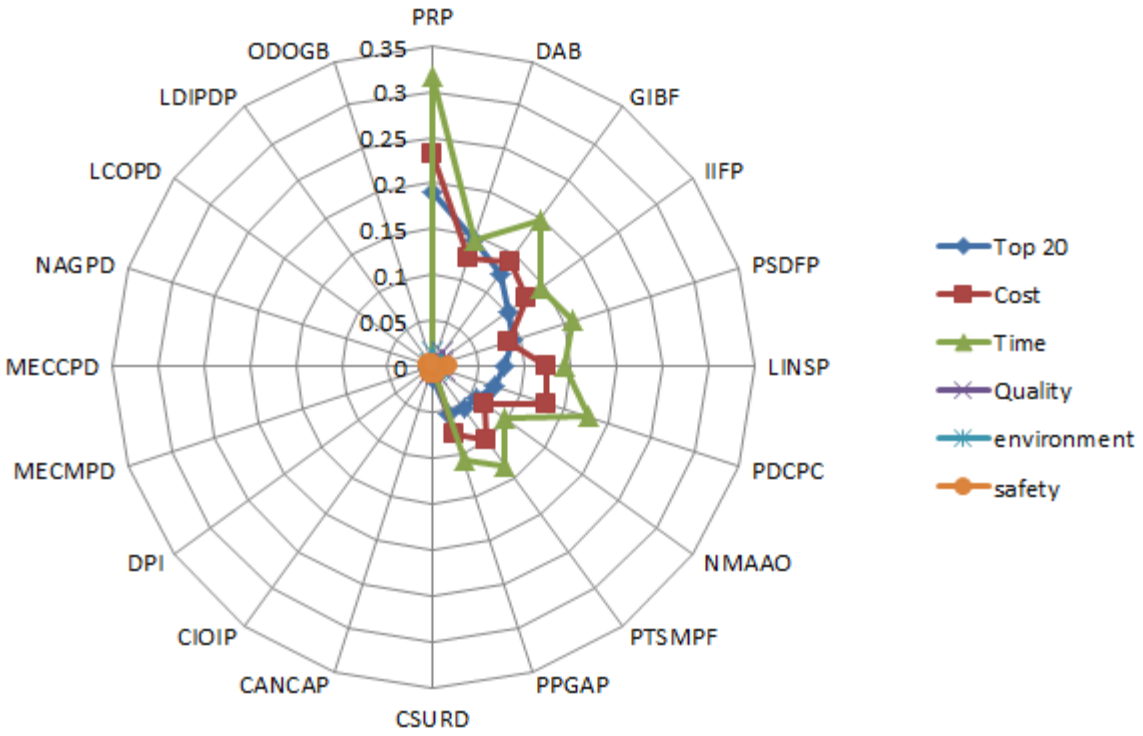


Figure 4.15: Comparison of the Top 20 key risks affecting the airport development project cycle and the Top 10 risks affecting project objectives.

It should be noted that, when FIS (mean) was utilized to determine the top 20 risks affecting the project cycle associated with airport's project development, the FIS numbers changed and, in some cases, were lower than the Top 10 risks affecting each project objective. However, the range for high assessment risks and medium assessment risks associated with the Top 20 key risks and the Top 10 project objectives by category was 0.31687879-0.13339567. This range was seen for the PRP, DAB, GIBF, IIFP, PSDFP, LINSP, PDCPC, NMAAO, PTSMPF and PPGAP risks (Table 4.16) and was similar for time and cost objectives as well as the Top 20 key risks. Quality, environment and safety related risks located in the lower half of the Top 20 key risk table fell within the lower medium to low assessment risk range 0.017810438-0.000697367 and coincided with the quality, safety and environment Top 10 project objective risks within this region. We can infer from this analysis that the top half of the

Top 20 key risks was cost and time related while the bottom half of the same category was quality, time and safety related. This finding also validated the accuracy of the Top 20 key risks because the range correlated with the range associated with quality, safety and environment risks as seen in Figure 4.15.

It is important to regard all risks in the Top 20 key risk category as important, irrespective of varying assessment due to the fact that, in a project cycle, such risks may occur as a group combination, throwing off the scale of probability × impact.

Of the Top 20 risks occurring in the phases, 2 occurred in phase one; 5 occurred in phase 2; 1 occurred in phase three; 10 occurred in phase 4; and 3 occurred in phase 5. This analysis can be seen in Figure 4.16. The analysis would indicate that the Top 20 key risks associated with airport ownership activities and the Top 10 risks affecting individual project objectives affect phase 4 the most. Phase 4 would be a phase to which airport ownership should pay attention.

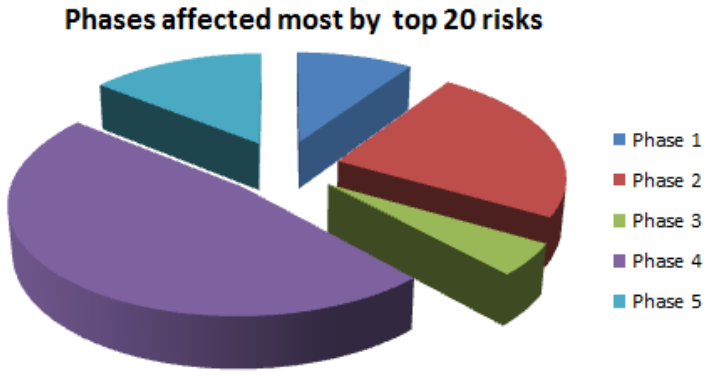


Figure 4.16: Phases affected by the Top 20 key risks associated with airport ownership activities in commercial airport development.

From the data represented in Table 4.73, a fishbone diagram (Figure 4.17), associated with the Top 20 key risks, allocates these risks to their respective project parties in tandem with the airport owner, and shows the phases where such risks occur and the possible combined

grouping where they could occur within their given phases. This fish bone diagram was utilized in the Zou et al. (2009) study about the identification of key risks in construction projects: lifecycle and stakeholders' perspective.

To determine the full meaning of the abbreviated risks stated in the fishbone diagram, review Figure 4.17 below. Also see Table 4.12 for phase description of identified risks. It is also important to note that the project objectives associated with these key risks are cost, quality, time, safety and environment (Zou et al, 2009).

In Figure 4.17, it was determined that risks which could occur simultaneously would be paired together within the project development phase where they occurred. It should be noted that risk is a probability occurrence and not a fixed variable; therefore, there is no notion that indicates a single risk will occur in a project development phase by itself. An example of such risk pairing would be the pairing of DPI and NAGPD as risks that could occur simultaneously in capital-development activities. NAGPD (the negative effects of "Acts of God" on project development) is a risk issue that can be forecasted but not necessarily 100% determined (Caltrans, 2007). The risk, disaster preparation issues (DPI), preps for such negative effects of "Acts of God" but, as a process, can have negative effects on project development if not properly planned (Tummala, 1999). Due to their similarity (they are both affected by natural acts of God and deal with the negative effects associated with such an issue), they can be grouped as two risks that could occur simultaneously.

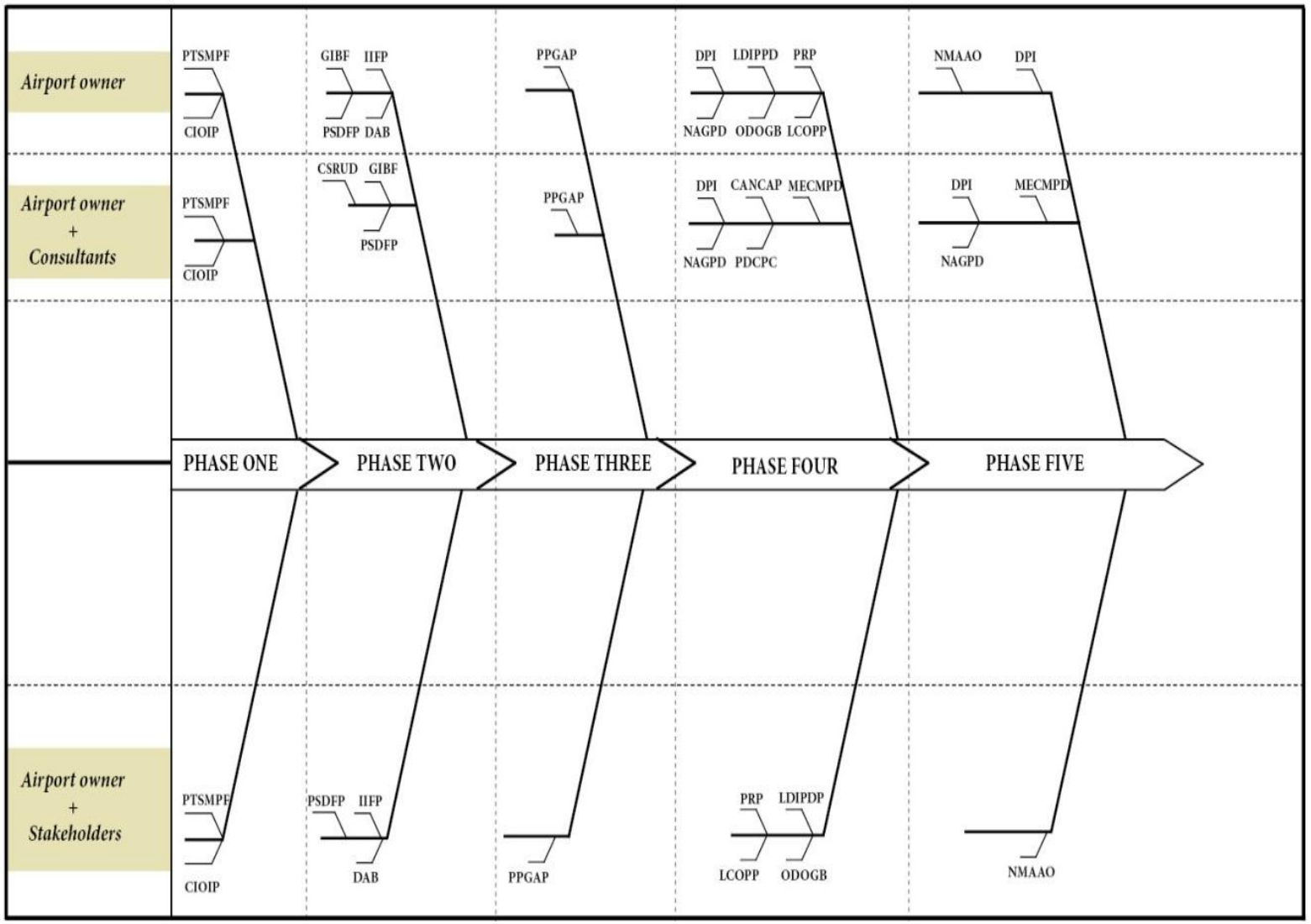


Figure 4.17: Twenty key risks as they occur by phase in commercial-airport development and their respective risk bearers in tandem with airport ownership (Zou et al, 2009).

It was also noted that, despite the fact that most risks listed in the chart do affect airport owners, responsibilities towards bearing and delivering risk management practices towards such risk are shared by other parties as well. These parties include consultants hired for airport development and stakeholders who have some bearing on project development and operations (Zou et al, 2009). As such, the airport owners' bearing of the key risks in Figure 4.17 is attached to these parties as well as separate. An example of this project party risk bearing combination can be seen in project development phase one where risk 2, phase1, project type and scope misrepresentation due to poor planning and feasibility related studies (PTSMPF) as well as risk 1, phase1, conflict of interest between ownership and other involved parties while determining initial project parameters (CIOIP) affect the airport owner, consultant and stakeholders in a trickle-down effect. First, conflict of interest related to project development prior to development involves the three parties listed (WSDOT, 2012). If the project development process is not agreed upon by these parties and continuously altered, the final project parameters and plans submitted by the airport owner to the governing aviation agencies (NPIAS and SASP) for funding and approval could be delayed and sent back for revision or could be rejected (WSDOT, 2012). The rejection of a project proposal by aviation agencies could slow the project time, affecting the predetermined project schedule and resulting in project related cost hikes (Horonjeff et al, 1994). As a result, time and cost related setbacks will affect all parties involved with this phase.

The number of risks indicated in Figure 4.17 exceeds the 20 key risks given in Table 3.48 because of 1) the pairing of risks within a similar phase based on their simultaneous occurrence and their noted impacts and 2) the occurrence of a risk in different project parties columns. To

determine the risks that would affect the airport owner and other associated parties, review Figure 4.17.

From Figure 4.17, the following risks affecting airport ownership can be determined. In the light blue highlights, it is indicated that the airport owner bears the risks for PTSMPF and CIOIP in phase one; GIBF, IIFP, PSDFP, and DAB in phase two; PPGAP in phase three; DPI, NAGPD, LDIPPD, PRP, ODOGB, and LCOPP in phase four; and NMAAO and DPI in phase five (See Table 3.48 for the abbreviation meanings). A similar inference can be made by utilizing the rows for Airport owner + Consultants and Airport owner + Stakeholders in Figure 4.17.

CHAPTER 5. CONCLUSION AND FURTHER RESEARCH

5.1. A review of the thesis component parts

The first portion of the thesis reviewed literature related to risk, risk management and commercial airport ownership activities in the commercial aviation industry. This covered the definition, organization, strategy and approach presented in the formal risk management process (Review Chapter2: Section 2.4) and provided a strategy of risk management approach utilizing Zou et al. (2009) paper, "Identifying key risks in construction projects: Life cycle and stakeholder perspectives as framework for airport owner risk determination in project cycle phases".

This review was done to acquire information that could be utilized to produce a project cycle specific to commercial airport ownership activities associated with capital and maintenance development projects. From this project cycle the principles of the risk management process: risk identification and risk classification were applied to provide a comprehensive list of risks that would affect an airport owner during a commercial airport project development and maintenance cycle.

This risk list once identified and classified was converted into a survey document as indicated in the Delphi method of data collection and analysis (Review Chapter 3). This document was issued to airport management across the USA with the goal of acquiring feedback that ranked risk issued in the document according to the different phases of a commercial airport capital and maintenance project.

Results of these survey responses were further analyzed utilizing a probability impact matrix and other statistical equations (Refer to Chapter 4) to rank the surveyed risk in order of importance to airport management .This was the application of the risk assessment and analysis process in the risk management cycle (Review Chapter 2 - Section 2.4).Further discussion, analysis and assessment related to risk rank results were made based on commercial airport size comparison, and location within the USA.

The final portion of the risk assessment and analysis process was utilized to provide a top 20 risk list that could be allocated in the form of a fishbone diagram to the phases of a commercial airport development and maintenance project and its participants. In this case risk allocation was done with the participants: airport management, stakeholders and consultants at stake. Further discussions pinpointing the importance of such a fishbone diagram utilized in commercial airport ownership risk determination, as well as the association of other parties to airport ownership risk duties were presented as the risk analysis and assessment conclusion of the risk management plan.

Though not a complete review of the risk management process (Review Figure 2.4 in Chapter 2), the thesis does setup a risk management framework that can be followed by commercial airport management for capital project and maintenance development. It also provides an overview of further guidance to help airport management in their further risk management endeavors that will venture past the assessment and analysis phase of the formal risk management process.

5.2. Thoughts on other research in comparison to thesis

Existing literature and reports in the area of risk management in the commercial airport field within the USA focus on the major parties in project development (owner, designer, and contractor) but give more emphasis to the designer and contractor in the risk management process. This is can be seen in the ACRP reports; 1) Airport Capital development cost (2009) and 2) Airport insurance coverage and risk management practices (2011).

These reports reviewed the practice of risk management in depth. Airport capital development cost (2009) focused on the financial implications of risk associated with primary commercial airports and the risk management practices to be reviewed to limit such risks. In this report there was no specific mention to the types of risks that would affect the airport owner associated with the development of a commercial facility. Rather the emphasis of risk management was placed on the finances at the disposal of the contractor, the project owner and designer of such facilities.

The report, Airport insurance coverage and risk management practices (2009) was more of a complex guide to insurance and risk management practices for commercial airport designers, contractors and owners .As a guide it required its users to understand predetermined concepts and analogies utilized in the commercial aviation industry and most of the risk management concepts utilized in the report were general in nature.

Horonjeff et al. (1994), “Planning and design of airports”, reviewed as literature for the thesis is a balanced view to the planning and design of commercial airports in the USA. To a novice who knows little about commercial airports in the USA, its provides a framework for the process of airport project development from the acquisition of permits to dealing with the FAA

and its regulations and policies, as well as financing commercial airport projects to name a few. Its design portion is more engineering oriented and focuses on what constituent parts of a commercial airport are required to be developed to ensure that on the whole a commercial airport operates the way it should.

Despite being a guide to the development of commercial airport facilities, the literature does not review risk management in commercial airport development and its review on airport ownership is limited to commercial airport privatization and government intervention in airport ownership and operations. However, it is important to note that the development and design frame work utilized in this literature, in addition to (The WSDOT commercial airport owner manual (2012) and the project management for construction project cycle (1998)),played a big part in the final risk management framework utilized in the thesis for project cycle purposes (Review Section 2.8 – Chapter 2) .

Academic reports, papers and journals such as Zou et al.(2009), "Identifying key risks in construction projects: life cycle and stakeholders perspectives" and Ospiova (2008), "Risk management in construction projects – A comparative study of the different procurement options in Sweden," aided in the process of identifying possible risks that could be associated with commercial development projects. These risks, however, were related to general construction projects and not specific to the commercial aviation industry or the airport owner. It was important to have a project framework for commercial airport development to associate some of the existing risks with the project cycle. This is where planning and design of airports (1994) was utilized. Furthermore determining which risks affected the airport owner specifically required understanding the process of commercial airport development from an airport owner's viewpoint. This is where the WSDOT commercial airport owner manual (2012) came into play.

It was through the combination of various relevant literature pieces and a specialization in risk management specifically tailored towards airport ownership, that a guidebook addressing airport ownership risk in commercial airport capital and maintenance projects was produced.

5.3. A guide to meeting project objectives and thesis goals

This thesis is a documented guide specifically for the airport owner in the commercial aviation industry. It reviews risk management from the viewpoint of a novice airport manager. The thesis also takes into consideration the user of the document and their skill set in the area of risk management, providing a step by step teaching cycle to commercial airport project development combined with the risk management process associated with such a venture.

It reviewed risk and broke it down into its component parts to enable the user to understand what risk as an issue comprises .It then reviewed risk management as a practice and showed the relationship between risk and risk management in general (risk and the risk management process).An understanding of commercial airports and, the parties involved in their development (specifically catered towards the airport owner)was presented to provide the reader with their duties as associated with the commercial airport development and risk management process. It is important to remember the reader was viewed in the context of an airport manager.

A formal risk management plan was then presented to show the reader the constituent parts of the risk management process and the required steps to follow when carrying out detailed risk management application. Once an understanding of the formal risk management plan was acquired, different approaches to risk in a commercial construction project are presented. For the sake of the user a holistic project cycle approach was determined as the most appropriate avenue to utilize in the application of the formal risk management plan. This was based on the fact that it

covers all facets of airport development and it can be tailored to the airport owner as seen fit by the reader.

Knowing the project cycle for an airport project was a requirement to effectively determine the phases of the project cycle in which airport ownership risk can occur. Utilizing literature from WSDOT (2012), several ACRP reports and Horonjeff et al (1994), the guidebook is able to determine the project cycle and the associated phases in which such risks occur. These processes of risk categorization and risk identification are carried out here utilizing the formal risk management plan. The utilization of the Delphi survey and interview methods to determine risk impacts and likelihood of occurrence was included in the guidebook. The ranking of the risks indicated in this survey is carried out by professionals and airport management in the commercial aviation field. This way risks that are limited in importance to airport management can be eradicated and only the most pertinent risk are further managed and controlled.

From survey data collected, analysis concerning risks that affect airport ownership was acquired. This analysis reviewed commercial airport ownership responses from the viewpoint of the region in which such ownership's airport facility is located and the respective size of the airport being reviewed. The analysis also statistically assessed the outcome of survey responses. The purpose of this was to be able to assure data result validity and compare and contrast risk issues associated with airport ownership based on the parameters of airport size and region .Two factors commonly used by the FAA were cargo and enplanement determination. These factors determined the overall size of an airport facility in question (FAA, Airport Categories, 2012).

5.4. Research outcome – Findings

From the analysis in Chapter 4, it was inferred that a majority of the primary-hub respondents who participated were small-hub and non-hub. This analysis was irrespective of the complete coverage of all airport types associated with primary commercial airports in the USA and oriented the viewpoints presented in the analysis towards these respondents.

It was important to review the project lifecycle of a commercial airport development to determine, holistically, the risks that are associated with both capital and maintenance projects. It was important to note that capital development risks affect maintenance development and vice versa (i.e., a poor development approach for a capital project could lead to a plethora of maintenance-related risk issues as was seen with the Denver airport's baggage handling system where poor capital development planning led to maintenance related risk issues that cost the airport $1 million per month from March 1995-August 2005, when the project was abandoned) (Consulting, 2008).

The majority of the Top 20 key risks associated with airport ownership activities for a commercial aviation facility's project lifecycle were valid based on the analysis and perceptions drawn from Chapter 4, and the risks were backed by substantial literature. As such, they should be utilized by all airport types irrespective of the thesis' focus on primary non-hub and small-hub respondents. It was also important to utilize the Top 10 risks affecting each project objective associated with the project development cycle, especially in situations where airport ownership and associated stakeholder parties envision a certain project objective as being affected to a greater degree during the course of a commercial airport's project development. This way, an in

depth focus on such risks affecting the particular objective could be carried out rather than dealing with a generality as associated with the Top 20 key risks.

It was inferred that a majority of the project objectives affected by the risks in this thesis, as indicated by this genre of participants (predominantly primary small-hub and non-hub participants), over the duration of a commercial airport's project cycle were cost and time related. This determination was due, in part, to the size limitation of airport facilities based on enplanement figures (FAA, Airport Categories, 2012), dependence on SASP and AIP related funding options where 90-95% of capital project cost is provided by such governing agencies (FAA, What is AIP, 2012) , and government related processes for a development's permitting and funding. Quality, safety and environmental project objectives were not selected as frequently by airport respondents but were still viewed as important for the project cycle at primary small-hub and non-hub airports. These project objectives were affected in phase 4 of the commercial airport project cycle during survey analysis (See Sections 4.22).

Utilizing the formal risk-management plan in Figure 4.1, it would be in the airport owners' interest to further the development of risk assessment for the 20 key risks given in Table 4.72, with an emphasis on cost and time related risk. Referring to Tables 4.50-4.51, which are primarily cost and time related risks, and comparing them with Table 4.72, which is a generality of the top 20 risks affecting the project cycle, will present airport owners with better insight about risk determination and associated assessment.

5.5. Thesis limitations

The limitations to the thesis lie in 1) the external inadequate research that has been done in the area of airport ownership risk management in commercial airport capital and maintenance

projects 2) Restrictive nature of information release associated with commercial airports and associated internal administrative protocols associated with such information release.

Information acquired for this thesis was a juxtaposition of material from different facets of the construction industry, the FAA and numerous aviation related paper and journals. This was done due to the limited nature of research related to risk associated with commercial airport ownership. Most research associated with risk in commercial airports that was reviewed for the thesis dealt with insurance coverage (Review Section 5.2) .Further research will have to be done to add to the base this research had provided for risk management in airport ownership related activities.

It is important to note that the USA had suffered noted loss during The September 11th, 2001 bombing attacks on the World trade center in New York. As a result certain precautions such as the prohibition of certain types of information related to commercial airport facilities internal and administrative workings were prohibited from being given out to individuals not associated with the FAA directly. As a result the acquisition of more data points that would have further validated the thesis were unable to be acquired. Currently the ACRP which is affiliated with the FAA is conducting similar research revolving around all parties associated with the commercial airport development.

It would also be risky in itself to say an airport owner should only be conversant in the risk associated with the given duties and obligations he has during the course of a commercial airport development project. An understanding of all party associated risks (airport owner, designer, and contractor) should be acquired by airport ownership to ensure that adequate

measures are taken in the risk management process to effectively limit the effects of risk on a commercial aviation project.

5.6. Future research recommendations

Further recommendation encourages applying a combination of mutually exclusive risk assessment scores for the cost and time associated risks that occur within similar phases of project development (Refer to Section 4.6.1). This process has already begun as more of a generality in Figure 4.16, where risks are paired based on their similarity, simultaneous occurrence and the party bearing capacity, in tandem with airport ownership. Utilizing this combination assessment method, risk severity will be properly determined based on a probability combination process. These new index values from the combination process can be further assessed for severity, and a risk planning stage (phase 7 in the risk management plan) can be implemented.

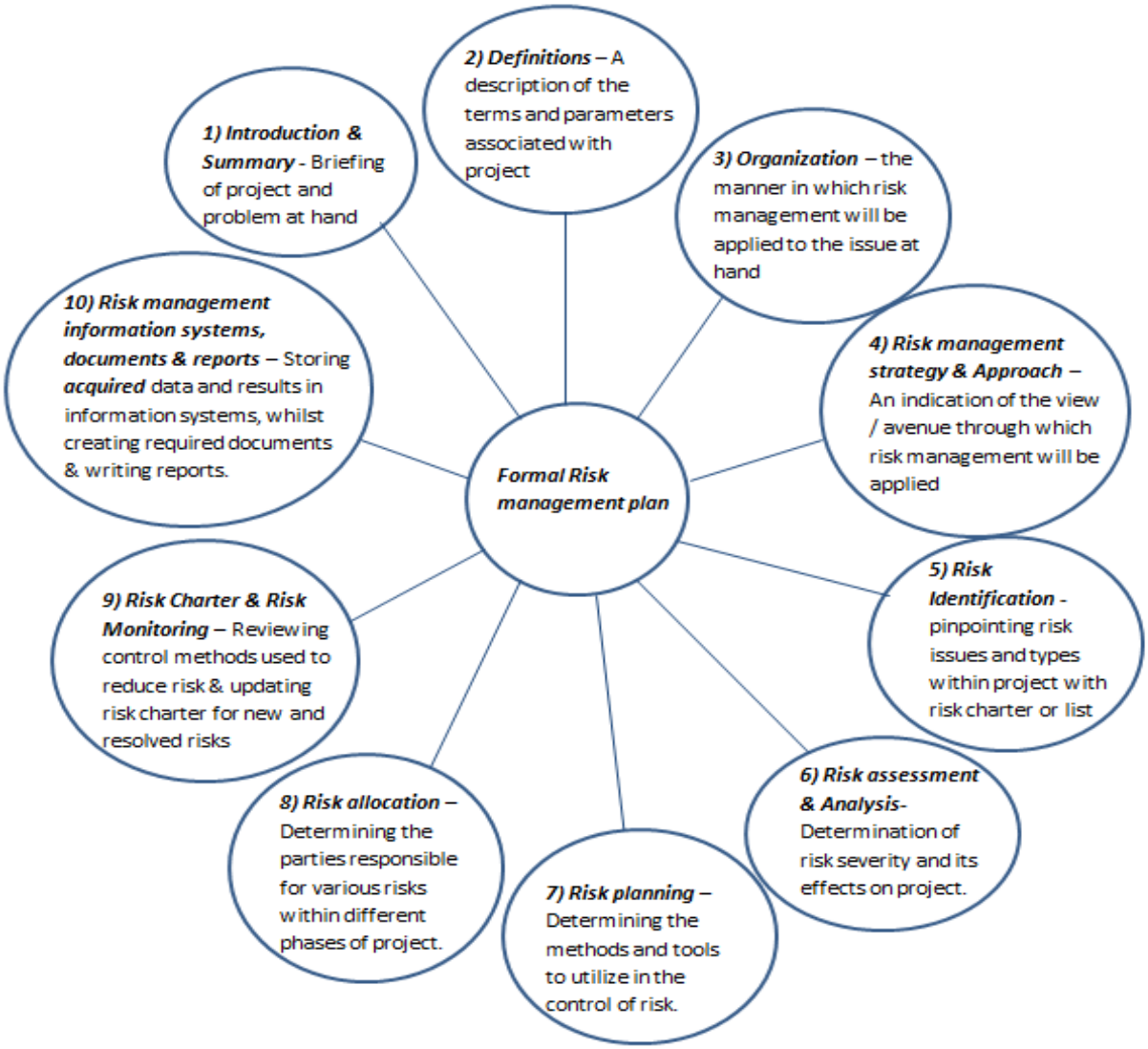


Figure 5.1: Continuation of the risk-management process for airport-ownership related risk in commercial aviation project development and maintenance (Burtonshaw-Gunn, 2009).

A detailed, step by step flow of the risk management process soon after completing phase 6 and the beginning of phase 7 can be seen in Figure 4.13. Material related to the risk management process and the associated tools to aid such process development can be acquired from Sections 2.5-2.8 of this thesis as well as from literature written by the NTRB, the ACRP and FAA, organizations that have done detailed research on risk management related processes for transportation related endeavors in the USA.

It is also important to note that the ACRP is carrying out a similar project that is aptly titled: "*A Guidebook for Successful Assessment and Management of Risk Associated with Commercial Airport Capital and Maintenance Projects"*. Analysis from the ACRP for a commercial facility's aviation related risks based on airport development may be a little more extensive but is more general in orientation. The ACRP study deals with all facets of airport facility risks, not just airport ownership risk.

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APPENDIX A

NDSU | NORTH DAKOTA STATE UNIVERSITY

Title of Research Study: Assessment and Management of Capital and Maintenance Projects Risks From An Airport Owner's Perspective.

Dear Participant:

This research is being conducted by Chidozie Ehiemere, under the supervision of Dr. Eric Asa. Chidozie is a graduate student in the Construction Management and Engineering Department at North Dakota State University, Fargo, North Dakota, USA.

This research is aimed at measuring, assessing, analyzing and mitigating risks associated with airport capital and maintenance projects from the standpoint of an airport owner. You are cordially being invited as the owner or a representative of the owner of a commercial airport facility to take part in this research project. Your participation is entirely voluntary, and you may change your mind or quit participating at any time, with no penalty to you.

It is not possible to identify all potential risks in research procedures, but the researcher(s) have taken reasonable safeguards to minimize any known risks. These known risks include: loss of confidentiality with general information issued within the survey and possible emotional / psychological distress that may be caused to participants by questions in the survey during the course of its completion. By taking part in this research, you may benefit from the results of the research as an airport owner or operator.

It would take about 45 minutes to complete the survey. The survey is based on filling in associated boxes with check marks and an alphabetical hierarchy system issued in the survey. The survey will be emailed to participants as an attached Microsoft word file. The completed survey will be sent back as an attachment to chidozie.ehiemere@my.ndsu.edu .

We will keep all research records that identify you private, to the extent allowed by law. Your personal information will be coded (01, 02, etc) and combined with other information and data. The data will then be analyzed. You will not be identified in any written reports/materials. We may publish the results of the study; however, we will keep your name and other identifying information private. This study is anonymous.

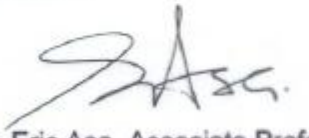
DEPARTMENT OF CONSTRUCTION MANAGEMENT AND ENGINEERING
NDSU Dept 2475 | PO Box 6050 | Fargo ND 58108-6050 | 701.231.7879 | Fax 701.231.7431 | www.ndsu.edu/cme

If you have any questions about this research project, please call me at 701-541-2577, or call my advisor Dr Eric Asa at 701-321-7246. Dr. Asa's email address is eric.asa@ndsu.edu.

You have rights as a research participant. If you have questions about your rights or complaints about this research, you may talk to the researcher or contact the NDSU Human Research Protection Program at 701.231.8908, ndsu.irb@ndsu.edu, or by mail at: NDSU HRPP Office, NDSU Dept. 4000, and PO Box 6050, Fargo, ND 58108-6050.

Thank you for taking part in this research. If you wish to receive a copy of the results, please give instructions for how to let you know.

Sincerely,



Dr. Eric Asa, Associate Professor.

APPENDIX B

Survey addressing Airport ownership risk associated with Commercial Airport Development and Maintenance projects

This survey is being utilized to determine facts for a research study pursued by Chidozie Ehiemere under the supervision of Dr Eric Asa at North Dakota State University.

Objectives: The survey aims to acquire professional feedback from Commercial Airport owners in the area of ownership risks related to capital and maintenance airport development projects. Participants will review and rank risk within different activity areas associated with airport development. The ranking criteria for risk will be based on its probability of occurrence, airport owner's level of involvement with such risks and the impact of the risk on the airport owner's project objectives.

From the results of the survey, the researcher will analyze the data and rank risks utilizing a risk reporting matrix ***(Probability – Impact matrix)*** .The matrix ranking will enable the researcher to assign priority to risks from the combined factors of severity (impact) and probability (frequency of risk occurrence).

Once risks have been prioritized, risk and sensitivity analysis and ***Monte Carlo simulation*** will be performed. The simulation will be applied to the prioritized risk list to determine the effects that changes in values of ranked risks will have on project objectives. Random selection and combination of risks variables on the priority list will be utilized to determine the changes in risk value. Results will be documented and mitigation implemented where high risk values are encountered.

Finally a decision analysis framework in the form of ***Economic modeling*** will be applied to the situations and risks that bring about relatively high risk values .These mitigation approaches will be aimed at reducing the impact of such risks on airport owner related duties and project objectives during the course of commercial airport development projects.

Goal: The goal of the survey and the associated activities is to create a commercial airport owner risk management guidebook to address analysis of survey data , economic modeling , risk analysis , Monte Carlo sampling and sensitivity analysis for risk encountered by the commercial airport industry during the execution of capital development and maintenance projects

GENERAL INFORMATION (OPTIONAL) PROVIDED RESULTS OF THIS STUDY CAN BE SENT TO YOU ON REQUEST

1) *Participant's Name* : .....
   Airport Name: .....
   Position / Title in Airport: .....
   Address: ..... *City :* ..... *State:* .....
   Country: ..... *Zip code / P.o.box :* ..... *Phonenumber :* .....
   Fax No: ..... *Email Address:* .....

AIRPORT PROJECT DETAILS

1 **AIRPORT CLASSIFICATION**

Note: ***This is not a requirement for Commercial Airport facilities in the United States of America.*** *All other participants in the survey should fill out airport classification based on the calculation example presented below:*

Airport Type (Commercial) *Please fill out if Airport is not located in the USA* **1**

Indicate with an ***X*** *in the appropriate box what category your commercial airport falls under. For categories without boxes indicate x in the appropriate row.*

Commercial Airport classification				
Primary Hub	*Large hub* ☐	*Medium hub* ☐	*Small hub* ☐	*Non-hub* ☐
Non primary Hub				
Reliever (commercial services)				

Enplanement calculation example *Please use to determine airport size for airports outside the USA*

Airport	*Airport enplanement figures (2011)*	*Total enplanement figure United States (2011)*
Chicago O'Hare International	31,892,301	724,158,046

Enplanement (%) = *Airport enplanement figures (2011)* x 100 %
Total enplanement figures (2011)

31,892,301 / *724,158,046* x 100 % = **4.404%**

Utilizing **4.404 %**, we refer to the commercial airport categorization chart and look for the commercial airport hub type, Chicago O'Hare International falls under.

Commercial Airport Categorization Chart

Primary Hub	*More than 10,000 passengers boarding each year within the airport facility*
Large hub	*Enplanement figures of airport for 2011 equal 1% or more of total enplanement figures for the given country*
Medium hub	*Enplanement figures of airport for 2011 equals at least 0.25% but less than 1% of the total enplanement figures for the given country*
Small hub	*Enplanement figures for 2011 equals 0.05% but less than 0.025% of total enplanement figures for the given country*
Non –hub	*Enplanement figures for 2011 less than 0.05% of total enplanement figures for the given country*
Non primary	*At least 2500 but no more than 10,000 passengers for fiscal year 2011*
Reliever (Commercial)	*Less than 2500 passengers for the fiscal year of 2011*

Chicago O'Hare airport is located under Primary Hub and it is a large hub as indicated by the pink coloration in airport categorization chart.

NOTE: *Participants should utilize total enplanement figures and airport enplanement figures for their respective countries.*

Approaching Survey: How to answer questions directed in the survey

Survey responses will address four different factors that will be used to assess risk. These factors are probability of risk occurrence, impact of risk on activity, Airport owners involvement with risk variables stated and risk variables impact on project objectives.

Terms to be used in the Survey chart

- ***Likelihood of Risk occurring (L):*** This is used to determine the likelihood of occurrence for a risk variable associated with an activity .The numbers 1-5 will be used to rank the likelihood for risk occurrence. Participants should note that ***L*** will be used in place of its full meaning ***Likelihood of risk occurrence*** when filling out survey charts.
- ***Impact of risk on activity (I):*** This is used to determine the impact the risk variables listed will have on the activity section under which they are listed. The numbers 1-5 will be used to rank the levels of risk impact within the survey. Participants should note that ***I*** will be used in place of its full meaning ***impact of risk activity*** when filling out survey charts.
- ***Airport owner's level of Involvement (O):*** This is used to determine the level of involvement airport owner has with regard to the risk variable listed. The alphabet A-E will be used to rank the airport owners level of involvement within the survey. Participants should note that I.R.A will be used in place of its full meaning ***impact of risk activity*** when filling out survey charts.
- ***Project objectives :*** These project objectives are generally identified in the survey as ***Cost, Quality, Time, Environment& Safety***. These objectives are also color coded to allow participants to easily identify them in the survey. The factors ***L. I. O*** talked about above are also indicated beneath the project objectives .This way participants can identify these factors as they pertain to the project objective that most affect them with each risk variable. If more than one project objective is affected by the risk variable please fill out the corresponding ***L.I.O.***
- ***Steps to filling out the survey***

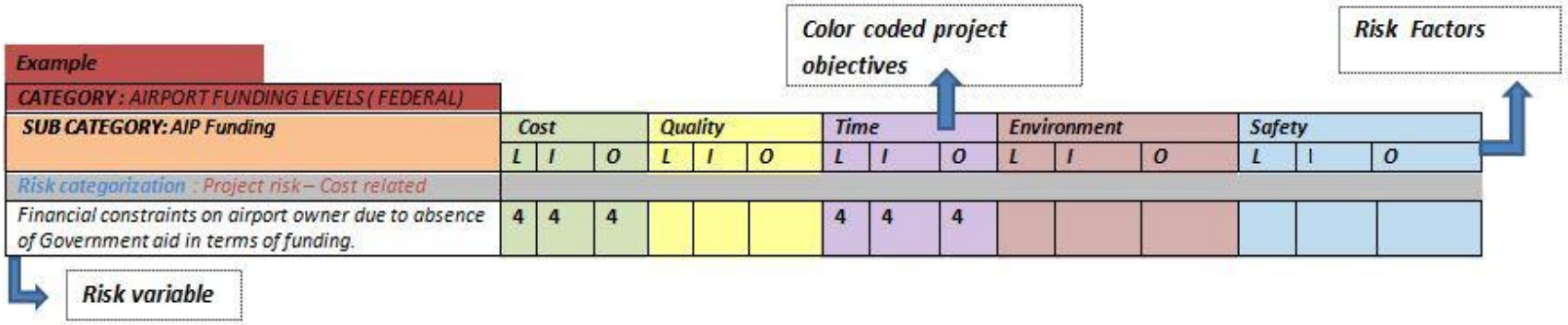
1. Review the rating system for risk and determine rating .This rating system will be used to indicate responses associated with **L.I.O**. The rating should always be a number. These are located under the ***level*** column of the risk rating system. Numbers represent the likelihood in the right column of the rating system.

RISK RATING SYSTEM

LEVEL	*LIKELIHOOD*
1	*Remote*
2	*Unlikely*
3	*Likely*
4	*Highly Likely*
5	***Near Certainty***

NOTE: *Always pick a number from the rating system.*

2. Indicate in the survey chart the ratings you have picked for the respective brackets (**L.I.O**) .



L	Likelihood of risk occurring
I	Impact of risk on activity
O	Airport owners level of involvement
Note	Use ranking table to the right

RISK RATING SYSTEM

LEVEL	LIKELIHOOD
1	Remote
2	Unlikely
3	Likely
4	Highly Likely
5	Near Certainty

Project objectives
Cost
Quality
Time
Environment
Safety

AIRPORT PROJECT SIZE AND TYPE	Pick one or more of the following project objectives below per risk variable and rank accordingly														
Airport project type & Size determination	Cost			Quality			Time			Environment			Safety		
	L	I	O	L	I	O	L	I	O	L	I	O	L	I	O
Risk Categorization :Project Risk - Cost related															
Financial discrepancies in terms of funding and project cost due to size misrepresentation															
Financial constraints that may occur due to wrongful project type determination.															
Risk Categorization :Project Risk – Time related															
Tight project schedule constraints occurring as a result of wrongful project size & type determination															

L	Likelihood of risk occurring
I	Impact of risk on activity
O	Airport owners level of involvement
Note	Use ranking table to the right

RISK RATING SYSTEM

LEVEL	LIKELIHOOD
1	Remote
2	Unlikely
3	Likely
4	Highly Likely
5	Near Certainty

Project objectives
Cost
Quality
Time
Environment
Safety

AIRPORT PROJECT SIZE AND TYPE	Pick one or more of the following project objectives below per risk varaiable and rank accordingly														
Airport project type & Size determination	Cost			Quality			Time			Environment			Safety		
	L	I	O	L	I	O	L	I	O	L	I	O	L	I	O
Risk Categorization :External Risk – Political															
Government interference in size determination															
Government interference in determination of project changes associated with airport															
New permits and additional information required to carry out project type development.															
Risk Categorization :Project Risk – Quality															
Incomplete inventory and analysis of enplanement figures and landed cargo (lbs.) studies.															
Inadequate research carried out to determine the extent of airport development requirements.															
AIRPORT FUNDING LEVELS (FEDERAL)															
AIP (Airport improvement program) funding															
Risk Categorization :Project Risk - Cost related															
Financial constraints on airport owner due to absence of Government funding or other aid .															
Lower than expected enplanement figures & landed cargo (lbs) affecting funding allocation															
Risk Categorization :Project Risk – Time related															
Approval process for AIP funding affects project development schedule															
Risk Categorization: External Risk- Political															
Government agency bureaucracy in determining eligibility for AIP related funding															
Inability of airport to meet NPIAS set standards. This is a requirement for AIP funding eligibility.															

Risk Categorization: External Risk- Political	Cost			Quality			Time			Environment			Safety		
	L	I	O	L	I	O	L	I	O	L	I	O	L	I	O
Rejection for funding while utilizing "The National priority rating system if required.															
FACILITY & EQUIPMENT FUNDS (F & E)															
Risk Categorization :Project Risk - Cost related															
Financial constraints on airport owner due to absence of Government or aid															
Risk Categorization :Project Risk – Time related															
Project development schedule affected by wait on F&E funding .															
Risk Categorization :External Risk – Political															
Government agencies bureaucracy in determining eligibility for F&E related funding .															
Risk Categorization :External Risk – Regulatory															
Incomplete approval due to absence of requisite documentation															

L	Likelihood of risk occurring
I	Impact of risk on activity
O	Airport owners level of involvement
Note	Use ranking table to the right

RISK RATING SYSTEM

LEVEL	LIKELIHOOD
1	Remote
2	Unlikely
3	Likely
4	Highly Likely
5	Near Certainty

Project objectives
Cost
Quality
Time
Environment
Safety

AIRPORT FUNDING LEVELS (FEDERAL)	Pick one or more of the following project objectives below per risk varaiable and rank accordingly														
MAP (Military airport program) funding	Cost			Quality			Time			Environment			Safety		
	L	I	O	L	I	O	L	I	O	L	I	O	L	I	O
Risk Categorization : External Risk - Regulatory															
Financial discrepancies in funding project cost due to size misrepresentation															
Financial constraints that may occur due to wrongful project type determination.															

Risk Categorization : *Project Risk – Time related*																
Tight project schedule constraints occurring as a result of wrongful project size & type determination																

AIRPORT FUNDING LEVELS (STATE)	*Pick one or more of the following project objectives below per risk variable and rank accordingly*														
SASP (State Airport System plan) funding	***Cost***			***Quality***			***Time***			***Environment***			***Safety***		
	L	*I*	*O*	*L*	*I*	*O*	*L*	*I*	*O*	*L*	*I*	*O*	*L*	*I*	*O*
Risk Categorization : *External Risk - Regulatory*															
Additional costs associated with Hangar related projects due to their ineligibility for funding at the State level.															
Risk Categorization : *External Risk – Political*															
Government bureaucracy in approval process for SASP funding which affects project cost and schedule.															
Loan acquisitions and stipulations															
Risk Categorization : *External Risk - Regulatory/ Political*															
Inability to meet the financial amount (%)required by Government before loans can be approved															
Default on payment of past project loan to Government															
Risk Categorization : *External Risk – Political*															
Government bureucracy in loan approval process.															
AIRPORT FUNDING LEVELS (LOCAL)															
General tax funds of Local Governments															
Risk Categorization : *External Risk – Funding*															
Insufficient funds at the local government level to aid airport owner in project development .															
Risk Categorization : *External Risk – Political*															
Government bureaucracy in determining level of funding airport owners receive at the local level															
AIRPORT FUNDING LEVELS (OTHER SOURCES)															
Airport user fees (For Operational airport facilities)															
Risk Categorization : *External Risk – Funding*															
Inadequate airport user fees to take care of airport development projects when required .															

Risk Categorization : *Internal Risk – Procedure change*																
Increasing airport fees to handle project development costs could affect airport operations negatively pushing away airline tenants and consumers of airport facility.																

AIRPORT FUNDING LEVELS (OTHER SOURCES)	*Pick one or more of the following project objectives below per risk variable and rank accordingly*														
Exsisting Airport Revenue	***Cost***			***Quality***			***Time***			***Environment***			***Safety***		
	L	*I*	*O*	*L*	*I*	*O*	*L*	*I*	*O*	*L*	*I*	*O*	*L*	*I*	*O*
Risk Categorization : *Internal Risk – Reorganization*															
Inadequacy of existing revenue to take care of airport - related development projects															
Risk Categorization : *Internal Risk – Procedural change*															
Utilization of airport revenue for other pertinent airport operations hindering airport development.															
Risk Categorization : *External Risk – Political*															
Government bureaucracy in determining how airport revenue is utilized.															
General Obligation / Revenue bonds															
Risk Categorization : *External Risk – Regulatory*															
Default on bond repayments to investors which may lead to litigation															
Risk Categorization : *External Risk – Funding*															
Inability to find investors willing to purchase bonds limiting funds available for development															
Risk Categorization : *External Risk – Political*															
Governmenrt bureaucracy in the processes associated with General Obligation / Revenue Bonds															
Loans (Non – Governmental)															
Risk Categorization : *External Risk – Funding*															
High intrest rates on loans that could pose financial constraints to airport owner															
Default on loan payments could affect airport owner															

financially	
Risk Categorization : *Internal Risk – Reorganization*	
High debt incurement affecting general airport operations	

L	*Likelihood of risk occurring*
I	*Impact of risk on activity*
O	*Airport owners level of involvement*
Note	*Use ranking table to the right*

RISK RATING SYSTEM

LEVEL	*LIKELIHOOD*
1	*Remote*
2	*Unlikely*
3	*Likely*
4	*Highly Likely*
5	*Near Certainty*

Project objectives
Cost
Quality
Time
Environment
Safety

PROJECT AND GOVERNMENT ASSOCIATED PLANNING PROCEDURES	*Pick one or more of the following project objectives below per risk variable and rank accordingly*														
Project description	*Cost*			*Quality*			*Time*			*Environment*			*Safety*		
	L	*I*	*O*	*L*	*I*	*O*	*L*	*I*	*O*	*L*	*I*	*O*	*L*	*I*	*O*
Risk Categorization *: Project Risk - Cost / Schedule*															
Continuous changes of project description affecting cost and schedule associated with project															
Cost overrun dilemma experienced by airport owner in project description process.															
Risk Categorization *:External Risk – Time related*															
Tight project schedule constraints occurring as a result of wrongful project size & type determination															
Risk Categorization *: External Risk – Political*															
Occurence of dispute between Airport owner and Government over projet description															
Project Goals and Objectives															
Risk Categorization *: External Risk – Regulatory*															
Opposition by local community members to the projected goals and objectives of the project															
Risk Categorization *: Project Risk – Quality*															
Development of unreasonable goals and objectives that cannot be met in the long run															
Risk Categorization *: Project Risk – Cost / Schedule*															

Inadequate goals and objectives affecting future phases of the project development financially and schedule wise	
Absence of sufficient professionals and managers to aid airport owner in the clarification of feasible objectives and goals for airport development.	
Risk Categorization :*External Risk – Political*	
Government intervention (FAA , DOT) in goal and objectives determination	
Strategic planning *(Mission& Vision statements / Forecast review / Project assessment / Funding strategies/ Operating & Revenue Analysis / Implementation & Recommendation)*	

L	*Likelihood of risk occurring*
I	*Impact of risk on activity*
O	*Airport owners level of involvement*
Note	*Use ranking table to the right*

RISK RATING SYSTEM

LEVEL	*LIKELIHOOD*
1	*Remote*
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3	*Likely*
4	*Highly Likely*
5	*Near Certainty*

Project objectives
Cost
Quality
Time
Environment
Safety

PROJECT AND GOVERNMENT ASSOCIATED PLANNING PROCEDURES	*Pick one or more of the following project objectives below per risk variable and rank accordingly*														
Strategic Planning	*Cost*			*Quality*			*Time*			*Environment*			*Safety*		
	L	*O*	*I*	*L*	*O*	*I*	*L*	*O*	*I*	*L*	*O*	*I*	*L*	*O*	*I*
Risk Categorization :*Project Risk - Schedule*															
Tight schedule issues compounded by a stall in measurement criteria determination for project															
Time related risk from setting development horizons for future development that may not be met by airport manager.															
Risk Categorization :*Project Risk – Quality*															
Inability to properly forecast airport traffic growth which will affect future activities associated with airport development															
Inability of airport manager to identify facilities that															

will require development and possible maintenance in the future leading to underdeveloped projects																
Airport strategic plan unable to adequately cover potential growth and development for airport in question																
Risk Categorization *:Project Risk - Cost related*																
Cost related projection is insufficient for future development horizons determined by airport management																
Risk Categorization *:External Risk – Funding*																
Airport administration not factoring in changes in Governmental funding plans with each fiscal year which may negate the financial plans they have set for future airport development																
Risk Categorization *:External Risk – Political*																
Government interference in the implimentation and recommendation process associated with airport development																

Capital Development: *Activities associated Commercial Airport Capital Development.*

3

L	*Likelihood of risk occurring*
I	*Impact of risk on activity*
O	*Airport owners level of involvement*
Note	*Use ranking table to the right*

RISK RATING SYSTEM

LEVEL	*LIKELIHOOD*
1	*Remote*
2	*Unlikely*
3	*Likely*
4	*Highly Likely*
5	*Near Certainty*

Project objectives
Cost
Quality
Time
Environment
Safety

PROJECT INCLUSION IN FIVE YEAR AIRPORT PROGRAM	Pick one or more of the following project objectives below per risk variable and rank accordingly														
Public Hearing	Cost			Quality			Time			Environment			Safety		
	L	I	O	L	I	O	L	I	O	L	I	O	L	I	O
Risk Categorization : External Risk - Regulatory															
Local community opposition to airport capital development															
Petition resolution / Petition package															
Risk Categorization : Project Risk - Schedule															
Tight project schedule affected further by excessive approval procedures within government agencies															
Risk Categorization : External Risk - Regulatory															
Incomplete approval and documents resulting in the refusal of petition package and petition resolution associated with the project by government agencies that oversee the process.															
Eligibility Statement															
Risk Categorization : External Risk - Regulatory															
Unfavorable feedback from government agency involved in the process															
Longer than expected review time of eligibility requirements for eligibility statement approval															
Agency Agreements															
Risk Categorization : External Risk - Political															
Occurrence of dispute between Airport owner and Government agency (DOT state secretary) over power allocation in activity arrangement associated with airport development															
Miscommunication between the airport owner and Government agency representative involved in the airport development process could lead to possible project scope creep affecting project cost & schedule.															
Consultant Selection															
Risk Categorization : External Risk - Political															
Government interferance in consultant selection leading to dispute between airport owner and Government bureau representatives involved in selection process.															

Government laws to keep Airport Development with State Regulations	
Risk Categorization : External Risk - Regulatory	
State laws may add additional unanticipated work to the project scope affecting project objectives(Cost / time / quality /safety / environment)	
Risk Categorization : External Risk - Political	
Government agency bureaucarcy in State regulations concerning airport development leading to occurrence of dispute between airport owner and government agency involved.	
PLANNING /FEASIBILITY STUDIES / DESIGN PHASE	Pick one or more of the following project objectives below per risk variable and rank accordingly
Airport Inclusion in the NPIAS (National plan of intergrated airport systems)	
Risk Categorization : External Risk - Regulatory	
Airport facility does not meet eligibility requirements to be included in the NPIAS	
Loss of grant funding at the Federal level (AIP) and state level due to ineligibility.	
Master Planning	
Risk Categorization : Project Risk – Cost	
Poor cost estimating practices utilized by design & planning consultants resulting in higher than expected development costs for airport owner in future development processes.	

L	Likelihood of risk occurring
I	Impact of risk on activity
O	Airport owners level of involvement
Note	Use ranking table to the right

RISK RATING SYSTEM

LEVEL	LIKELIHOOD
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4	Highly Likely
5	Near Certainty

Project objectives
Cost
Quality
Time
Environment
Safety

PLANNING /FEASIBILITY STUDIES / DESIGN PHASE	Pick one or more of the following project objectives below per risk variable and rank accordingly														
Master Planning (continued)	Cost			Quality			Time			Environment			Safety		
	L	I	O	L	I	O	L	I	O	L	I	O	L	I	O

Risk Categorization : External Risk - Regulatory
Incomplete design and legal documents submitted to the FAA which disqualifies airport for AIP funding
Risk Categorization : External Risk – Political
Government bureaucracy in approval of master plans for project development
Airport Layout Plan
Risk Categorization : External Risk - Regulatory
ALP plan doesnot meet governmental agency (FAA) standards for grants / funding
Feasibility Studies
Risk Categorization : Project Risk – Quality
Chosen airport location does not fit with the proposed planning , development and operation of airport facility affecting overall development product.
Risk Categorization : Project Risk – Cost
Inventory practices utilized in airport planning lead to wrongful identification of site in question for development . This could cost the airport owner financially in the long run.
Incomplete surveys / studies lead to poor planning / design of airport facility in question affecting the airport owner financially in the long run
Environmental Public hearing /Environmental Review
Risk Categorization : External Risk - Regulatory
Inability to follow NEPA, CA and AA act in the environmental review process leading to airport disqualification for funding.
Categorical Exclusion
Risk Categorization : External Risk - Regulatory
Disapproval for categorical exclusion resulting in the filing for an environmental review which wastes financial resources and results in project delay for airport owner
Risk Categorization : External Risk – Political
FAA bureaucracy in categorical checklist determination

for environmental review exclusion	
Environmental Impact Statement (EIS) / Agricultural impact statement	
Risk Categorization : *Project Risk – Schedule*	
Long waiting period resulting in project delay for airport owner	
Risk Categorization : *Project Risk – Cost / Schedule*	
Rejection of EIS that could lead to additional cost and time issues associated with project development	
Risk Categorization : *External Risk - Regulatory*	
Agricultural landowners unwilling to sell land for airport development purposes	
Opposition to airport development by local community member resulting in the delayed approval of the AIS or EIS	
Evaluating factors for Airport Site investigations	
Risk Categorization : *Project Risk – Cost*	
Cost related overrun issues arising from inadequate evaluation of factors associated with project development	
Risk Categorization : *Project Risk – Schedule*	
Airport site investigation procedures affecting time schedule for project development	
Risk Categorization : *External Risk – Political*	
FAA bureaucracy in setting standards for NPIAS inclusion affecting approval for funding which hinges on airport site investigations .	

L	*Likelihood of risk occurring*
I	*Impact of risk on activity*
O	*Airport owners level of involvement*
Note	*Use ranking table to the right*

RISK RATING SYSTEM

LEVEL	*LIKELIHOOD*
1	*Remote*
2	*Unlikely*
3	*Likely*
4	*Highly Likely*
5	*Near Certainty*

Project objectives
Cost
Quality
Time
Environment
Safety

DESIGN ACTIVITIES	Pick one or more of the following project objectives below per risk variable and rank accordingly														
Runway Protection Zones	**Cost**			**Quality**			**Time**			**Environment**			**Safety**		
Risk Categorization : External Risk - Regulatory															
Legal lawsuits from parties affected by runway zone location															
Risk Categorization :Project Risk – Quality															
Future safety issues occurring as a result of absence of obstruction determination along runway zone location															
Airport property interests															
Risk Categorization :Project Risk – Quality															
Inadequate analysis done to determine areas of airspace that require permit protection which will affect present and future airport development carried out on airspace															
Risk Categorization : Project Risk – Schedule															
Excessive approval times in Government agencies for zoning and easement proceedings associated with airport property interests leading to project delay															
Risk Categorization : External Risk - Regulatory															
ALP and Runway protection zones plans not indicating airport property interests leading to their rejection by the FAA and a halt to project development															
Aviation Easements															
Risk Categorization : Project Risk – Schedule															
Aviation acquisition process takes longer than expected due to Government approval procedures															
Zoning around Airport															
Risk Categorization : External Risk - Regulatory															
Absence of zoning stipulations within ALP leading to its rejection and funding allocation															
Apron Design															
Risk Categorization : Project Risk – Cost															
Hangar development costs not covered by FAA funding leaving airport owner to look for alternative funding															

Design variations that donot meet FAA specificatons within apron design may slow the course of airport project cevelopment and incur additional cost for airport owner															
Risk Categorization :*Project Risk – Quality*															
Design consultant not following apron design or grade standards set by the FAA which could lead to its possible rejection affecting cost and schedule related resources associated with the project															
Other Design related activities															
Risk Categorization :*Project Risk – Quality*															
Unresolved constructability issues with design that could affect project objectives in the construction phase of airport development															
PROCUREMENT & CONSTRUCTION	*Pick one or more of the following project objectives below per risk variable and rank accordingly*														
Land requirements															
Risk Categorization :*External Risk - Regulatory*															
Land owners unwilling to sell identified land for airport development															
Local communities pose objection to airport development on land within their vicinity															
Threats of lawsuits															
Risk Categorization :*Project Risk – Schedule*															
Project schedule affected by delays in approval process associated with land procurement															

L	*Likelihood of risk occurring*
I	*Impact of risk on activity*
O	*Airport owners level of involvement*
Note	*Use ranking table to the right*

RISK RATING SYSTEM

LEVEL	*LIKELIHOOD*
1	*Remote*
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3	*Likely*
4	*Highly Likely*
5	*Near Certainty*

Project objectives
Cost
Quality
Time
Environment
Safety

AIRPORT CONSTRUCTION (Contracts / Project Delivery Methods / Construction)	Pick one or more of the following project objectives below per risk variable and rank accordingly														
Project Delivery Methods (Design. Bid. Build)	**Cost**			**Quality**			**Time**			**Environment**			**Safety**		
Risk Categorization : Project Risk - Cost															
The onus of financial risk falls on the airport owner due to DBB stipulations															
Risk Categorization :Project Risk – Cost / Schedule															
Overlapping of one or more project limits , scope of work and schedule															
Risk Categorization :Project Risk – Quality															
Airport owner interferance in the design and construction phase of this delivery method															
Project Delivery Methods (Construction Manager at Risk)															
Risk Categorization :Project Risk – Quality															
Airport owners inability to relay possible design errors / omissions to contrcator pre – construction which could incur longer schedules and higher costs for project															
Project Delivery Methods (Design. Build)															
Risk Categorization : Project Risk - Cost															
Price inflation for construction materials and methods utilized in the DB related project delivery method by contractor affectng airport owner budget for development															
GMP (Guaranteed Maximum price) related disputes in project delivery methods between airport owner and contractor															
Project Delivery Methods (Integrated project delivery)															
Risk Categorization : Project Risk															
Unceratainty associated with the IPD delivery method if utilized may not be able to be handled by airport owner or contractor alike															
Project Risk - **OSHA related** – affects all project delivery methods															
OSHA related stipulations not adequately mapped out in the project delivery method contracts affecting															

schedule & cost associated with the project.
Grant Amendments
Risk Categorization : *External Risk - Political*
Government agency identify project cost as excessive and doesn't fund project as a result
Government bureaucracy in grant amendment process
Contracts
Risk Categorization : *External Risk - Reorganization*
Unforeseen duties of airport owner present in contracts
Risk Categorization : *External Risk - Political*
Airport owners limitation in contract process due to Government interference
Risk Categorization : *Project Risk - Cost / Schedule*
Contract approval procedures affect project schedule and associated project cost
Construction activities / Monitoring construction
Risk Categorization : *Project Risk - Schedule*
Project schedule delays brought about by contractor and contract related issues

L	*Likelihood of risk occurring*
I	*Impact of risk on activity*
O	*Airport owners level of involvement*
Note	*Use ranking table to the right*

RISK RATING SYSTEM

LEVEL	*LIKELIHOOD*
1	*Remote*
2	*Unlikely*
3	*Likely*
4	*Highly Likely*
5	*Near Certainty*

Project objectives
Cost
Quality
Time
Environment
Safety

	Pick one or more of the following project objectives below per risk variable and rank accordingly														
Construction activities / Monitoring construction	***Cost***			***Quality***			***Time***			***Environment***			***Safety***		
Seasonal constraints that will hinder project development															
OSHA related infringements affecting project construction development															
Risk Categorization : *Project Risk – Cost / Schedule*															
Security related issues slowing down the construction process and affecting project cost															

Possible labor strikes affecting project construction process																
Risk Categorization :*External Risk – Funding*																
Changes in Government funding for the fiscal year affecting project schedule																
Risk Categorization :*Internal Risk – Procedure change*																
Construction activities interference with airport operation activities																
PROJECT COMPLETION	***Pick one or more of the following project objectives below per risk variable and rank accordingly***															
Risk Categorization :*External Risk – Regulatory*																
Final inspection failure leading to postponement of facility opening																
Risk Categorization :*External Risk – Funding*																
Financial settlement disputes between airport owner and bureau in charge of airport project																
Risk Categorization :*External Risk – Regulatory*																
Occurrence of dispute between parties involved in the project over parameters that determine project completion.																

Maintenance Development: *Activities associated Commercial Airport Maintenance projects* **4**

L	*Likelihood of risk occurring*
I	*Impact of risk on activity*
O	*Airport owners level of involvement*
Note	*Use ranking table to the right*

RISK RATING SYSTEM

LEVEL	*LIKELIHOOD*
1	*Remote*
2	*Unlikely*
3	*Likely*
4	*Highly Likely*
5	*Near Certainty*

Project objectives
Cost
Quality
Time
Environment
Safety

AIRPORT MAINTENANCE ACTIVITIES	Pick one or more of the following project objectives below per risk variable and rank accordingly														
Annual Airport Activities (Determination/ Checklists)	**Cost**			**Quality**			**Time**			**Environment**			**Safety**		
Risk Categorization : External Risk - Funding															
Government restrictions on funding for certain airport maintenance projects															
Risk Categorization : Project Risk - Quality															
Insufficient time window to determine all airport maintenance related activities															
Risk Categorization : Project Risk - Schedule															
Seasonality restricting ceratin planned airport activities															
Risk Categorization : Project Risk - Schedule/Cost /Quality															
Lack of coordination between parties involved in the maintenance determination process															
Seasonal Airport Opening Activities															
Risk Categorization : Project Risk - Cost															
Inexperienced consultants hired by airport owner to determine seasonal maintenance needed by the airport facility in question															
Risk Categorization : External Risk - Regulatory															
Failed Government inspection of facilities leading to a delay in the seasonal opening of airport															
Seasonal Airport Closing Activities															
Risk Categorization : Project Risk - Cost															
Failure to identify maintenance issues that could be cost in curative during airport opening															
Risk Categorization : External Risk - Regulatory															
Failure to identify maintenance issues that could result in saftey issues associated with airport operations															
Regular Airport Inspections															
Risk Categorization : Project Risk - Schedule															
Airport owners failure to have airport ready for predetermined bureau inspections of airport facilities															
Inspection failure hinders airport operation activities															
Maintenance Guidelines															

(Airfield / Runway / Airport / Vegatation)															
Risk Categorization : External Risk - Regulatory															
Failure to meet maintenance guidelines hindering funding from the FAA															
Risk Categorization : External Risk - Political															
Government bureaucracy in administering frequent guideline checks															
Obstruction Identification and Removal Process															
Risk Categorization : Project Risk - Schedule/ Cost / Quality															
Non removal of obstruction within the airfield vicinity could hinder airport operations															

RECOMMENDATIONS

Please List any other suggestions you may have with regards to this document

Thankyou very much for your participation. If you have any further questions or issues please free to contact :

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APPENDIX C

Survey addressing airport owners' risk associated with commercial airport capital development and maintenance projects

This survey is being utilized to collect data and information for a research study conducted by ***Chidozie Ehiemere*** *under the supervision of* ***Dr. Eric Asa*** *at* ***North Dakota State University.***

Objectives: *This survey is aimed at acquiring professional feedback from commercial airport operators and owners on ownership on risks associated with the development of capital and maintenance projects.*

The data acquired from the survey responses will be statistically analyzed utilizing the probability impact matrix and Minitab to assess the impact of risks associated commercial airport owners during the planning and execution of capital and maintenance projects. The identified risks would then be mitigated for by utilizing economic modeling and decision analysis strategies.

Goal: *The goal of this research study is to produce a risk management guide book that can be utilized by commercial airport owners to address ownership risk at differing project phases during the development of commercial airport capital and maintenance projects.*

1) GENERAL INFORMATION (OPTIONAL):

Participants Name: _____ *Airport Name:* _____ *Phone Number:* _____

Position / Title in Airport: _____ *Address:* _____ *Fax No:* _____

City: _____ *State:* _____ *Email address:* _____

Country: _____ *Zip code / P.O. Box:* _____

2) AIRPORT CLASSICFICATION

Note: ***This is not a requirement for Commercial Airport facilities in the United States of America.***

For international participants, please indicate from the options below, your airports yearly enplanement figures:

☐ *7,300,000 passengers or more*

☐ *At least 1, 900, 000 passengers but less than 7,300,000*

☐ *At least 370,000 passengers but less than 1,900,000*

☐ *At least 10,000 passengers but less than but less than 370,000*

☐ *At least 2500 passengers but less than 10,000*

☐ *Less than 2500 passengers*

3) *FILLING OUT THE SURVEY : Please read the following before filling out the survey.*

- Review the rating system for risk and determine the appropriate rating .This rating system will be used to indicate responses associated with risk issues below. The rating should always be a letter from A – E. The last column is personal opinion related based on available project objectives.
- Indicate in the appropriate boxes, the ranking you have picked from the rating system.
- The survey will review risk issues in commercial airport project phases according to four given criteria (1) ***Risk impact on phase listed*** (2) ***Likelihood of risk occurring*** (3) ***Airport owners' level of involvement with risk*** (4) ***Other project objectives the risk issue may affect***.
- Risks have been classified based on the DOE Risk identification classification system utilized by the NCHRP (National Cooperative research program) in the USA.

RATING SYSTEM

RISK IMPACT ON PHASE LISTED	LIKELIHOOD OF RISK ISSUE OCCURING	AIPORT OWNERS' LEVEL OF INVOLVEMENT WITH RISK	PROJECT OBJECTIVES
A) Very high	A) Near certainty	A) Near Certainty	COST
B) High	B) Highly Likely	B) Highly Likely	QUALITY
C) Medium	C) Likely	C) Likely	TIME
D) Low	D) Unlikely	D) Unlikely	SAFETY
E) Very low	E) Remote	E) Remote	ENVIRONMENT

Risk classification

Project phase

Risk criteria

Example

PHASE ONE : AIRPORT PROJECT TYPE & SIZE DETERMINATION				
Risk Classification : *Project Risk (Quality)*	***Risk Impact on phase one***	***Likely hood of risk issue occurring***	***Airport owners' involvement with risk***	***Other project objectives risk issue may affect***
1) Project type and scope misrepresentation due to poor planning and feasibility related studies.	*A*	*A*	*C*	*Cost & Time*

Risk

Response columns

Please start Survey response here. Thank you

RATING SYSTEM

RISK IMPACT ON PHASE LISTED
A) Very high
B) High
C) Medium
D) Low
E) Very low

LIKELIHOOD OF RISK OCCURING
A) Near Certainty
B) Highly Likely
C) Likely
D) Unlikely
E) Remote

AIPORT OWNERS' LEVEL OF INVOLVEMENT WITH RISK
A) Near Certainty
B) Highly likely
C) Likely
D) Unlikely
E) Remote

PROJECT OBJECTIVES
COST
QUALITY
TIME
SAFETY
ENVIRONMENT

PHASE ONE : AIRPORT PROJECT TYPE (Capital or maintenance) & PROJECT SIZE DETERMINATION				
Risk Classification: *Internal risk (reorganization) External risk (regulatory).*	*Risk Impact on phase one*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
1) Conflict of interest between ownership and other involved parties whilst determining initial project parameters				
Risk Classification : *Project Risk (Quality)*	*Risk Impact on phase one*	*Likely hood of risk issue occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
2) Project type and scope misrepresentation due to poor planning and feasibility related studies.				

RATING SYSTEM	RISK IMPACT ON PHASE LISTED	LIKELIHOOD OF RISK OCCURING	AIPORT OWNERS' LEVEL OF INVOLVEMENT WITH RISK	PROJECT OBJECTIVES
	A) Very high	A) Near Certainty	A) Near Certainty	COST
	B) High	B) Highly Likely	B) Highly Likely	QUALITY
	C) Medium	C) Likely	C) Likely	TIME
	D) Low	D) Unlikely	D) Unlikely	SAFETY
	E) Very low	E) Remote	E) Remote	ENVIRONMENT

PHASE TWO : AIRPORT FUNDING LEVELS (Federal / State / Local /others)				
Risk Classification: *External risk (political)*	*Risk Impact on Phase two*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
1) Government intervention and bureaucracy in funding related processes.				
Risk Classification: *Project risk (schedule)*	*Risk Impact on Phase two*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
2) Project schedule affected by delays from numerous funding approval processes.				
Risk Classification *: External Risk (funding)*	*Risk Impact on Phase two*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
3) Litigation issues associated with default payments on external funding options (loans / bonds)				
Risk Classification *: Project Risk (Cost)*	*Risk Impact on Phase two*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
4) Inadequate internal funding options (ie) airport user fees (etc) to cover airport facility development				
5) Debt accruement which cannot be effectively balanced by the owner of the project				
PHASE THREE : PROJECT AND GOVERNMENT ASSOCIATED PLANNING PROCEDURES (Project Description/ Goals & Objectives / Strategic planning)				
Risk Classification *: Internal Risk (procedural changes)*	*Risk Impact on Phase three*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
6) Project varaitions leading to associated disputes between project parties & ownership				
Risk Classification *: External Risk (Regulatory)*	*Risk Impact on Phase three*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
7) Planning procedures affected by government approval & associated processes .				

RATING SYSTEM	RISK IMPACT ON PHASE LISTED	LIKELIHOOD OF RISK OCCURING	AIPORT OWNERS' LEVEL OF INVOLVEMENT WITH RISK	PROJECT OBJECTIVES
	A) Very high	A) Near Certainty	A) Near Certainty	COST
	B) High	B) Highly Likely	B) Highly Likely	QUALITY
	C) Medium	C) Likely	C) Likely	TIME
	D) Low	D) Unlikely	D) Unlikely	SAFETY
	E) Very low	E) Remote	E) Remote	ENVIRONMENT

PHASE FOUR : ACTIVITIES ASSOCITED WITH COMMERCIAL CAPITAL PROJECTS				
Risk Classification: *External Risk (regulatory)*	*Risk Impact on Phase four*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
1) Local community opposition to project development				
2) Occurrence of dispute between ownership and aviation governing bodies over policy requirements for development				
3) Litigation issues arising from negligence of safety related processes on site during construction phase of development.				
4) Permitting related processes (i.e.) Environmental impact statement approval pre development (etc.) that slow down project development process.				
5) Cyber threat related issues				
Risk Classification : *Project Risk (schedule)*	*Risk Impact on Phase four*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
6) Project schedule affected by review time for project development in aviation governing bodies review agencies				
Risk Classification : *Internal Risk (reorganization)*	*Risk Impact on Phase four*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
7) Consultant staff hired unable to meet project requirememts and standards				
Risk Classification : *Internal Risk (procedural)*	*Risk Impact on Phase four*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*

8) *Monitoring equipment and communication during Capital project development*				
9) *Disasater preparation issues*				
10) *Security threat on facilities posed by airport development*				
Risk Classification : *Project Risk(Cost)*	*Risk Impact on Phase four*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
11) *Project design constructability issues affecting project cost*				
12) *Utilization of unfavorable project delivery methods that negatively affect airport owernship finances*				
Risk Classification : *External Risk (Political)*	*Risk Impact on Phase four*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
13) *Land development issues (eminent domain / sacred burial grounds) stall project devlopment process*				
Risk Classification : *Project Risk(Schedule / quality / cost)*	*Risk Impact on Phase four*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
14) *Contract related disputes*				
15) *The negative effects of " Acts of God " on project development*				
Risk Classification : *Internal Risk (reorganization)*	*Risk Impact on Phase four*	*Likely hood of risk occurring*	*Airport owners' involvement with risk*	*Other project objectives risk may affect*
16) *Construction activities negatively affect current airport operations*				

RATING SYSTEM

RISK IMPACT ON PHASE LISTED
A) Very high
B) High
C) Medium
D) Low
E) Very low

LIKELIHOOD OF RISK OCCURING
A) Near Certainty
B) Highly Likely
C) Likely
D) Unlikely
E) Remote

AIPORT OWNERS' LEVEL OF INVOLVEMENT WITH RISK
A) Near Certainty
B) Highly Likely
C) Likely
D) Unlikely
E) Remote

PROJECT OBJECTIVES
COST
QUALITY
TIME
SAFETY
ENVIRONMENT

PHASE FIVE : MAINTENANCE DEVELOPMENT : ACTIVITIES ASSOCIATED WITH COMMERCIAL AIRPORT MAINTENANCE PROJECTS				
Risk Classification: External risk (regulatory)	Risk Impact on Phase five	Likely hood of risk occurring	Airport owners' involvement with risk	Other project objectives risk may affect
1) Inspection procedures of aviation governing bodies affec maintenance schedule of project and its associated objectives.				
2) The possibility of cyber threats				
Risk Classification : Project Risk (cost / schedule / quality)	Risk Impact on Phase five	Likely hood of risk occurring	Airport owners' involvement with risk	Other project objectives risk may affect
3) Unidentified maintenance issues affecting the current maintenance process				
Risk Classification : Project Risk (quality)	Risk Impact on Phase five	Likely hood of risk occurring	Airport owners' involvement with risk	Other project objectives risk may affect
4) Funding provision for certain aspects of maintenance by governing aviation bodies limiting scope of maintenance project				
Risk Classification : Internal Risk (reorganization)	Risk Impact on Phase five	Likely hood of risk occurring	Airport owners' involvement with risk	Other project objectives risk may affect
5) Negative effects of maintenance activities on airport operations				
Risk Classification : Internal Risk (Procedural)	Risk Impact on Phase five	Likely hood of risk occurring	Airport owners' involvement with risk	Other project objectives risk may affect
6) Monitoring equipment and communication during maintenance activities				
7) Disaster preparation issues				

PROJECT INFORMATION

Please kindly provide financial and risk related information pertaining to recent commercial airport capital or maintenance projects your facility may have carried out .

RATING SYSTEM

RISK IMPACT ON PHASE LISTED
A) Very high
B) High
C) Medium
D) Low
E) Very low

LIKELIHOOD OF RISK OCCURING
A) Near Certainty
B) Highly Likely
C) Likely
D) Unlikely
E) Remote

AIPORT OWNERS' LEVEL OF INVOLVEMENT WITH RISK
A) Near Certainty
B) Highly Likely
C) Likely
D) Unlikely
E) Remote

PROJECT OBJECTIVES
COST
QUALITY
TIME
SAFETY
ENVIRONMENT

Project Type (C = Capital or M= Maintenance)	*Financial value in dollars ($)*	*Start date of project*	*Finish date of project*	*General impact of risk on project*	*Airport owners' level of involvement with risk in project*	*Project objectives affected by risk during project development*
1)						
2)						
3)						
4)						
5)						
6)						
7)						

RECOMMENDATIONS

Please List any other suggestions you may have with regards to this document

Thank you very much for your participation. If you have any further questions or issues please free to contact :

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