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# MKM227 Postgraduate Dissertation

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# "Developing a scope Risk Evaluation Framework for Olympic Games' Legacy Projects and Implementing the Framework as a case study survey for Convergence Theme in Regeneration of London Host Boroughs"

A dissertation submitted in partial fulfilment of the requirements of the Royal Docks Business School, University of East London for the degree of **MSC PROJECT MANAGEMENT**

**[MAY, 2013]**

**WORDS [14,418]**

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# Postgraduate Dissertation

## "Developing a scope Risk Evaluation Framework for Olympic Games' Legacy Projects

## *and Implementing the Framework as a case study survey for Convergence Theme in Regeneration of London Host Boroughs"*



St. No: 1149602

*To my mother and my father*

*For all their support and love*

# Abstract

Discovering and generating something new is an exciting experience although heuristic research is often a difficult task as you may not always find others' footprints to step on. It was exactly what happened in this research as effort was made to answer a real life business need i.e. the need for a suitable framework for evaluating scope risks in Olympic Legacy projects.

The present dissertation had two components the first a heuristic one to develop a scope risk evaluation framework, and the second a case study survey to apply the model to a high value purpose area of the legacy i.e. convergence of the host boroughs to the neighboring areas and the rest of the city of London.

The main questions to address in this research were if there could be identified any logical goal-oriented model of risk-based thinking with the help of which a legitimate framework can be developed to understand what are the main probable risk factors for legacy functions (in this case convergence theme) and what would be the impact levels and priority of such risks.

In this research, after developing the framework, a questionnaire battery was developed with customized phrasing of known scope risk factors so as to reflect negative forces which may impact convergence desired outcomes. The online administration of the survey revealed that 10 out of 11 risk categories were evaluated by a group of 34 selected respondents as probable and having significant impact on the convergence aims. It was also revealed that 17 of the 30 risk factors under these categories were evaluated as likely and very likely to happen. And 20 of these 30 risk factors have significant impact on convergence aims in case that they happen. Prioritization of the results also showed that exaggerated future functionality, overestimated funding, unmanaged downsizing, intangible deliverable problems are the most important priority risk factors threatening the convergence aims.

# Acknowledgements

This work could not be done without accurate guidance and feedback from Dr. Paolo Taticchi, the advisor of this dissertation to whom I feel indebted for his insightful comments.

I wish to thank all my professors and my colleges in UEL for their comments on the subject selection methodology decisions and statistical techniques refinement.

My special thanks shall be extended to all dear respondents, project managers, authorities and organizations in the stakeholder bodies, for accepting my request and filling the rather lengthy questionnaire online.

Last but not least I wish to thank my family and friends for their support during the accomplishment of this research.

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# Chapter 1: Introduction

In this chapter summary of the main points covered in this research is presented. The predominant approach and intention of this research was to address a concurrent issue with real life effects. An encouraging experience of the researcher in sustainability project of London 2012 Olympic Legacy as a team project formed the starting idea for identifying major probable risks for sustainability purposes. However since there were reports that indicated positive trend and audit and standard test results for sustainability project on one hand, and there were a number of serious concerns about achievement of other Legacy projects like regeneration and convergence (as will be discussed in chapter one), it was decided that a study on the latter area would probably be of higher value.

From the first Olympic event of ancient Greece in 776 BC the enthusiasm for the huge event has not lessened. Though the event runs every four year, the preparation efforts for the host cities take nearly twice as much time and lots of expense and effort (IOC, 2012). Alterations like host city rotary selection, professionalism of participants, and addition of winter Olympics and Paralympics together with mass media and technology effect and growing country participation as well as increasing security and terrorist concerns have made this mega-event a stage for many fields of expertise among which risk management profession have a special stance (Jennings, 2012).

Olympic Games have always been a stage for symbolic benevolent and humanitarian gestures. These gestures have turned into serious institutionalized programs in recent Olympic events. Major long lasting and infrastructural, environmental, and socio-cultural benefits remaining in the host cities of the Olympic Games after the Games have finished, are termed Olympic Legacies as the residents will take advantage from the facilities, developments and infrastructure created for the games.

Major entities of the legacy promises and objectives include overreaching aims of sustainability, convergence, inclusion, (MacRury, & Poynter, 2009) and spirit (Kingman, 2012) infrastructure (Leromonachou et al., 2010) as well

as a sensitive general aim to avoid the white elephant phenomenon (LOCOG, 2012; Comptroller and Auditor General, 2000).

The picture is not always realized as such and many problems might impede the desired results. So there is always uncertainty toward the Legacy outcomes in terms of intentional, operational, functional, financial, and other shortcomings.

The present dissertation took a challenging step toward high-end purpose risk evaluation. The research has two parts. The first part was devoted to find or develop a suitable framework for Olympic Legacy project risk evaluation. In the second part the logic and applicability of the framework is tested by devising and administering a specific questionnaire battery for it as a survey in a focus area of risk i.e. scope risks and for a focus Legacy purpose area i.e. convergence.

For the first part various models of risk management, sources of information about Legacy projects and databases of risk factors were investigated via library and online search, resulting in identification of gaps and necessities in the subject area and leading to formation of main logic of proposed framework. Since many Legacy ventures take the form of construction projects, therefore risk management models and methods which were specifically developed for construction projects will get required attention in the literature review chapter.

Formal risk management authorities often require evidence of qualitative risk management from the host city officials and want to make sure they have proper risk identification methods (IOC 2004: p. 5 as cited in Jennings 2012). While being a logical approach this indicates that there does not exist a comprehensive specialized risk framework upon which they can prescribe a quantitative risk assessment.

Modernization and scientific and technical progresses and as a result higher attempts at control, can become a risk source for itself (as cited in Jennings 2009)

One other factor is the bidding process. Olympic Host city bidding process has been discussed to incur major risks such as optimism bias (Flyvbjerg, 2007), over-promises (Jennings 2012), Under-attention of bids to insufficiencies and issues, and under-estimation (Flyvbjerg et al. 2003). Even the Official Olympic Report (1908) contend that the Olympic budget involve under-estimated expenditure which has become a norm in Olympic budgeting.

In the second part scrutinizing of the problems reported around Legacy, regeneration, and convergence functions and detailed scope risk sources and factors resulted in pessimistic questions envisioning pre-mortem situations about convergence outcomes based on which the questionnaire was devised.

Convergence theme was selected for the case study and application of the developed framework because from one hand the stated promises were of high value to the life of the people in the regions and the city and from the other hand it was the theme with the most probability of scope risk affliction based on the literature review.

The concept is about integration of the host boroughs to the surrounding districts and the city of London and aspires for creating wealth and reducing poverty, supporting healthier lifestyle, and developing successful neighborhood (LLDC, 2012).

The convergence purpose is tightly connected to the regeneration projects and actually, it is actualized in regeneration programme. The concept has a long history as the host boroughs have already had lists of demands and later accumulated as Single Regeneration Budget Programmes (SRBs) and Strategic Regeneration Framework (SRF) which tried to address insecurity, social isolation, access to new employment and business opportunities due to lack of formal education, insufficient work related skills , and ill health (Sampson, 2011). The attempts were not effective and the East London regeneration remained a “wicked problem” as Rittel and Webber (as cited in Sampson, 2011) describe it since they believe the concept is “ill-defined” and vague and different interpretations are made about it with little agreement.

Central government stated convergence vision such that: “within 20 years the communities who host the 2012 Games will have the same social and economic chances as their neighbors across London” (HBU, 2009; Government Olympic Executive, 2012), But host boroughs consider government strategic plans to be high level with little real-life impacts and insist on proper funding for their SRFs which was later integrated to Legacy plans (Sampson, 2011).

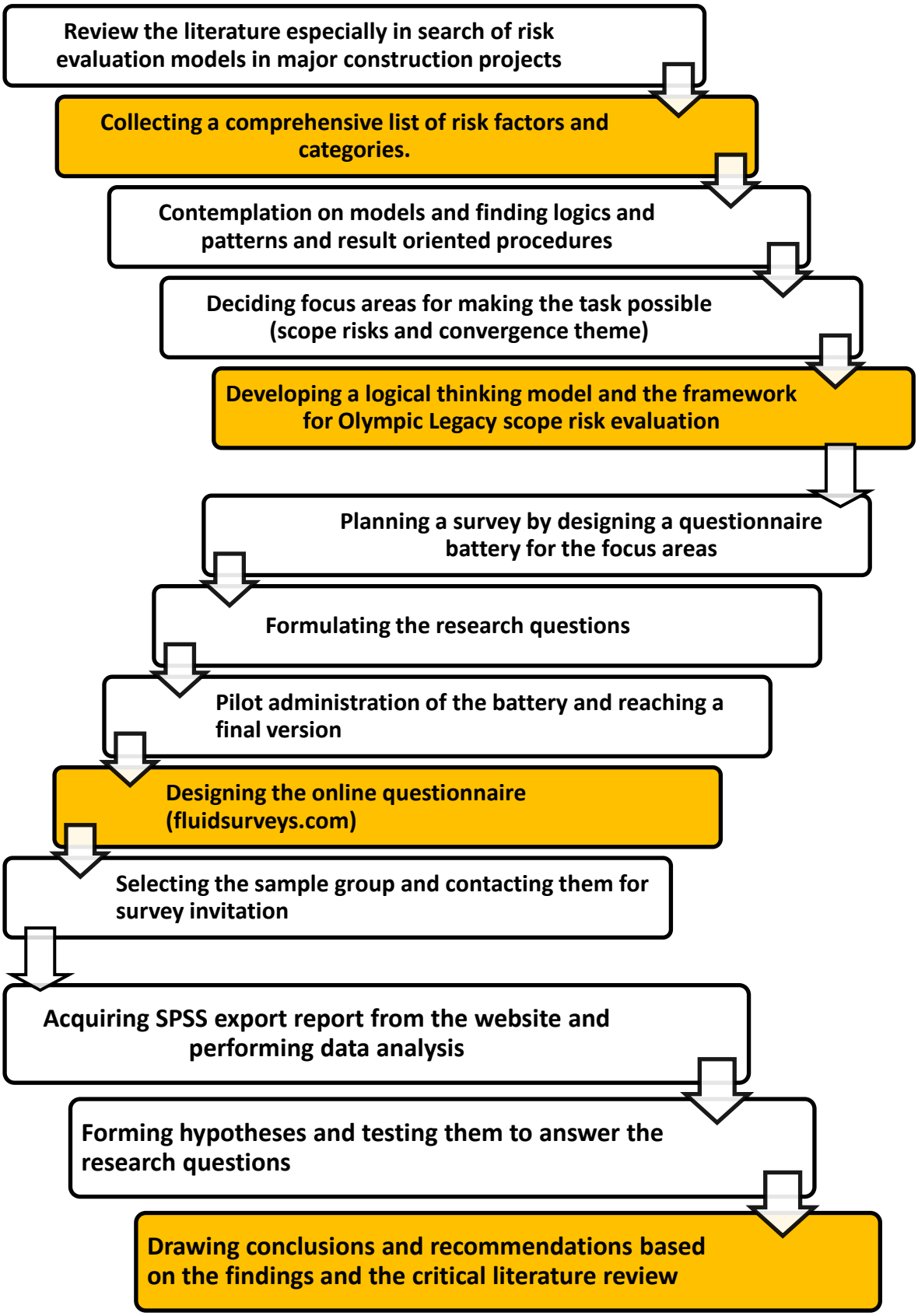
The aim of this research was in the first place to identify possible threats for the Legacy project especially regeneration functions. But there was a lack of specific criteria for the risk evaluation beyond common practice of project time and cost and quality. The researcher also identified important gaps in the field. Fist gap was that there were no specific framework that could directly address the risks associated with the aims and purposes of the Legacy projects as observed endeavors are often experience-centered and issue-based as the researcher scrutinized the risk analyses reported in official documents like The London Legacy Development Corporation’ business plan (LLDC, 2012). The lack of a framework for risk analysis has been stated in the Legacy Masterplan (LLDC, 2012).

Moreover no indication were found confirming that the enterprise risk management model adopted for the Legacy will do a different practice than assessment of cost and time of the Legacy projects employing ordinary risk premises.

Basically the scope of Legacy has not been the focus of attention and was overshadowed by the Games event with large emphasis on security risk category and with focus on Game-time security issues.

All these gaps and necessities encouraged the researcher to enter into difficult task of developing a framework for Legacy functions scope risk identification and risk impact analysis. It became necessary to form a foundation and a pack of criteria for evaluation.

The journey thereafter followed the following steps:



The CPM of the main research steps for the preparation of dissertation has been presented in annex five.

The introduction to this research was necessary to explain how the conclusions were reached and give an idea to the reader as to what extent the products of this study could be useful and suitable for practical purposes and further research promotion.

# Chapter 2: Critical Literature Review

## Introduction

This chapter starts with an introduction to the concept of risk management in Olympic event to explain its complexities and sensitivities. Difference between Games-time and Legacy period requirements and approaches to address them are then discussed.

The second discussion in this chapter is project risk management. The concept of risk, the process of risk management, scope risks and requirements engineering are discussed emphasizing the need for comprehensive and multi dimensional approach to risk identification. Then risk management in the current Legacy projects is discussed as for some gaps and defects identified.

A special part is dedicated practical models developed for huge construction projects' risk management. In this part the researcher's enthusiasm for finding best fit model of risk evaluation for Legacy project favored the formation of a database for various risk factors which were later narrowed down to scope risk factor as they directly connected to the goals of a project.

At the end of this chapter endangered aims of the Legacy are discussed. An overview of the past Olympics achievements is given and London 2012 Olympic Legacy and convergence promises are then introduced with a glance to the initial impact study that have been performed based on Legacy indicators.

## Risk Management in Olympics Games

Olympic Games as mega-events are subject to a plethora of risks and therefore require extensive and comprehensive risk analysis and management. Major part of the literature on Olympics risk analysis refers to the Games phase external security issues like terrorist attacks (Karyotis

2007, p. 286, Yu et al., 2009) and some tend to cost and time overruns (Spillane, 2012; Flyvbjerg et al., 2007, Priemus et al., 2008). However fields like public health, food safety, and politics.

London 2012 Olympics Games-time security risk management was addressed by Jennings and Lodge (2009) based on the quadrant NATO government tools developed by Hoods (1983) shown in the following figure:


*Figure 2-1: Hoods' (1983) Quadrant NATO security risk management (cited in Jennings & Lodge, 2009)*

For instance Nodality tools in the London Olympics included: Intelligence (e.g. Olympic Security Committee), counter-terrorism, transnational information-sharing, Olympic intelligence centre, risk assessments, knowledge transfer programmes. Or organization tools were Layout and architecture of the Olympic site, police, emergency services, CCTV monitoring, pedestrian screening. Surprisingly they found that there was little similarity of patterns of tool choice for security risk management in sport mega-events despite sharing risk properties (Jennings & Lodge, 2009).

Will Jennings (2012) in his presentation slides titled "Managing Olympic Risks" explained aside from long lasting OCOG's insurance practice which dates back to 1900, the emergence of formal risk management (RM) in the

Olympic Games has been started from 1988 in Calgary winter Olympics. It comprised of a number of review processes of documents and contracts, some inspections, and consultations to managers.

The next RM effort was Vancouver 2010 In which an enterprise risk management framework was adopted with distinct categorization for pre_Games, during the Games and post-Games risks in functional and strategic levels. ERM aim was to promote a culture of risk management in which proactive thinking would support functional objectives and desired outcomes.

London Olympic risk management model is reported by Jennings (2012) to be a holistic enterprise level one, governing the whole of the program encompassing infrastructure, security, policy, finance, operations and legacy functions, incorporating programme, project, and operational risks both at the strategic and individual program levels. Risk-based thinking especially in the preparation phase for the Olympic Games has been more extensive. Jennings cites Power (2004) who adds to this a capability of a shared language which enables communication between discrete functions and people from different categories of practice.

Despite these claims no direct risk approach is addressed for the Legacy functions and beyond the main Games event.

## Project Risk Management

Uncertainty as Cretu et al. (2011) refer to is: "lack of knowledge about current and future information and circumstances, which poses a special set of problems to the management of the projects as it can potentially affect the outcomes for both the good and the bad".

Therefore the objectives of project risk management, as PMI (2008) puts, are "to increase the probability and impact of positive events and decrease the probability and impact of negative events in the project."

PMBOK Guide (4th edition) defines project RM as " the processes concerned with conducting risk management planning, identification, analysis , response, and monitoring and control on a project".

Sarmadi (2011) compared risk management models namely PRMA, SHAMPU, IRM/AIRMIC/ALARM, PMBOK, PLEACH, Prichard, Smith& Guymerritt, and Wideman (Sarmadi, 2011) and concluded that PMBOK was capable in most optimal criteria especially based on their process area comprehensiveness, provision of tools and techniques, integration to other PM process areas, and methodology. Similar notions that were indicated by Seyedhoseini et al (2009).

According to PMBOK Guide (4th edition) a project has 5 process groups including initiating, planning, executing, monitoring and control, and closing the main part of project RM happens in two process groups of planning and monitoring and control.

As cited in Cretu et al. (2011), International Standard Organization (2009) (ISO) 31000:2009 Risk management principles and guidelines provide a descriptive purpose-based definition for RM as it should: create value, become integral part of organizational processes, be part of decision making, explicitly address uncertainty, be systematic and structured, be based on the best available information, be tailored, take into account human factors, be transparent and inclusive, be dynamic, iterative, and responsive to change, be capable of continued improvement and enhancement.

## Project scope management:

Project scope should exactly determine why the project is launched and what it is going to deliver and what it is not about. It should introduce project objectives and goals, phases and sub-phases of the projects, main works to be accomplished and the time and resources needed to perform them.

Scope, Time and cost are considered as the triple constraints of project (PMI, 2012; Walker, 2012). As Walker contends “Time and cost are relatively easy to understand because they can be easily quantified. Scope, on the other hand, is fuzzy i.e. it is usually expressed in qualitative terms that leave room for interpretation and misunderstanding. Consequently, it's often the biggest source of conflicts in a project.” (Walker, 2012).

Charette (2005) believes that scope management process should be supported with sound change management not just sticking to controls, and that it should be integrated into project risk management. Other factors like decision making, organization environment, business lifecycle (Manalo et al, 2010) and technical factors have been considered by Myddelton (2007).

## Requirement engineering:

In a wider connotation of scope any efforts for identifying the requirements of the project is part of scope definition (Pressman, 2010).

In requirements engineering (RE) a wide spectrum of issues must be considered, ranging from strategic level objectives to low level technical requirements (Bergman, et al., 2002).

Impair RE can create great risks for the project time, cost and quality outcomes and have been reported to be the main factor for projects failures especially in software projects (The Standish Group, 1995; Chua, 2009; Drummond, 1998).

Bergman et al. (2002) advises to adopt heterogeneous requirements management practices of low-level financial ecology as well as high-level political ecology network of interaction to find out possible effects and implications. Agile requirement engineering is advocated by Schwaber (2004) but the very method may produce a risk source if not managed wisely (Sutherland, 2004).

## Scope risks:

Kendrick (2003) cites scope risks reported in the Project Experience Risk Information Library (PERIL) database as:

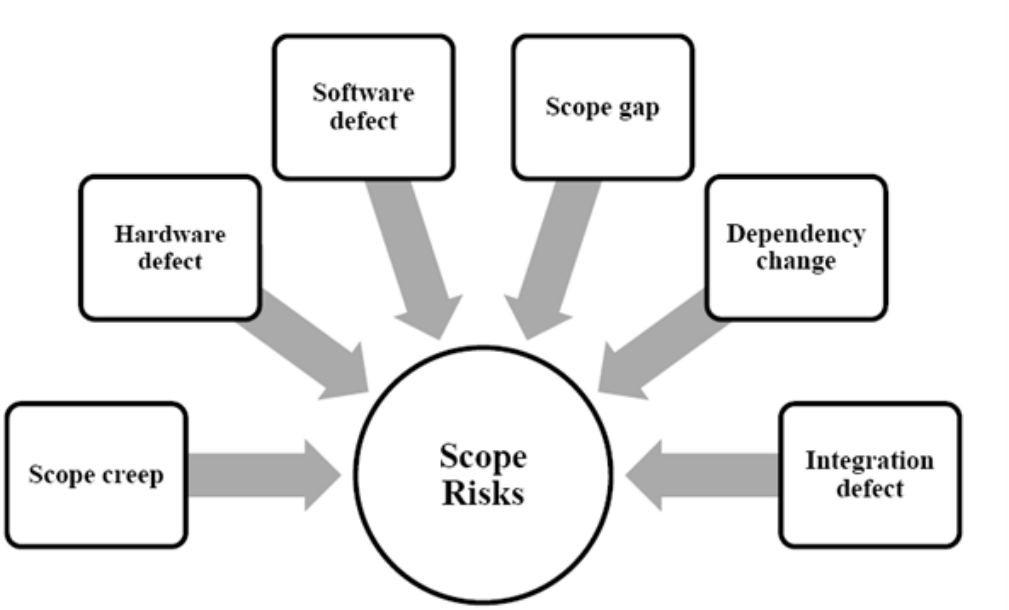



*Figure 2-2: Kendrick's (2003) categorization of PERIL's Scope risks*

Project scope management starts in the initiation phase by scope statement within the project charter. This statement turns into more detailed description of the scope and the products and limitations and forms the basis of project scope planning which in turn enables the scope verification and scope control mechanisms by setting criteria for determining if a project or phase is completed successfully (PMBOK, 4th edition).

Mathur (2012) discusses that the ambiguity of scope may create delay and unnecessary work. Scope which is not collaboratively formed leads to misinterpretations in requirements and design. Incomplete scope and Scope creep (uncontrolled growth or change in project and requirement specifications) result in delay and cost overruns. Reports especially in software projects reveal severity of the risk (Charette, 2005; Standish Group, 1995) Transient scope leads uncertainties and never ending project.

Scope forms 30% of the risks in the PERIL database, but their impact equals to the total impact of all other risk categories as shown below (Kendrick, 2003).

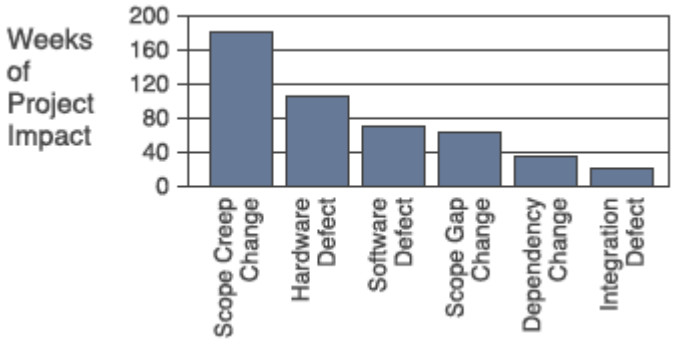



*Figure 2-3: Scope risk impact level (PERIL database as cited in Kendrick, 2003)*

Poor scope definition can affect the work breakdown structure and exert significant amount of risk due to uncertainty on the work to be performed (Kendrick, 2003; Drummond, 1998)

## Risk management approaches and models in construction projects

Most of the Legacy promises are linked to some form of construction projects. Therefore risk management models and methods specifically developed for construction projects have been reviewed.

Panama Canal expansion is one outstanding mega-project for which a comprehensive risk management approach has been adopted. As demonstrated in the figure 2-4 the first four logical steps before risk planning start with identifying list of risks, followed by qualitative analysis of their probability and impact, providing data for the third quantitative step of prioritization, which in turn sets foundation for in-depth quantification of critical risk as a result of which a risk model is produced with related benchmarking (Alarcón et al, 2011).

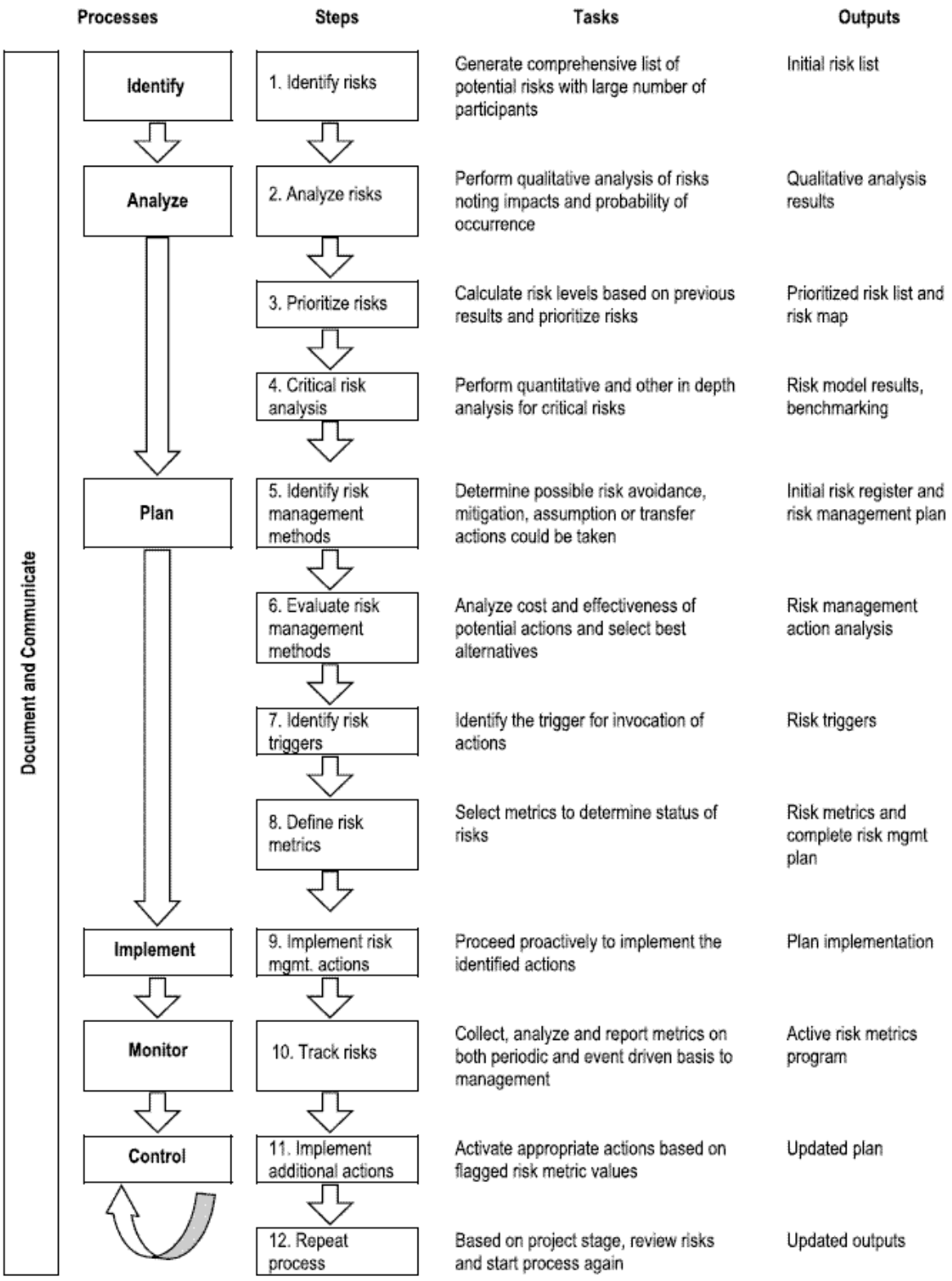



*Figure 2-4: Panama Canal risk management process model (Alarcón et al., 2011)*

Alarcón et al (2011) explained how the program risk management venture could integrate cost and time estimations into risk management process to

come up with more realistic and accurate contingency requirements. The Panama Canal completed in 1914 is one of the greatest engineering projects of all times and its expansion program is also a huge undertaking as it aspires doubling the canal capacity by 2015 with a budget equal to $ 5.2.5via a new lane which will be larger than the former two lanes. The scale of the program and interdependence of single projects (i.e. two new lock facilities each with three chambers and three basins, the excavations of new access to these locks, widening, deepening of the channels etc.) forced the authorities to get help from a spectrum of risk management advisors and methods. Critical qualitative and quantitative analysis and risk modeling and procedure analysis were employed to identify 200 potential risk factors. 14 most important sensitive risks were selected including: design and quantity changes, extreme weather, general inflation, inadequate claims administration, inefficient contracting process, inefficient planning, insufficient revenues, lack of controls, lack of skilled and local labor, local labor strikes and finally material, equipment and labor costs.

The Unique approach of the model to contingency was that the contingency budget was linked to the whole program and was not withdrawn in case that the single project's contingency conditions were not realized (Alarcón et al , 2011).

Hastak and Shaked (2000) developed a model to cope with the complexity of risk factor relations in international construction projects. Their International Construction Risk Assessment Model (ICRAM-1) tried to analyze the risks in macro (country), market, and project level as shown below:

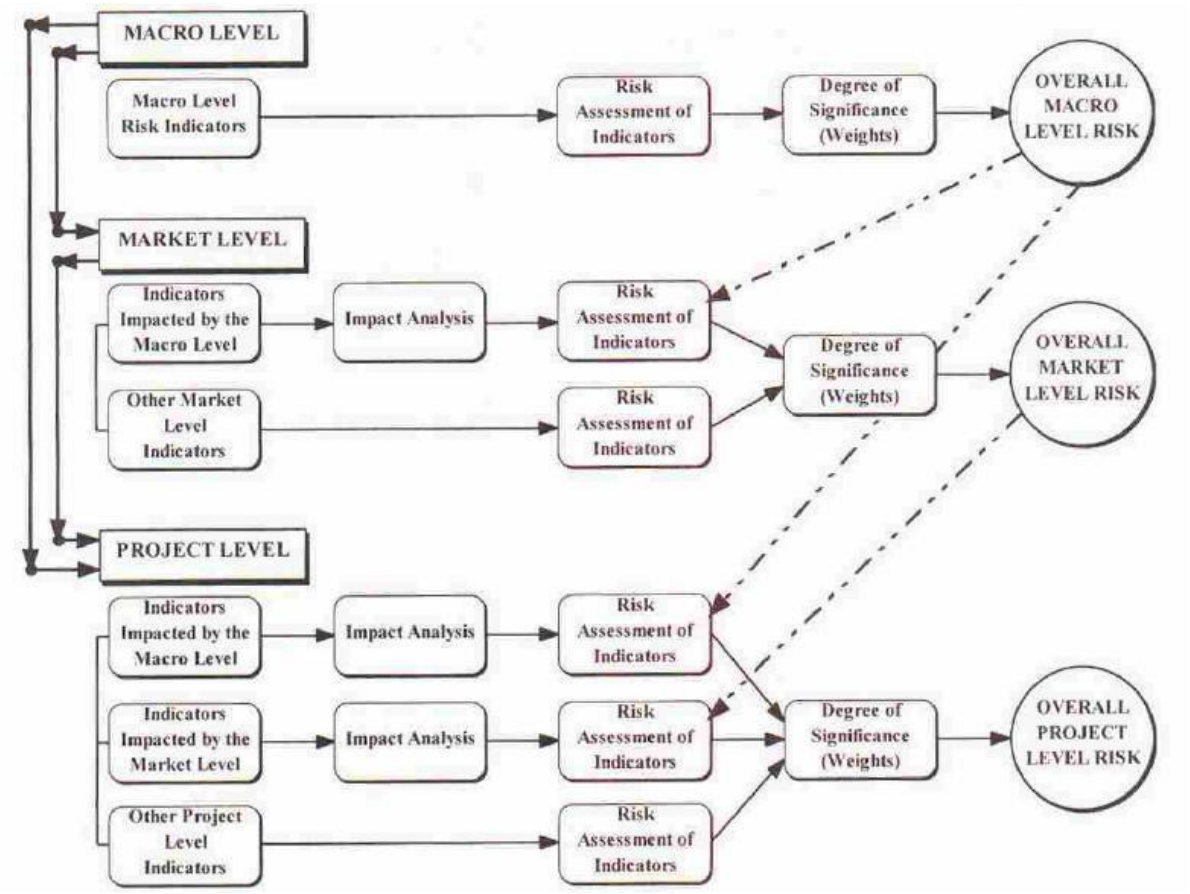



*Figure 2-5: ICRAM three layer risk management model (Hastak & Shaked, 2000)*

In a subjective assessment this model recognizes 3 additional inter-level impacts on risk indicators (Hastak and Shaked, 2000).

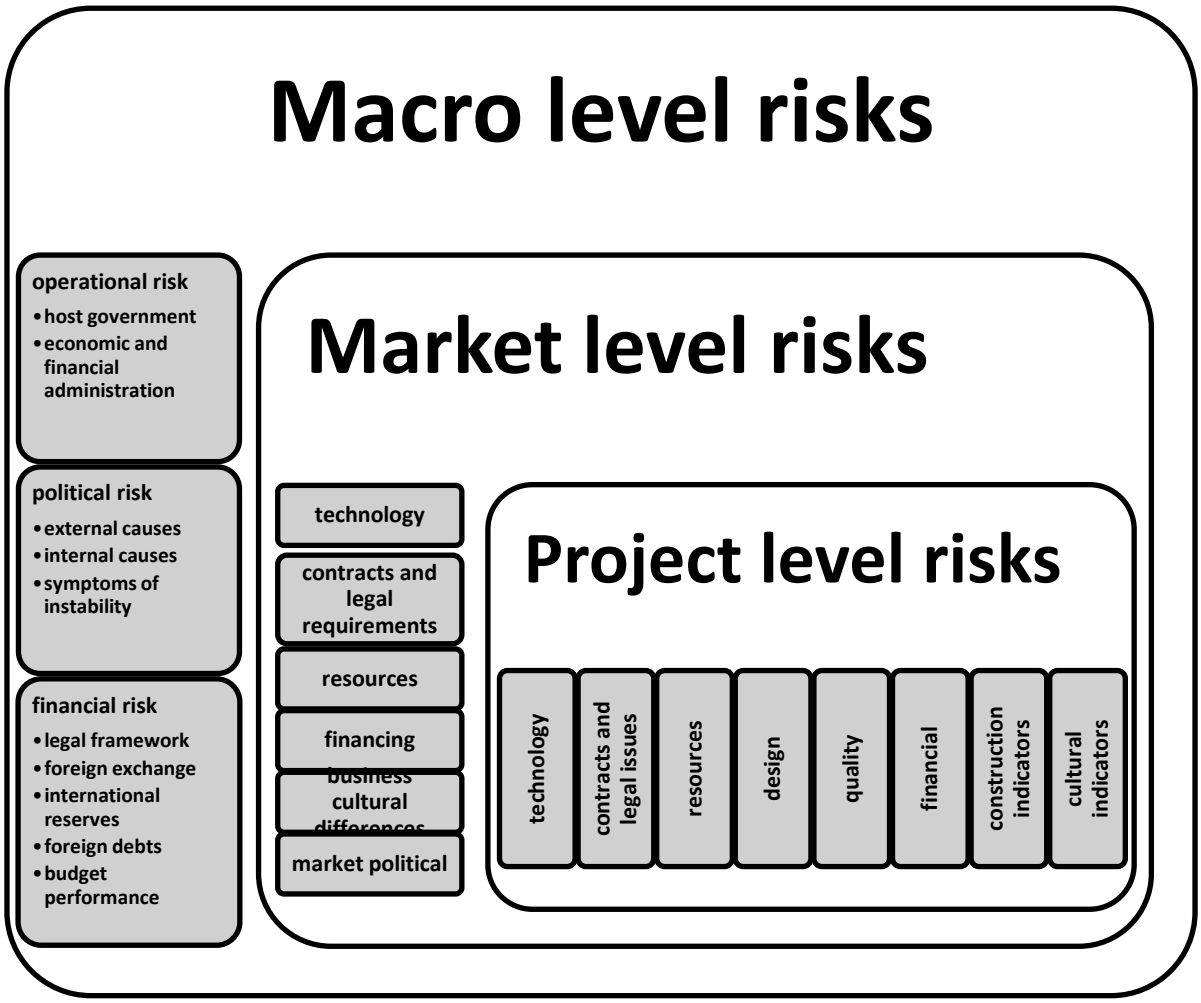



*Figure 2-6: ICRAM model's risk factors (Hastak & Shaked, 2000)*

Risk value was assigned to each indicator by referring to gathered information and with regard to probability of occurrence and its impact. Analytical hierarchy process (AHP) was employed in ICRAM-1 to determine the hierarchy of indicators within each level and their relative importance. Transfer of risk between levels was analyzed by Pair Wise Comparison (PWC). 14 most important indicators were selected as a manageable set of high-risk indicators.

Zhang and Zou (2007) in an attempt to present a systematic and holistic approach to identify risks and analyze their likelihood and impact on the project objectives in terms of **cost**, **time**, **quality**, **safety**, and **environmental sustainability**. Their focus was to deal with key risks in construction projects with respect to lifecycle of the project as they related to stakeholders that comprised: **clients**, **designers**, **contractors**, **subcontractors** and

**government bodies**. The data gathered via questionnaire was analyzed by calculating the risk significance index devised by Shen et al. (2001). A total of 51 risks were identified to have impact of which 20 were selected as key risks including: tight project schedule, design variations, bureaucracy of the government, occurrence of disputes, approval procedures, high quality or performance expectations, inadequate program scheduling, unsuitable construction program planning, variations by the client, low management competency of subcontractors, incomplete approval and other documents, lack of coordination between project participants, unavailability of sufficient professionals and managers, unavailability of sufficient skilled workers, general safety accident occurrence, price inflation of construction materials, serious noise pollution caused by construction and insufficient site information . Fish bone diagram was then used to demonstrate occurrence stage of each stakeholder relevant risk during 4 project lifecycle stages of **feasibility**, **design**, **construction**, **operation** (Zhang and Zou, 2007).

Though the respondents were minimal, the model itself was unique and gave some insight as when specific stakeholder risks might happen during the project lifecycle, most probably. Among others a sound conclusion of the study was that cooperation of stakeholders is necessary form the feasibility stage into the project.

Hanna and Gunduz (2005) tried to develop a quantitative risk assessment model that could help identify warning signs of over-budgeted projects early in the bid phase before construction phase. They surveyed 116 mechanical and electrical construction projects via a questionnaire which extracted data characteristic for over-budgeted (distressed) projects, the risk sources and factors associated with them and their efficiency (EFF) factor. The questionnaire was devised with regard to the past studies and by the help of CII committee. The three main categories of factors comprised: contractor and owner experience, design issues, and management related issues. They calculated the correlation by means of the logistic regression model and reported 71% of distressed projects were successfully estimated to be so (predictable) by employing this model.

In an attempt to develop a quantitative method for assessing risk in Joint venture projects, Zhang and Zou (2007) presented the fuzzy analytical hierarchy process or **AHP** model. A hierarchy of risk factors was first devised with three levels of objective, criteria, and attributes. The categorization in each level provided room for more independent risk factor analysis for example they identified three main risk categories in the criteria level including internal risks, project specific risks, and external risks each comprising 12, 10, and 16 factors in the attribute level respectively.

Although the study claims to provide a comprehensive risk appraisal model suitable for all projects, little evidence was provided so as to encompass the wide level of risks and limited the categories were identified for level two criteria. Moreover interdependence of risks is not completely accounted for. However the hierarchy provides a general base upon which any specific risk analysis model can be developed.

Cretu et al. (2011) who focused on RM for design and construction believe that RM should be dynamic with active evolutionary participation of people, therefore time spent on RM phases should be reconsidered and the major time share should be given to monitoring and control and response planning (solutions and their execution) rather than logically accepted traditional emphasis on RM planning and risk identification (i.e. problems and their analysis) (p. 150). They compromise with a 50% risk tolerance as a criterion. However immediately pinpoint that **political sensitivity**, **public scrutiny**, **funding availability**, and **schedule criticality** are the real-life factors that might force a meticulous risk tolerance.

Risk identification is the essence of RM and categorization is a usual helper either from the start to streamline the mind or in the end to extract a blue print for risk response planning. PMBOK advises to devise a risk breakdown structure of which Cretu et al. (2012, p. 238) present a sample for construction project risks that include:

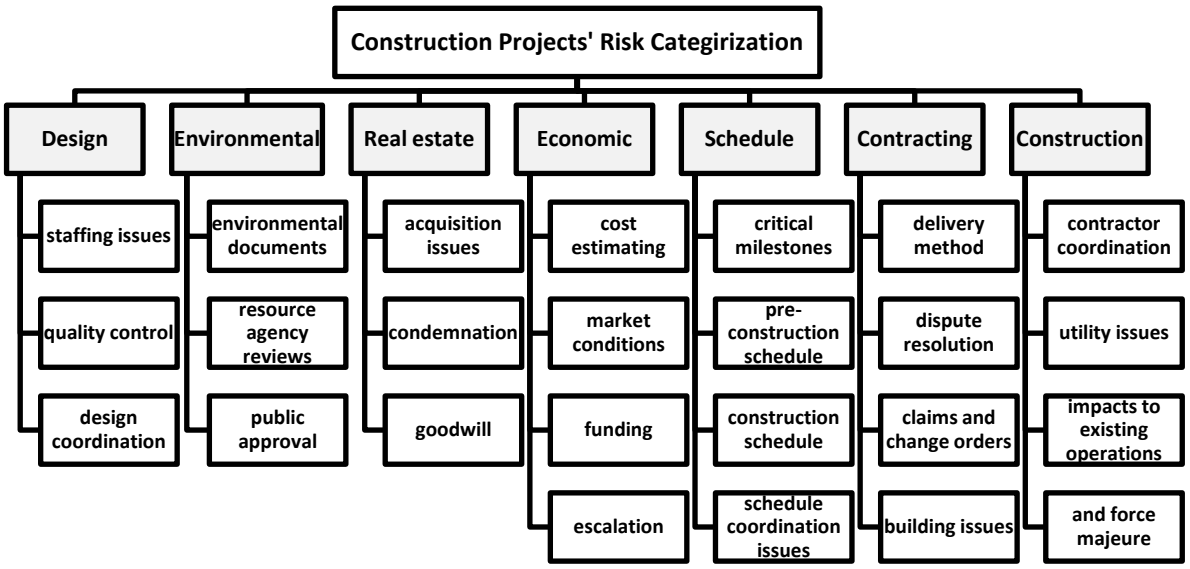



*Figure 2-7: Sample risk breakdown structure for construction projects (Cretu et al., 2012)*

Advanced Programmatic Risk Analysis and Management Model or **APRAM** was developed primarily for the aerospace industry, but Imbeah and Guikema (2009) tried to test the usefulness of the model for cost, time and quality risk management and resource allocation in construction industry as well.

The model was developed following NASA's faster, better, cheaper missions and has 8 steps as shown below:

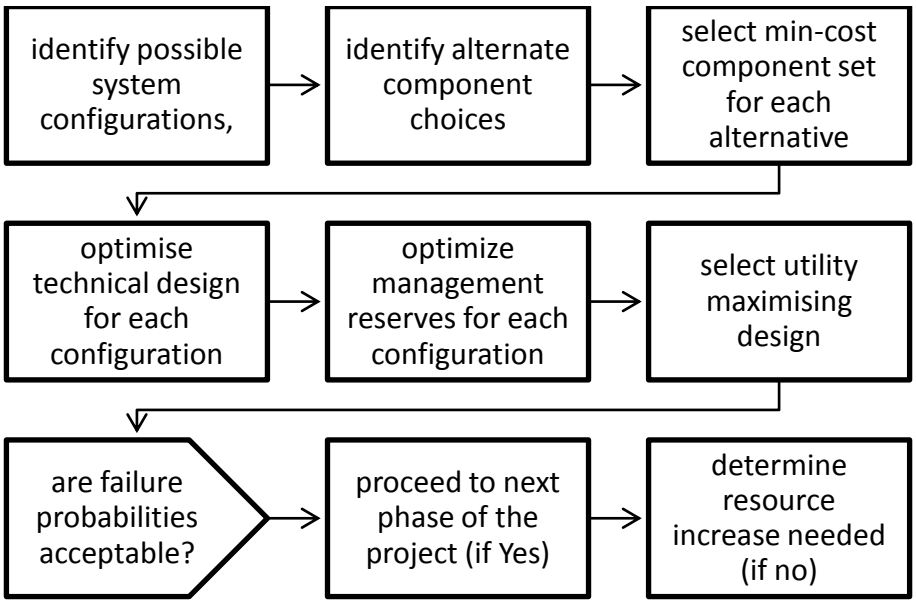



*Figure 2-8: APRAM risk management process model (Imbeah & Guikema, 2009)*

APRAM can be used as a decision making tool in design phase so it requires all possible technical and financial configurations and alternatives being considered therefore Imbeah and Guikema identified 4 alternatives for 5 structural components namely : structural frame, reinforcement steel, HVAC, roofing, façade, moisture protection. Optimal allocation of residual budget would be based on least probabilities of failure and least possible cost of failure. (Imbeah and Guikema 2009)

Another decision support tool in the form of a quantitative risk allocation method was developed by Kokkaew and Chiara (2010). In order coming up with an objective equitable risk allocation between stakeholders they identified 23 influencing factors like risk attitude of the participants, ability to estimate consequences, upper limit for risk exposure, financial requirements, corporation history, government support level, etc.

## What might be at risk in Olympic Legacy Project?

Project success evaluation usually is based on project time and cost and quality and quantity of products but to form a sound judgment other criteria like project and business outcome and economic impacts and legacy of the project must be taken in to account (Jacklin, 2011; Cooke-Davies, 2002).

## Legacy of Olympics

Olympic legacy ventures as International Olympic Committee (2012) reports often are criticized or praised for their long-lasting heritage which remains for the host cities. This heritage or Legacy may be an economic impact, improved transport infrastructure, the Games' venues utilization, environmental plans, cultural preservation, education plans, tourism promotion, etc. Some Olympic Games bear a Legacy identity like the green Olympic of Sydney and some are exemplified as disasters like forsaken venues of Athens (Leromonachou, et al., 2010).

Based on information provided in London Assembly (2007), Leromonachou et al. (2010) summarized the past Olympic performance on Legacy projects demonstrated in the table 1. As shown in the table 1 Barcelona 1992 had strong urban renewal, city economy, and environmental achievements branding itself as regeneration Games. Atlanta 1996 was successful only in city economy. Sydney 2000 Games had prominent environmental, urban renewal, and disability awareness and was praised as the green Games. Athens 2004 was only good in urban renewal with ancient roman themes. All 4 Games failed in sport and community participation.

| | 1992 Barcelona | 1996 Atlanta | 2000 Sydney | 2004 Athens |
|---|---|---|---|---|
| **'Strap line' aspiration** | Regeneration Games | Centennial Games | Green Games | Refreshing the Olympic ideals |
| **Urban renewal** | (+) | (–) | (+) | (+) |
| **Environment** | Slight (+) | Slight (+) | (+) | (–) |
| **City economy** | (+) | (+) | (+) | (–) |
| **Tourism** | (+) | Slight (+) | | |
| **Sports and community participation** | (–) | (–) | (–) | (–) |
| **Disability awareness** | (0) | (0) | (+) | (0) |
| **Employment** | (+) | | Slight (+) | |
| **Skills** | (0) | (0) | (0) | (0) |
| **Overall ranking** | **Very positive** | **Fair** | **Positive** | **Fair** |

*Figure 2-9: Olympic Games Legacy performance scorecard*

## London 2012 Olympics Legacy

The lifespan of regeneration projects is demonstrated in the master plan provided by LLDC (2012) in figure below:

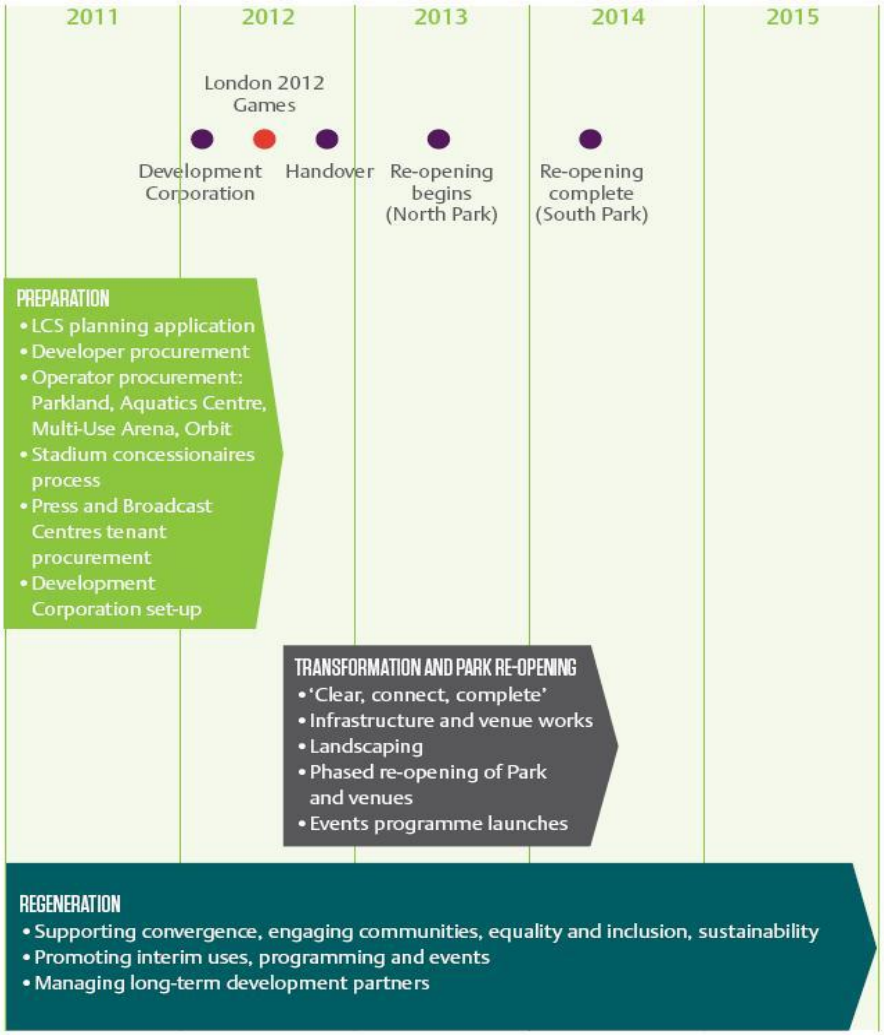



*Figure 2-10: Lifecycle of Legacy (adopted from LLDC, 2012)*

MacRury (2009) demonstrated London Olympics Legacy promises, programme objectives and lead stakeholder presented in the Legacy Masterplan as shown in following figure. The five promises went through an evolutionary process.

| Promises/ Strategic Objectives National Government (DCMS) | Key Programmes | Lead Stakeholder(s) | Sub-Strategies |
|---|---|---|---|
| **Promise 1: Making the UK a world-leading sporting nation** | UK world class performance programme PE & sport strategy Healthy living campaign | HMG Sport England BOA HMG Mayor 5 Boroughs | Investment in most talented athletes Quality community sport programme Promote Olympic ideals Secure athletes success at London 2012 Maximize sport participation across UK Maximize participation at community level across London Promote activity as component of Strategic Regeneration Framework |
| **Promise 2: Transform the heart of East London** | Legacy Masterplan Framework ODA Delivery Plan LEST Action Plan Regeneration Framework 'Why Place Matters' Olympics Legacy Multi-Area Agreement London Plan | HMG ODA Mayor 5 Boroughs HMG 5 Boroughs Mayor (GLA) | Maximize economic, health, environment benefits the games brings to UK/East London Maximize cultural benefits of Games to UK/East London Sustainable legacy plan for Olympic park Create 12,000 job opportunities, help 20,000 jobless Londoners; create 2,500 apprenticeships/placements Transport infrastructure development, housing, employment opportunities Priorities -Housing, skills/worklessness, public realm Infrastructure/connectedness; employment, skills, housing thro' investment and agreements with LAs |
| **Promise 3: Inspire a generation of young people** | Cultural Olympiad Personal Best Programme London 2012 Education Programme | LOCOG Mayor/GLA, Job Centre Plus/LOCOG LOCOG | Secure support/engagement across UK Stage inspiring opening/closing ceremonies and cultural events 70,000 trained volunteers (10% graduates of PB Programme) Engagement with schools, colleges, universities across UK |
| **Promise 4: Make the Olympic Park a blueprint for sustainable living** | ODA Sustainability Strategy London 2012 Sustainability Plan Olympic Park Legacy (OPLC) | LDA ODA OPLC Mayor/ 5 Boroughs | Remediate land Deliver venues on-time, to budget Deliver venues for agreed legacy use Develop plan for effective legacy use post-2012 Effective legacy use of sports facilities across London |
| **Promise 5: Demonstrate the UK is a creative, inclusive place to live, visit and do business** | Business Network Train to Gain HMG Tourism Strategy Cultural Olympiad | LOCOG/ODA LDA HMG LOCOG/5 Boroughs LOCOG | Contracts Supply chain (50,000 contracts) Skills, apprenticeships, work placements (2,500 places) East London – a place to visit |

*Figure 2-11: Legacy promises and objective sub-categories (MacRury, 2009)*

Legacy impact of the London 2012 Olympic Games was studied by University of East London and the Thames Gateway Institute for Sustainability on behalf of the IOC and issued a Pre-Games Report in 2010 summarized results for environmental, socio-cultural, economic impacts in the figure below:

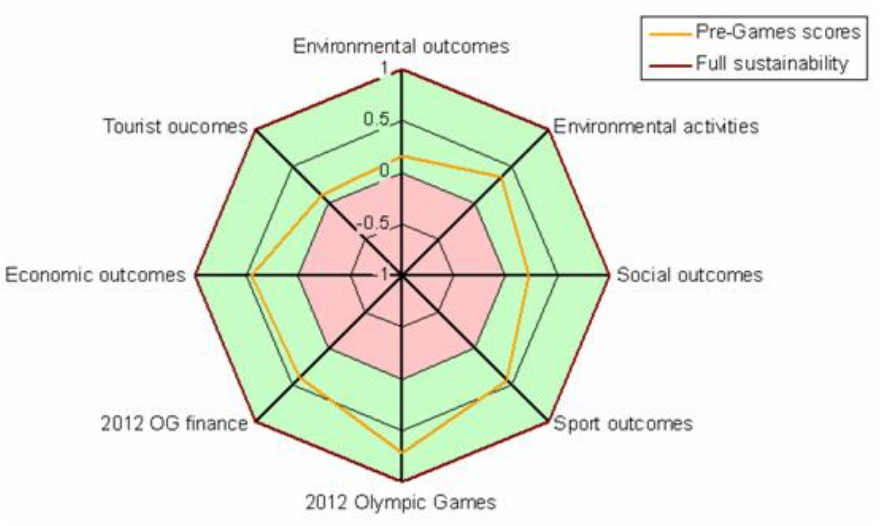



Figure 2-12: OGI Pre-Games Legacy impact report summary (UEL, GLA, TGIFS & OGI, 2010)

A total of 56 indicators including 11 environmental indicators, 23 socio-cultural indicators and 22 economic indicators were studied. There were some limitations of the study as it relied on secondary data (not directly surveyed), annual availability constraints, limiting to quantitative data and analysis within the framework of indicators which did not reflect the impacts comprehensively. However the study enjoyed objectivity and comparability as data sources and descriptions were assured (UEL, GLA, TGIFS & OGI 2010). The final OGI report will be issued in 2015.

The New promises (Government Olympic Executive, 2012) emphasized:

- Regeneration of the region through housing and infrastructure and green landscape in the regions around boroughs mainly the Olympic Park emphasizing district and city-scale convergence.
- Developing public transport based on sustainable development premise.
- Create valued changes in health habits, and sport participation of the Britons by developing public sport facilities and utilizing the facilities created in boroughs for other feasible purposes after the Games.

The legacy outcomes take years to reveal, However, there are concerns as the hosting expenses were high in the recession times (Kingman, 2012) although

the initial budgets were reduced (OGI, 2010). Transport infrastructure legacy is more perceivable since many of the related plans have already been implemented. Intangible outcomes are obscure. Successful management of Olympic Games event and British athletes brilliant results and satisfactory progress reports of the Legacy plans (Conn, 2012) promises an unprecedented Olympic project lifecycle management, however uncertainties and ambiguities in some respects have brought concerns about the Legacy project outcomes such as public sport investments, food and life habits (Kingman, 2012). The most important danger seems to be the quality of implementation, Inequality, segregation, lack of spirit and participation will be the pessimistic outcome of poor and implementation. With full awareness of such risks timely measures and amendments can be adopted. Comprehensive goal-oriented risk management of the project should be rigorously and periodically exercised to ensure fulfillment of the valuable promises with regard to the prolonged recession, future pressure from the impact communities, and national and international regulatory authorities for accountability (O'Connor, 2012).

## Scope risk in the Olympics Legacy project:

There have already been instances of scope creep in the Legacy projects e.g. main Athens stadium roof and Montreal velodrome design changes, and recurrent rise in steel prices in Olympic construction projects, and changes in Legacy promises and the budget revisions the London 2012 Olympic Games.

Any creep or change will have wide critic and impacts and should be managed.

## Overview:

Selective search in the literature for risk models and scope risk factors dominated the literature review of this dissertation. The researcher found it necessary for mastering the concepts required for the framework development. As a result a sound database of risk approaches,

categorizations, and evaluations was formed. The next chapter explains the roadmap for to the logical model formation and thereby to the framework and the relevant questionnaire development, and thereby to the practical application case.

# Chapter 3: Research methodology

## Introduction:

As stated in the previous chapters this research primarily aimed at identifying obstacles and threats for the Legacy project. But lack of a specific criteria for the risk evaluation beyond common practice of project time and cost and quality and created a turning point in research aim.

Further evidence for the necessity of a specialized scope evaluation framework suitable for Olympic Legacy projects lead the researcher to do a comprehensive review of the existing risk management models. Some of the gaps identified in the study were:

- There is no specific framework that can directly address the risks associated with the aims and purposes of the Legacy projects and current endeavors are often experience-centered and issue-based (LLDC, 2012)
- The lack of a framework for risk analysis has been stated in the Legacy Masterplan (LLDC, 2012).
- There is no indication that the enterprise risk management model which was reported to be adopted for the Legacy will go any future in analyzing the risks than indirect assessment of cost and time of the projects associated with the Legacy projects employing common risk categories and risk factors.
- Scope of Legacy themes has not been the focus of attention and was overshadowed by the Games event which enjoyed a risk management focused on Game-time security issues.

Such drivers made this research a passion for developing a framework for Legacy functions scope risk identification and risk impact analysis.

For this purpose a primary library and online review was performed to consider 1- various factors and criteria employed in different risk management models to identify and rate the risks associated with scope of

the project, and 2- various Olympic Legacy projects and their purpose areas with regard to the promises that were made or the projects which were accomplished.

The second step was to ponder upon shortcomings, issues and needs stated in various essays, reports, critics, and official plans and documents published with regard to the current London 2012 Olympic Legacy risk management projects (Jennings, 2012; Flyvbjerg, 2012, Hardy, 2012).

Therefore the required framework should address these gaps and should be based on lessons learned both in Olympic management and in project management.

The next step was to test drive the framework as the concurrent event i.e. the London Legacy projects were in the implementation phase and it provided a unique opportunity to get feedback about the logic and the assessment model. For this purpose a questionnaire was developed to elicit data on probability occurrence and impact level of scope risks for convergence theme of the legacy from project teams, project managers, and stakeholders in the relevant projects especially regeneration endeavors.

The hierarchy of aims for the convergence is shown in figure 3-1 between boroughs and the rest of the city of London encompasses such aims as: creating Wealth and reducing poverty, supporting healthier lifestyle, and developing successful neighborhood (LLDC, 2012).

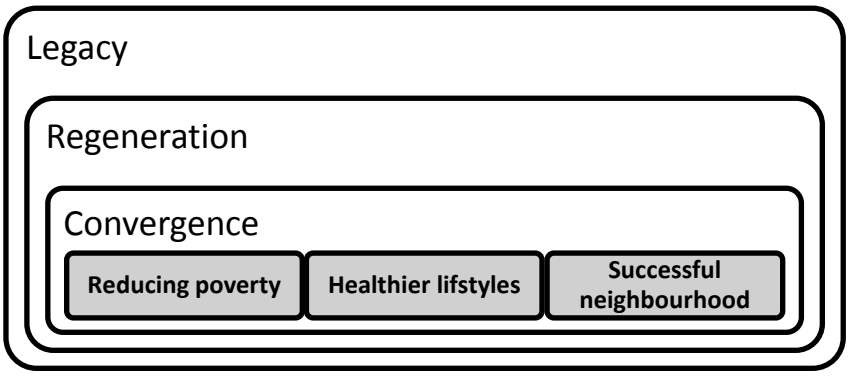



*Figure 3-1: Convergence aims in hierarchical view (adopted from LLDC business plan, 2012)*

So the case study would find out answers to these questions:

1. What is the probability of occurrence of scope risks for the convergence purpose in the legacy regeneration projects?
2. What is the impact level of these scope risks on achievement of convergence outcomes?
3. What are the high priority scope risks for the convergence outcomes?

A number of hypotheses will be stated and tested based on the researcher's knowledge acquired from literature review and feedback from the initial questionnaire administration.

## Research approach:

The study has been an applied research since is practical in real situation for a concurrent case entity. The framework developed during this research aimed to address a real-world need as the Olympic organizers and the host countries need a basis to define their scope of work when deciding the Legacy goal setting as well as trace any conceptual, operational, intentional, structural, functional, and behavioral, risk factors that can endanger the high level aims, and often complicated multi dimensional purpose themes considered for the Legacy projects. Therefore the result of this study can be used in current and future Olympic Legacy projects' risk management practices by the main stakeholders both in the ignition phase for initial

requirement prioritization and in the implementation and delivery phases as a supervision tool.

## Research method:

The research method in this study was both exploratory and descriptive. The framework design was a qualitative exploratory and historical data mining effort in which behavioral data sources like PERIL database and past legacy performance were considered. The case study survey by the questionnaire tried to describe an existing situation i.e. the risk probability and impact level for the convergence theme and therefore it was a descriptive study.

## Framework development:

To develop the intended framework for legacy purpose theme risk analysis the following steps were taken:

### Determining Factors in Risk Approach Decisions:

Risk management approach is determined by many factors. Project related factors, field related factors, and personality related factors are among the most discussed factors determining the depth, focus, and method of risk identification, analysis and response (The institute of risk management, 2012).

The size of the project can force a detailed and comprehensive heterogeneous risk analysis. Mega projects always cause internal and external pressures for cautions, and formal risk handling mechanisms (Manolov, et al, 2011).

The field of construction projects has a long history in risk analysis as reviewed in the previous chapter. Mega-events entail lots of security management endeavors and established standard and institutionalized network of mechanisms for ensuring security (Jennings, 2012)

Risk appetite in terms of the level at which the organization can handle and accept risk is an important element in determining risk approach in a project.

## The proposed framework for Olympic Legacy projects risk analysis:

Risk is usually assessed based on its impact on time, coast and quality. In this research effort has been made to develop a model of risks in which risk is assessed based on its impact on legacy objectives and legacy themes' success criteria.

## *The proposed model for legacy requirements identification:*

In fact this is a higher level business outcome assessment. The main logic came from integrating the general outcome success factors with specific Legacy goal achievement as shown in the following table.

*Table 3-1: Fundamental logic of the proposed framework*

| | | | Risk factor flavor (Themes) (impact areas) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Overreaching Goal Categories within the Scope Of Olympic Legacy | | | | | |
| | | | Sustainability themes | | | Sport themes | No white elephant | Convergence |
| | | | Climate change, Material, waste, | biodiversity, inclusion | healthy living | Participation, Spirit, | Future costs, Future use, future Revenue, | Convergence with the neighborhood and the city, poverty |
| Risk Impact Level | General project success criteria | Time, Cost, Quality | | | | | | |
| | Business outcome categories | Revenue, Effectiveness, Stakeholder Value, Governance | | | | | | |
| | City & Country & International level Outcomes | Tourism, Business attraction, Hospitality image, Credibility, Benchmark | | | | | | |


## *The proposed framework for Legacy risk analysis:*

However the challenge was correlating these two concepts so as to come up with tangible risk factors can practically be used in qualitative rating and quantitative assessment. For this purpose the following steps were taken:

1- The scope risks were chosen for the focus
2- The risk categories The three-level
3- Hybrid risk factors were formed by mixing conventional risk factors with elements of outcomes (project, business, macro) and elements of legacy purpose themes
4- The legacy purpose areas were categorized under 4 main general areas

The resulting framework is shown in the following matrix:

*Table 3-2: the proposed framework for legacy themes risk analysis*

| | | Legacy purposes (Functional Themes) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Economic themes | | | | | Community themes | | | Social themes | | | | Environmental themes |
| | | Infrastructure development | Venues Translocation | Job opportunities | Business & Tourism | Regeneration | Convergence | Inclusion | Poverty reduction | Participation | Lifestyle | Education | Spirit | Sustainability |
| *Country& intl. level risks* | | | | | | | | | | | | | | |
| | Operational risk | | | | | | | | | | | | | |
| | Scope Risks | | | | | | | | | | | | | |
| | Political risk | | | | | | | | | | | | | |
| | Financial risk | | | | | | | | | | | | | |
| | Cultural indicators | | | | | | | | | | | | | |
| *City and business level risks* | | | | | | | | | | | | | | |
| | Technology | | | | | | | | | | | | | |
| | Scope Risks | | | | | | | | | | | | | |
| | Contracts and legal requirements | | | | | | | | | | | | | |
| | Resources | | | | | | | | | | | | | |
| | Financing | | | | | | | | | | | | | |
| | Market political | | | | | | | | | | | | | |
| | Boroughs & city | | | | | | | | | | | | | |
| *Project level risks* | | | | | | | | | | | | | | |
| | Stakeholder | | | | | | | | | | | | | |
| | Technology | | | | | | | | | | | | | |
| | Scope Risks | | | | | | | | | | | | | |
| | Environmental | | | | | | | | | | | | | |
| | Real estate | | | | | | | | | | | | | |
| | Economic | | | | | | | | | | | | | |
| | Schedule | | | | | | | | | | | | | |
| | Contracting and legal | | | | | | | | | | | | | |
| | Construction | | | | | | | | | | | | | |
| | Resources | | | | | | | | | | | | | |
| | Project management | | | | | | | | | | | | | |
| | Financial | | | | | | | | | | | | | |

### *Forming Scope Risk Sources and Risk Factors database:*

Scope of the project determines the real span and depth of the work to be done, the real outputs in terms of quality and quantity of deliverables and the real outcome in terms of functionality, operability, benefits and economics of the results. The project management terms directly affecting scope according to PMBOK guidelines are deduced as depicted in the figure 3-2:

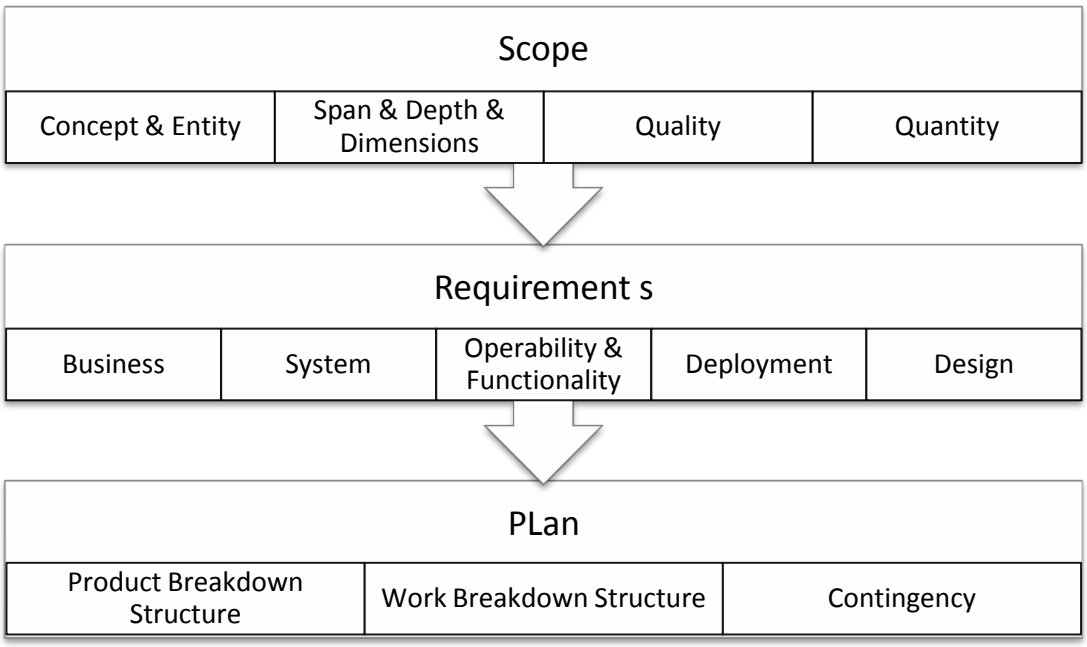



*Figure 3-2: Project management entities with directly affecting the scope (deduced from PMBOK guidelines)*

Summary of the Relevant Scope risk Factors gathered with the above mentioned mindset through review of the related literature is presented in annex 1.

## Risk analysis method:

After preparing the comprehensive list of project scope risk factors the risk analysis was performed in two stages:

## Qualitative risk analysis:

Qualitative analysis of risk is a process in which assessing the probability of occurrence and level of impact of the risks were accomplished. In this research a questionnaire was employed for the assessment and then the following measures were taken:

1- Calculating frequency of the choices made for each questions for probability and impact level
2- Calculating percentage of each choice selection by dividing frequency of the choice by total number of responses for that question.
3- Determining each risk factor mean by multiplying frequency percentage of each choice by the points gained for that choice.

## Quantitative risk analysis:

Quantitative analysis is the process of numerical analysis on identified risks for the high-end aims of convergence. Regarding the matrix method employed in this study the following steps were taken:

1- Calculating impact severity level by calculating the sum of multiplication mean calculated in the previous stage by the following formula:

$$Si = \Sigma^{3}_{j=1} w_{j*} \mu ij$$

2- Calculating risk rate with the following formula:

$$R_i = P_i * S_i$$

3- Normalizing the risk rate calculated in the previous stage to answer the hypotheses
4- Determining the priority levels with the help of probability-impact matrix with modified rating ranges and weighting of Likert-type scale choices.

## Prioritizing the risks:

In this stage the results of the analysis performed in the previous stages were used to form the probability-impact 5*5 cell matrix by which the risks are prioritized as being extreme, high, moderate, and low risks based on their probability and impact level scores.

The relevant hypotheses will be tested using SPSS software with indicators like variance, standard deviation, T-test, mean and median.

## Survey method:

### *Target community and sampling:*

The stakeholders of the convergence theme who had already been involved with the concept and knew what was meant by convergence in regeneration projects, including authorizing stakeholders, project managers, and main stakeholders and end user borough officials were selected for the survey section of the research. The stake holders not mentioning the number of communities of people future residents were Host boroughs' officials, Host Boroughs Unit (HBU), Greater London Authority (GLA), London Dockland Development Corporation (LDDC), LOCOG, Urban Development Corporations (UDC), Local east London mayoral officials, some knowledgeable researchers who have published papers about regeneration.

### *Developing the questionnaire:*

#### Structure of questionnaire:

The questionnaire was a two column grid matrix rating using Likert-type scale and comprised of two main components:

**The First component:** The survey started with a brief explanation about the aim of survey and the selected respondents. The second page required personal page demographic information from the respondents including their: Education level, Field of study, Field of activity, Years of experience, Age (years), e-mail to get feedback (Optional). The information was used to interpret any statistically significant correlations.

**The second component:** formed the body and contained the matrix. The row of the matrix were scope risk factors stated in a pre-mortem, worse case happened description of risk occurrence. The columns of the matrix were scales for probability and impact level. Convergence theme explanatory phrase appeared at the top-right corner over the column headers accompanied with three subcategories of convergence goals to help respondents stay focused on the concept throughout completion time which was estimated to be 5 minutes.

The probability was defined as the likelihood of the risk occurrence and had such levels as: Very likely (Certain), Likely, Neutral, Likely, Very Unlikely.

Impact level was defined as any deviations (of quality, quantity, functionality, span, depth) from the scope promised for the theme, in case that the occurred and had levels of Very High, High, Medium, Low, and Very Low.

## Contents of the questionnaire:

The following scope risk categories were studied as for their likelihood and the impact on convergence theme from the literature review specially PMBOK 4th edition, PERILL database black swan scope risks as cited in Kendrick (2008), Millennium Dome reviews (Millennium experience, 2007) Chaos report (Standish Group, 1995) for software projects, construction projects risk analysis frameworks, and risk management approaches of the past and present legacy and many issue-based discussions and reviews published about London 2012 legacy projects (Jennings, 2012; Flyvbjerg, 2012; Kingman, 2012; Leromonachou et al., 2010):

- Immature concept
- Vague delimitations
- Documentation
- White elephant
- Requirements engineering
- Stakeholder pressure
- Rare events
- Optimism bias
- Planning & design
- Change management
- Delivery management

About 100 scope risk factors were collected by literature review, and 70 were used in a preliminary version of the questionnaire. The wording has been modified to adapt to legacy mind-frame for ease of response. After administering the questionnaire to a group of 4 project managers and advisors, some risk factors were merged together and 20 factors with least relevance and impact based on the knowledge gained through Olympics literature review were deleted and some modified. The final questionnaire (annex 1) contained 30 risk factors under 11 categories. The questionnaire was administered online on fluidsurveys.com.

## Reliability of the questionnaire:

The questionnaire employed Likert-type scale double column grid matrix for quantitative elicitation of qualitative, attitudinal data. Reliability of the questionnaire in qualitative risk analysis stage Cronbach's Alpha was used with a threshold greater than or equal to 70% and all the data gathered were analyzed by SPSS software. The reliability of the questionnaire was calculated to be 89% which is quite acceptable rate and the questionnaire can be judged as reliable. The summary of the results is displayed in table 3-4.

*Table 3-3: Reliability results for the questionnaire*

| Cronbach's Alpha for probability | Cronbach's Alpha for impact level | Number of items |
|---|---|---|
| 0.867 | 0.897 | 30 |

The results of reliability analysis of the questionnaire are shown in annex 2.

### Validity of the questionnaire:

For validating the framework developed in this research and the questionnaire , expert judgments from project risk management and civil engineering construction fields of expertise were used and the framework and the questionnaire were judged as enjoying face validity and experimental validity based on adoption and references made to validated sources in identification of risk factors and the validated construct employed in presenting the concept for data analysis and guided risk identification and analysis.

## Limitations of the study:

The developed framework provides grounds for comprehensive Legacy specific risk management however as far as the limitations of the study were concerned effective depth of applicability is restricted to scope of the legacy themes sine risk factors were only customized for the scope risk category and not for the other risk categories. Other categories are handpicked from a vast literature review of huge construction projects' risk management models because bulks of the legacy projects are of construction nature.

Further limitation is that only two processes of project risk management i.e. risk identification and risk analysis, have been dealt with in this study and no

effort was made to enter into risk response planning, risk monitoring and control processes, however suggestions were made wherever the results of the study could help.

# Chapter 4: Data analysis

## Introduction

As mentioned in previous chapters this dissertation aimed to present a framework for the Olympics Legacy projects risk analysis with which analysis is for the impact of probable customized risk factors directly on the promised outcomes. For this purpose a focus risk category i.e. scope risks and a focus purpose area i.e. convergence was selected as case study and a detailed scope risk factor analysis questionnaire was devised and administered.

## The developed framework:

As discussed in chapter three the developed framework was major result of the study both as a helper if design phase and as a tool for risk identification and evaluation with direct focus on aims promised for the legacy. The 73 scope risks identified (especially the 30 selected for the survey questionnaire) were hybrid product of the most important scope risk factors appeared in the literature and the multilayer concerns of mega projects.

## The developed questionnaire for Legacy scope risk analysis:

The final questionnaire contained 30 scope risk factors categorized under 11 risk source subjects (see annex 2) including: immature concept, vague delimitations, documentation, white elephant, requirements engineering, stakeholder pressure, rare events (black swans), optimism bias, planning & design, change management, and delivery management.

## The case study survey for convergence theme:

As discussed earlier one of the aspirations in the London 2012 legacy project was the convergence between boroughs and the rest of the city of London. As a major Legacy theme convergence comprised three subcategories and aimed to set the grounds for the boroughs to be in a state of minimum distance from the surrounding city districts by:

- Creating Wealth and reducing poverty
- Supporting healthier lifestyle,
- Developing successful neighborhood

## The research questions:

The research's case study questions were:

4. What is the probability of occurrence of scope risks for the convergence purpose in the legacy regeneration projects?
5. What is the impact level of these scope risks on achievement of convergence outcomes?
6. What are the high priority scope risks for the convergence outcomes?

## The research hypotheses:

To formulate case study research hypotheses the most probable answers to the research questions based on the literature review were stated as follows:

**Major hypothesis 1:** All scope risk categories and factors are probable to happen for convergence outcomes.

**Major hypothesis 2:** All scope risk categories and factors have significant impact on convergence outcomes if they occur.

**Major hypothesis 3:** All scope risk categories are of equal importance (priority) for convergence outcomes.

**Hypothesis 3-1:** in white elephant category Future functionality and operability is the most important risk factor.

**Hypothesis 3-2:** In Immature concept category, low common understanding is the most important risk factor.

**Hypothesis 3-3:** In black swans category, Scope changes resulting from external dependencies is the most important risk factor.

**Hypothesis 3-4:** In Optimism bias category, overestimated funding is the most important risk factor.

**Hypothesis 3-5:** In change management category, no change management procedure is the most important risk factor.

**Hypothesis 3-6:** In stakeholder pressure category, gold plating is the most important risk factor.

**Hypothesis 3-7:** In Requirements engineering category, incomprehensive requirements is the most important risk factor.

## Descriptive and demographic data:

This section describes the status quo in survey sample. The demographic data of the respondents is presented in table 4-1 to 4-3 below:

*Table 4-1: Statistics percentage on age-ranges of respondents*

| Age-range (Years) | number of persons | Percentage |
|---|---|---|
| **20-30** | 5 | 14.7 |
| **30-40** | 9 | 26.5 |
| **40-50** | 15 | 44.1 |
| **50-60** | 4 | 11.8 |
| **60-70** | 1 | 2.9 |
| **Total Responses** | 34 | 100 |

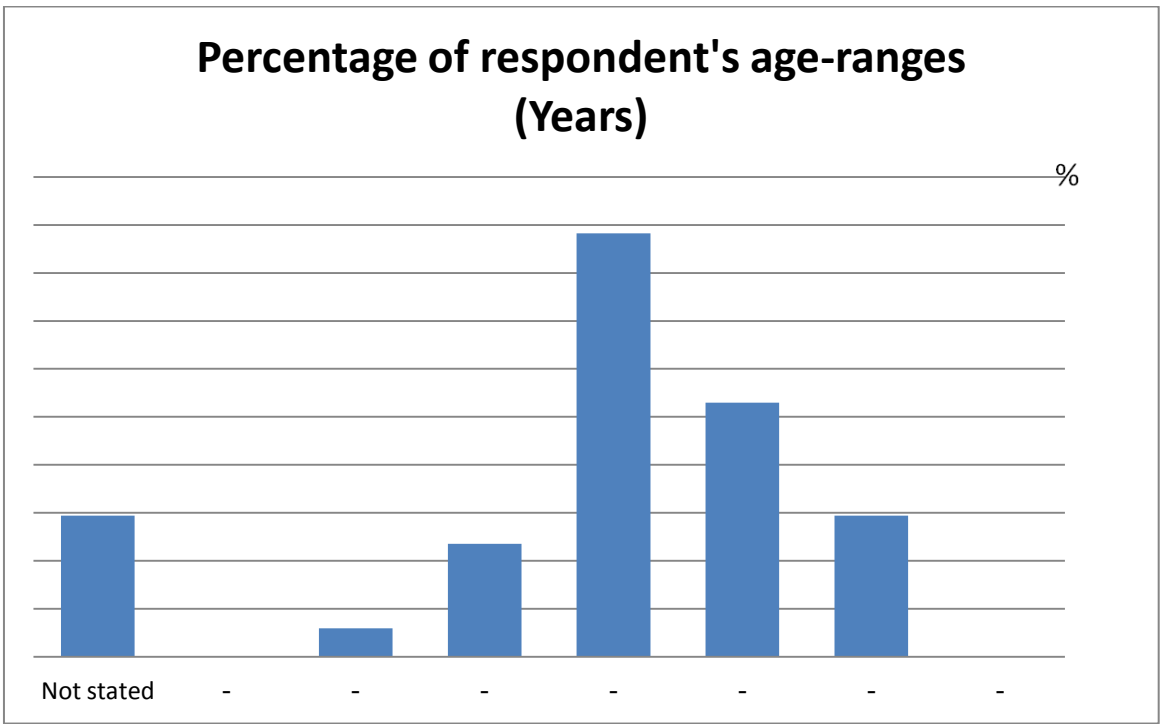



*Figure 4-1: Comparison of age-ranges of respondents*

As shown in the graph most of the respondents were in the 40-50 age range (%44.1). The next frequent age range was 30-40 (%26.5).

*Table 4-2: Statistics on experience of respondents*

| Experience range (years) | number of persons | Percentage |
|---|---|---|
| **1-5** | 1 | 2.9 |
| **5-10** | 9 | 26.5 |
| **15-20** | 6 | 17.6 |
| **20-25** | 8 | 23.5 |
| **25-30** | 3 | 8.8 |
| **30-35** | 4 | 11.8 |
| **Not stated** | 3 | 8.8 |
| **Total Responses** | 34 | 100 |

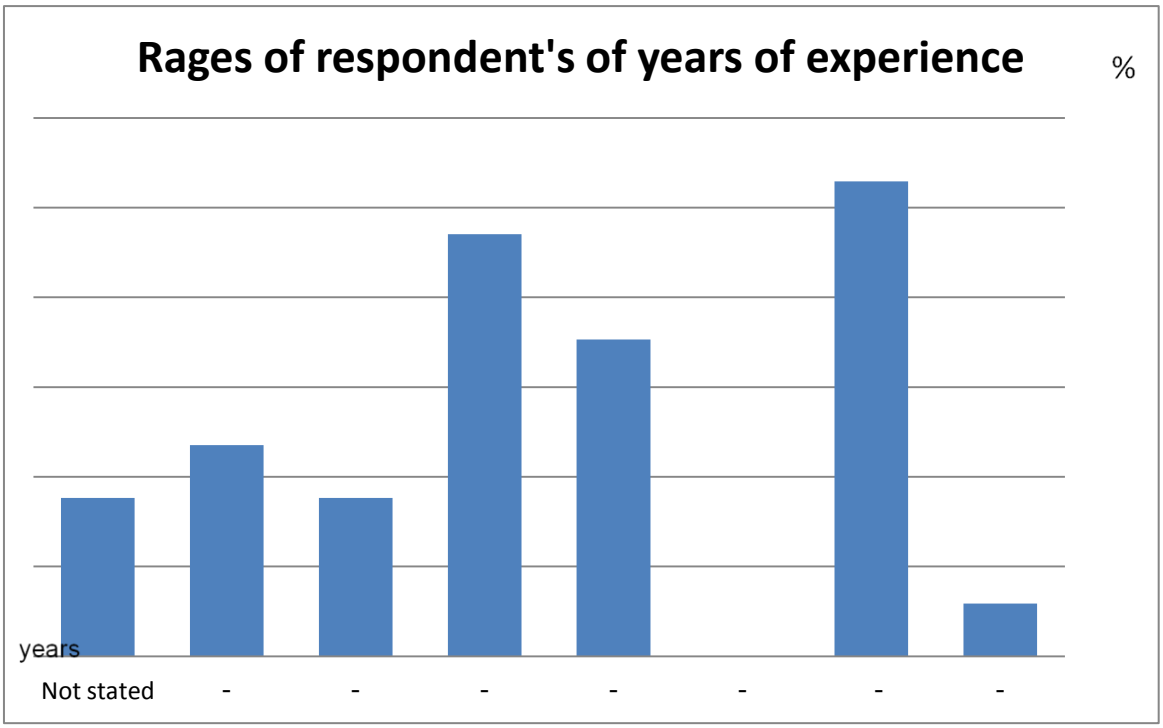



*Figure 4-2: Comparison of the respondents' years of experience*

The respondent group was quite experienced as %88 had more than 5 years of experience among which 5-10 years was the most frequent range (%26.5)

Table 4-3: statistics on education level

| education level | number of persons | Percentage |
|---|---|---|
| Doctoral Degrees | 10 | 29.4 |
| Masters Degrees | 16 | 47.1 |
| Bachelor's Degrees | 7 | 20.6 |
| Postgraduate Degrees | 1 | 2.9 |
| Total Responses | 34 | |

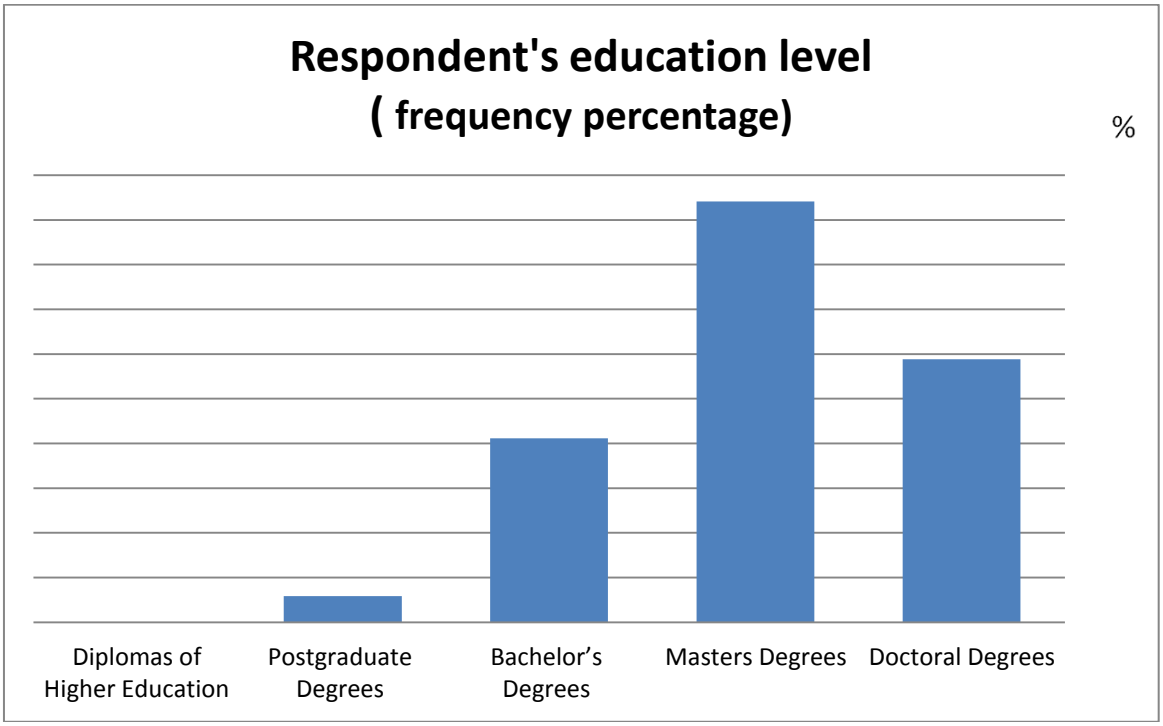



*Figure 4-3: Comparison of the respondents' education level*

The respondents were highly educated as %76.5 of them had either masters or doctoral degrees with masters being the most frequent.

*Table 4-4: Statistics on field of study of respondents*

| field of study | number of persons | Percentage |
|---|---|---|
| Project management | **6** | 17.6 |
| Business management | **5** | 14.7 |
| Civil engineering | **6** | 17.6 |
| Financial & accounting | **2** | 5.9 |
| Computer sciences | **4** | 11.8 |
| Architecture and Design | **2** | 5.9 |
| Environmental studies | **2** | 5.9 |
| Public administration | **6** | 17.6 |
| Transportation | **1** | 2.9 |
| Total Responses | **34** | |

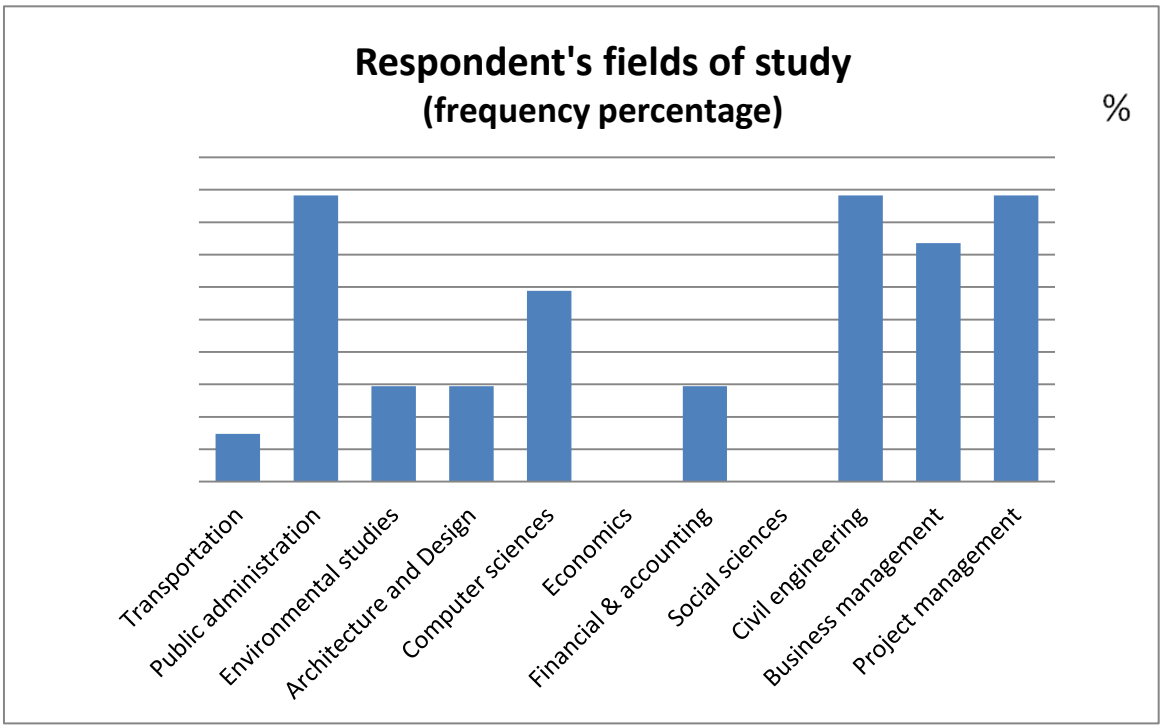



*Figure 4-4: Comparison of the respondents' fields of study*

Project management, civil engineering, public administration formed the predominant fields of study with equal 17.6 percentages each.

*Table 4-5: statistics on field of activity of respondents*

| field of activity | number of persons | Percentage |
|---|---|---|
| Project management | **5** | 14.7 |
| Business management | **5** | 14.7 |
| Civil engineering | **5** | 14.7 |
| Financial & accounting | **3** | 8.8 |
| Computer sciences | **3** | 8.8 |
| Architecture and Design | **3** | 8.8 |
| Public administration | **8** | 23.6 |
| Transportation | **2** | 5.9 |
| Total Responses | **34** | |

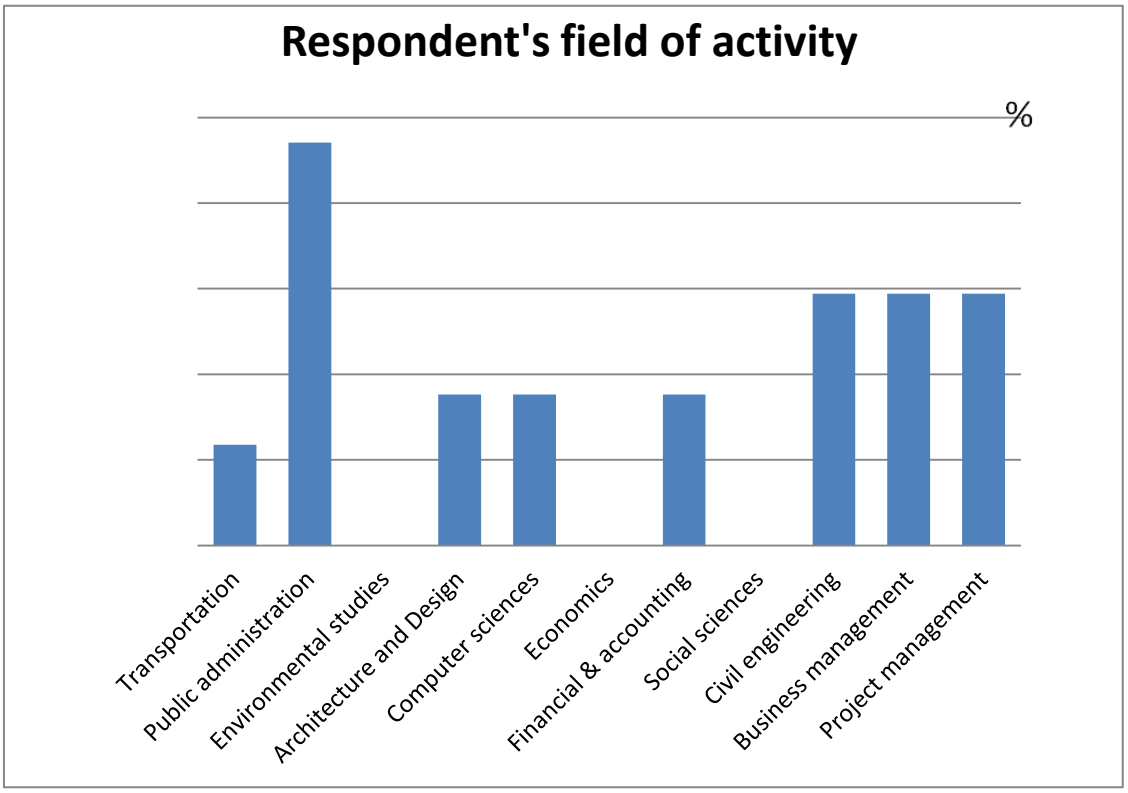



*Figure 4-5: Comparison of field of activity of respondents*

The most frequent field of activity was public administration (%23.6) and good majority of the respondents were in technical fields of activity project and business management and civil engineering.

## Results for qualitative risk analysis:

The survey questionnaire tool provided the opportunity to qualitatively assess the probability of occurrence of risks and the impact they had on the convergence theme in case of occurrence. The results of the rankings judged by the respondents based on their knowledge and experience are presented in this section.

## *The questionnaire statistical results:*

*Table 4-6: Frequency and percentage of each risk factor for probability*

| Risk factors | Very likely | | Likely | | Neutral | | Unlikely | | Very Unlikely | | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Frequency | percentage | Frequency | percentage | Frequency | percentage | Frequency | percentage | Frequency | percentage | |
| **RF1** | 6 | 17.6 | 13 | 38.2 | 9 | 26.5 | 3 | 8.8 | 3 | 8.8 | 34 |
| **RF2** | 6 | 17.6 | 16 | 47.1 | 3 | 8.8 | 3 | 8.8 | 6 | 17.6 | 34 |
| **RF3** | 6 | 17.6 | 6 | 17.6 | 6 | 17.6 | 13 | 38.2 | 3 | 8.8 | 34 |
| **RF4** | 6 | 17.6 | 21 | 61.8 | 6 | 17.6 | 1 | 2.9 | 0 | 0.0 | 34 |
| **RF5** | 0 | 0.0 | 9 | 26.5 | 22 | 64.7 | 0 | 0.0 | 3 | 8.8 | 34 |
| **RF6** | 0 | 0.0 | 9 | 26.5 | 16 | 47.1 | 6 | 17.6 | 3 | 8.8 | 34 |
| **RF7** | 9 | 26.5 | 19 | 55.9 | 3 | 8.8 | 3 | 8.8 | 0 | 0.0 | 34 |
| **RF8** | 22 | 64.7 | 8 | 23.5 | 1 | 2.9 | 3 | 8.8 | 0 | 0.0 | 34 |
| **RF9** | 9 | 26.5 | 16 | 47.1 | 3 | 8.8 | 6 | 17.6 | 0 | 0.0 | 34 |
| **RF10** | 3 | 8.8 | 6 | 17.6 | 13 | 38.2 | 9 | 26.5 | 3 | 8.8 | 34 |
| **RF11** | 3 | 8.8 | 16 | 47.1 | 9 | 26.5 | 3 | 8.8 | 3 | 8.8 | 34 |
| **RF12** | 6 | 17.6 | 13 | 38.2 | 9 | 26.5 | 6 | 17.6 | 0 | 0.0 | 34 |
| **RF13** | 3 | 8.8 | 16 | 47.1 | 9 | 26.5 | 6 | 17.6 | 0 | 0.0 | 34 |
| **RF14** | 0 | 0.0 | 3 | 8.8 | 6 | 17.6 | 16 | 47.1 | 9 | 26.5 | 34 |
| **RF15** | 6 | 17.6 | 13 | 38.2 | 3 | 8.8 | 6 | 17.6 | 6 | 17.6 | 34 |
| **RF16** | 6 | 17.6 | 6 | 17.6 | 13 | 38.2 | 3 | 8.8 | 6 | 17.6 | 34 |
| **RF17** | 9 | 26.5 | 16 | 47.1 | 3 | 8.8 | 6 | 17.6 | 0 | 0.0 | 34 |
| **RF18** | 6 | 17.6 | 9 | 26.5 | 3 | 8.8 | 3 | 8.8 | 13 | 38.2 | 34 |
| **RF19** | 0 | 0.0 | 3 | 8.8 | 9 | 26.5 | 16 | 47.1 | 6 | 17.6 | 34 |
| **RF20** | 19 | 55.9 | 6 | 17.6 | 6 | 17.6 | 3 | 8.8 | 0 | 0.0 | 34 |
| **RF21** | 0 | 0.0 | 6 | 17.6 | 16 | 47.1 | 9 | 26.5 | 3 | 8.8 | 34 |
| **RF22** | 1 | 2.9 | 2 | 5.9 | 16 | 47.1 | 12 | 35.3 | 3 | 8.8 | 34 |
| **RF23** | 3 | 8.8 | 6 | 17.6 | 9 | 26.5 | 13 | 38.2 | 3 | 8.8 | 34 |
| **RF24** | 16 | 47.1 | 13 | 38.2 | 3 | 8.8 | 0 | 0.0 | 2 | 5.9 | 34 |
| **RF25** | 9 | 26.5 | 16 | 47.1 | 6 | 17.6 | 3 | 8.8 | 0 | 0.0 | 34 |
| **RF26** | 9 | 26.5 | 9 | 26.5 | 13 | 38.2 | 3 | 8.8 | 0 | 0.0 | 34 |
| **RF27** | 25 | 73.5 | 6 | 17.6 | 0 | 0.0 | 3 | 8.8 | 0 | 0.0 | 34 |
| **RF28** | 0 | 0.0 | 2 | 5.9 | 13 | 38.2 | 16 | 47.1 | 3 | 8.8 | 34 |
| **RF29** | 16 | 47.1 | 6 | 17.6 | 6 | 17.6 | 3 | 8.8 | 3 | 8.8 | 34 |
| **RF30** | 6 | 17.6 | 9 | 26.5 | 16 | 47.1 | 3 | 8.8 | 0 | 0.0 | 34 |

*Table 4-7: Frequency and percentage of each risk factor for Impact level*

| Risk factors | Very High | | High | | Medium | | Low | | Very Low | | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Frequency | percentage | Frequency | percentage | Frequency | percentage | Frequency | percentage | Frequency | percentage | |
| **RF1** | 19 | 55.9 | 9 | 26.5 | 0 | 0.0 | 6 | 17.6 | 0 | 0.0 | 34 |
| **RF2** | 13 | 38.2 | 9 | 26.5 | 3 | 8.8 | 9 | 26.5 | 0 | 0.0 | 34 |
| **RF3** | 3 | 8.8 | 9 | 26.5 | 3 | 8.8 | 13 | 38.2 | 6 | 17.6 | 34 |
| **RF4** | 19 | 55.9 | 9 | 26.5 | 0 | 0.0 | 6 | 17.6 | 0 | 0.0 | 34 |
| **RF5** | 3 | 8.8 | 6 | 17.6 | 19 | 55.9 | 3 | 8.8 | 3 | 8.8 | 34 |
| **RF6** | 3 | 8.8 | 9 | 26.5 | 3 | 8.8 | 6 | 17.6 | 13 | 38.2 | 34 |
| **RF7** | 6 | 17.6 | 25 | 73.5 | 3 | 8.8 | 0 | 0.0 | 0 | 0.0 | 34 |
| **RF8** | 19 | 55.9 | 12 | 35.3 | 0 | 0.0 | 3 | 8.8 | 0 | 0.0 | 34 |
| **RF9** | 12 | 35.3 | 19 | 55.9 | 0 | 0.0 | 0 | 0.0 | 3 | 8.8 | 34 |
| **RF10** | 6 | 17.6 | 6 | 17.6 | 3 | 8.8 | 16 | 47.1 | 3 | 8.8 | 34 |
| **RF11** | 6 | 17.6 | 13 | 38.2 | 9 | 26.5 | 6 | 17.6 | 0 | 0.0 | 34 |
| **RF12** | 3 | 8.8 | 9 | 26.5 | 0 | 0.0 | 13 | 38.2 | 9 | 26.5 | 34 |
| **RF13** | 13 | 38.2 | 6 | 17.6 | 9 | 26.5 | 6 | 17.6 | 0 | 0.0 | 34 |
| **RF14** | 0 | 0.0 | 3 | 8.8 | 0 | 0.0 | 13 | 38.2 | 18 | 52.9 | 34 |
| **RF15** | 22 | 64.7 | 9 | 26.5 | 0 | 0.0 | 0 | 0.0 | 3 | 8.8 | 34 |
| **RF16** | 15 | 44.1 | 13 | 38.2 | 3 | 8.8 | 3 | 8.8 | 0 | 0.0 | 34 |
| **RF17** | 22 | 64.7 | 9 | 26.5 | 3 | 8.8 | 0 | 0.0 | 0 | 0.0 | 34 |
| **RF18** | 13 | 38.2 | 9 | 26.5 | 6 | 17.6 | 3 | 8.8 | 3 | 8.8 | 34 |
| **RF19** | 14 | 41.2 | 19 | 55.9 | 1 | 2.9 | 0 | 0.0 | 0 | 0.0 | 34 |
| **RF20** | 13 | 38.2 | 16 | 47.1 | 2 | 5.9 | 0 | 0.0 | 3 | 8.8 | 34 |
| **RF21** | 9 | 26.5 | 16 | 47.1 | 6 | 17.6 | 0 | 0.0 | 3 | 8.8 | 34 |
| **RF22** | 1 | 2.9 | 6 | 17.6 | 8 | 23.5 | 10 | 29.4 | 9 | 26.5 | 34 |
| **RF23** | 13 | 38.2 | 6 | 17.6 | 3 | 8.8 | 9 | 26.5 | 3 | 8.8 | 34 |
| **RF24** | 12 | 35.3 | 20 | 58.8 | 0 | 0.0 | 2 | 5.9 | 0 | 0.0 | 34 |
| **RF25** | 16 | 47.1 | 13 | 38.2 | 2 | 5.9 | 3 | 8.8 | 0 | 0.0 | 34 |
| **RF26** | 6 | 17.6 | 25 | 73.5 | 3 | 8.8 | 0 | 0.0 | 0 | 0.0 | 34 |
| **RF27** | 6 | 17.6 | 16 | 47.1 | 6 | 17.6 | 3 | 8.8 | 3 | 8.8 | 34 |
| **RF28** | 1 | 2.9 | 2 | 5.9 | 2 | 5.9 | 13 | 38.2 | 16 | 47.1 | 34 |
| **RF29** | 9 | 26.5 | 16 | 47.1 | 6 | 17.6 | 3 | 8.8 | 0 | 0.0 | 34 |
| **RF30** | 9 | 26.5 | 9 | 26.5 | 6 | 17.6 | 1 | 2.9 | 9 | 26.5 | 34 |

## *Results for quantitative risk analysis:*

With regard to the results of qualitative evaluation rankings statistical indicators were calculated as demonstrated in table 4-7 below. These indicators include mean, median, minimum, maximum, variance, standard deviation, standard error, T-value, and the freedom degree.

The scale for mean and median was expanded from maximum 5 to maximum of 9 for technical facilitation of SPSS statistical analysis. So the medium number became 5 instead of 3.

## *Deductive statistical methods:*

### Variables:

In this section a description is provided for each category (source) of scope risks as the variables of the research.
Each variable was assessed by a number of questions representing the relevant risk factors. The Likert-type scale ratings' numerical value for each person was calculated and the average numeric value of the ratings of all responses to each question was calculated. Then comparability and statistical analysis of the variable became possible. Then indicators were calculated for variables

### Hypotheses testing:

Possible hypotheses are tested in this section to generalize the results taken from the sample community.
The results for probability are shown in the table 4-8 below:

*Table 4-8: statistical results for probability*

| Variables | Valid | Mean | Median | Min | Max | 1st Quarter | 3rd Quarter | Variance | Standard deviation | St. Error |
|---|---|---|---|---|---|---|---|---|---|---|
| **RC1** | 34 | 5.55 | 6.00 | 1.00 | 8.33 | 3.67 | 7.00 | 4.78 | 2.19 | 0.37 |
| **RC2** | 34 | 5.97 | 6.00 | 2.00 | 8.00 | 6.00 | 7.00 | 1.30 | 1.14 | 0.20 |
| **RC3** | 34 | 5.91 | 6.00 | 2.00 | 8.00 | 5.00 | 7.00 | 1.96 | 1.40 | 0.24 |
| **RC4** | 34 | 6.45 | 6.67 | 3.00 | 9.00 | 5.67 | 7.67 | 2.25 | 1.50 | 0.26 |
| **RC5** | 34 | 5.94 | 6.33 | 3.00 | 8.33 | 5.00 | 7.00 | 1.40 | 1.18 | 0.20 |
| **RC6** | 34 | 5.10 | 5.00 | 2.50 | 7.50 | 4.00 | 6.50 | 2.18 | 1.48 | 0.25 |
| **RC7** | 34 | 4.82 | 5.00 | 2.60 | 7.40 | 3.40 | 5.80 | 1.93 | 1.39 | 0.24 |
| **RC8** | 34 | 6.00 | 6.00 | 3.00 | 9.00 | 5.00 | 7.00 | 2.24 | 1.50 | 0.26 |
| **RC9** | 34 | 6.62 | 6.00 | 3.00 | 9.00 | 6.00 | 8.00 | 2.24 | 1.50 | 0.26 |
| **RC10** | 34 | 5.97 | 6.00 | 3.00 | 8.00 | 5.00 | 7.00 | 1.42 | 1.19 | 0.20 |
| **RC11** | 34 | 6.38 | 6.00 | 3.00 | 9.00 | 5.00 | 7.00 | 2.91 | 1.71 | 0.29 |

The mean values for all (except for RC7) variables were larger than 5 as the average level. Some variables had mean value of 6 which indicates that these variables are likely to happen as shown in figure below:

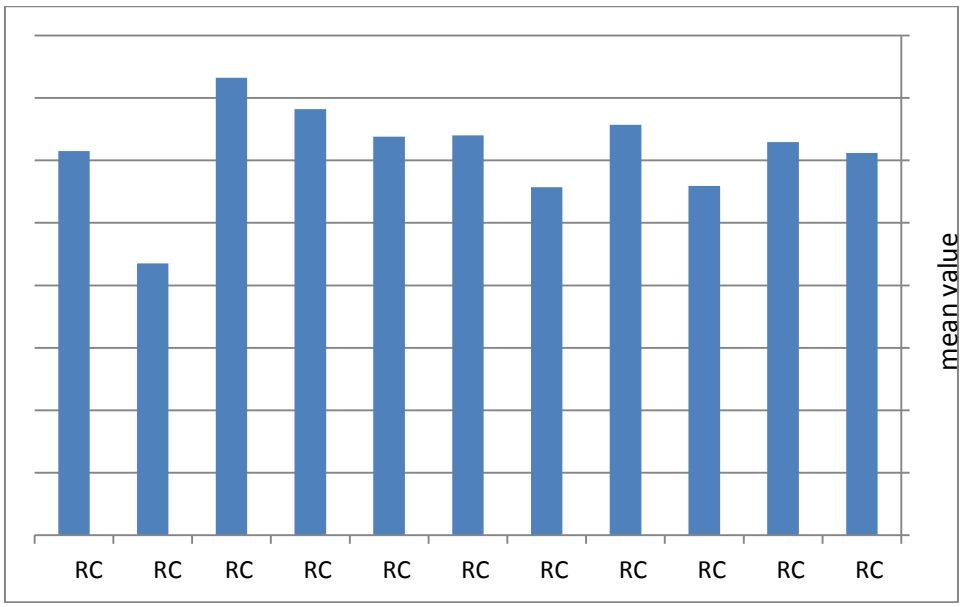



*Figure 4-6: Comparison of probability of scope risk categories*

The results for **impact level** are shown in the table 4-9 below:

*Table 4-9: statistical results for impact level*

| Variables | Valid | Mean | Median | Min | Max | 1st Quarter | 3rd Quarter | Variance | Standard deviation | St. Error |
|---|---|---|---|---|---|---|---|---|---|---|
| **RC1** | 34 | 6.12 | 6.33 | 2.33 | 9.00 | 4.33 | 7.67 | 3.44 | 1.85 | .32 |
| **RC2** | 34 | 6.29 | 6.50 | 3.00 | 9.00 | 5.00 | 8.00 | 2.82 | 1.68 | .29 |
| **RC3** | 34 | 5.59 | 5.00 | 4.00 | 8.00 | 4.00 | 7.00 | 2.31 | 1.52 | .26 |
| **RC4** | 34 | 6.57 | 6.67 | 1.67 | 9.00 | 5.67 | 7.67 | 3.04 | 1.74 | .30 |
| **RC5** | 34 | 5.57 | 5.67 | 2.33 | 9.00 | 3.67 | 7.67 | 4.15 | 2.04 | .35 |
| **RC6** | 34 | 6.40 | 7.00 | 2.50 | 8.50 | 5.50 | 7.50 | 1.68 | 1.30 | .22 |
| **RC7** | 34 | 6.38 | 6.60 | 2.20 | 9.00 | 5.80 | 7.40 | 2.19 | 1.48 | .25 |
| **RC8** | 34 | 6.82 | 7.00 | 2.00 | 9.00 | 5.00 | 8.00 | 3.36 | 1.83 | .31 |
| **RC9** | 34 | 7.32 | 8.00 | 4.00 | 9.00 | 7.00 | 8.00 | 1.56 | 1.25 | .21 |
| **RC10** | 34 | 4.35 | 4.50 | 1.00 | 8.00 | 3.00 | 5.00 | 3.20 | 1.79 | .31 |
| **RC11** | 34 | 6.15 | 7.00 | 2.00 | 9.00 | 4.00 | 8.00 | 4.61 | 2.15 | .37 |

The mean values for all variables (except RC10 i.e. Change management) were larger than 5 as the average level so the H0 for hypothesis 2 was marginally rejected in the category level. Even some variables had mean value of 6 which indicates that these variables have impacts on the convergence outcomes in case of occurrence as shown in figure below:

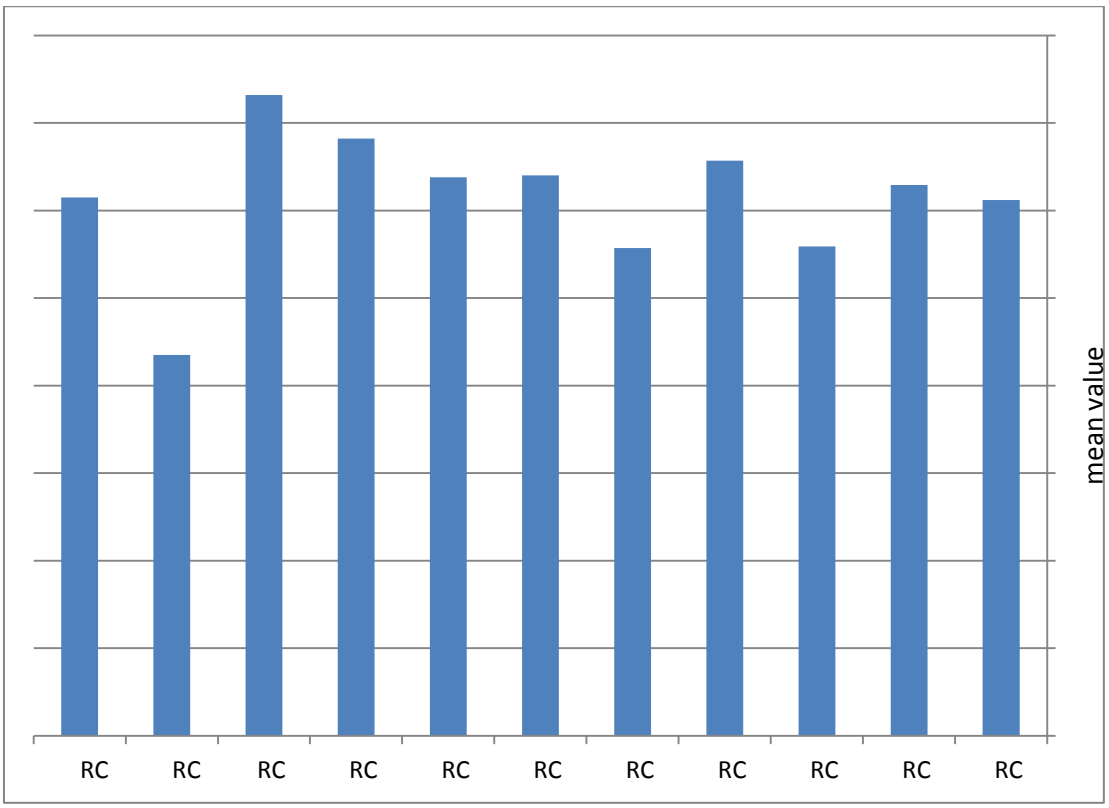



*Figure 4-7: Comparison of Impact level of scope risk categories*

The first question to answer was whether the scope risks categories likely to happen and affect the convergence outcomes?

In order to test this hypothesis[1] T-test was employed and the results are shown in the following table:

**Major hypothesis 1:** All scope risk categories and factors are <u>probable</u> to happen for convergence outcomes.

[1] H1: there is significant difference between the levels of importance between variables at %95 confidence level.
H0: there is no significant difference between the levels of importance between variables at %95 confidence level.

*Table 4-10: Statistical tests for probability of risk categories*

| Risk factors | Valid | Mean | Median | Min | Max | Variance | Standard deviation | T-value | DF | P |
|---|---|---|---|---|---|---|---|---|---|---|
| RF1 | 34 | 5.94 | 7 | 1 | 9 | 5.39 | 2.32 | 2.364 | 33 | .024 |
| RF2 | 34 | 5.76 | 7 | 1 | 9 | 7.52 | 2.74 | 1.626 | 33 | .113 |
| RF3 | 34 | 4.94 | 5 | 1 | 9 | 6.66 | 2.58 | -.133 | 33 | .895 |
| RF4 | 34 | 6.82 | 7 | 3 | 9 | 1.79 | 1.34 | 7.956 | 33 | .000 |
| RF5 | 34 | 5.12 | 5 | 1 | 7 | 2.65 | 1.63 | .421 | 33 | .676 |
| RF6 | 34 | 4.82 | 5 | 1 | 7 | 3.24 | 1.80 | -.572 | 33 | .571 |
| RF7 | 34 | 7.00 | 7 | 3 | 9 | 2.91 | 1.71 | 6.837 | 33 | .000 |
| RF8 | 34 | 7.88 | 9 | 3 | 9 | 3.44 | 1.85 | 9.061 | 33 | .000 |
| RF9 | 34 | 6.65 | 7 | 3 | 9 | 4.24 | 2.06 | 4.667 | 33 | .000 |
| RF10 | 34 | 4.82 | 5 | 1 | 9 | 4.70 | 2.17 | -.475 | 33 | .638 |
| RF11 | 34 | 5.76 | 7 | 1 | 9 | 4.61 | 2.15 | 2.077 | 33 | .046 |
| RF12 | 34 | 6.12 | 7 | 3 | 9 | 3.93 | 1.98 | 3.289 | 33 | .002 |
| RF13 | 34 | 5.94 | 7 | 3 | 9 | 3.21 | 1.79 | 3.064 | 33 | .004 |
| RF14 | 34 | 3.18 | 3 | 1 | 7 | 3.24 | 1.80 | -5.907 | 33 | .000 |
| RF15 | 34 | 5.41 | 7 | 1 | 9 | 7.95 | 2.82 | .852 | 33 | .401 |
| RF16 | 34 | 5.18 | 5 | 1 | 9 | 6.88 | 2.62 | .392 | 33 | .697 |
| RF17 | 34 | 6.65 | 7 | 3 | 9 | 4.24 | 2.06 | 4.667 | 33 | .000 |
| RF18 | 34 | 4.53 | 5 | 1 | 9 | 10.44 | 3.23 | -.849 | 33 | .402 |
| RF19 | 34 | 3.53 | 3 | 1 | 7 | 2.98 | 1.73 | -4.964 | 33 | .000 |
| RF20 | 34 | 7.41 | 9 | 3 | 9 | 4.31 | 2.08 | 6.774 | 33 | .000 |
| RF21 | 34 | 4.47 | 5 | 1 | 7 | 2.98 | 1.73 | -1.787 | 33 | .083 |
| RF22 | 34 | 4.18 | 5 | 1 | 9 | 2.94 | 1.71 | -2.802 | 33 | .008 |
| RF23 | 34 | 4.59 | 5 | 1 | 9 | 5.04 | 2.24 | -1.070 | 33 | .292 |
| RF24 | 34 | 7.41 | 7 | 1 | 9 | 4.31 | 2.08 | 6.774 | 33 | .000 |
| RF25 | 34 | 6.82 | 7 | 3 | 9 | 3.24 | 1.80 | 5.907 | 33 | .000 |
| RF26 | 34 | 6.41 | 7 | 3 | 9 | 3.76 | 1.94 | 4.243 | 33 | .000 |
| RF27 | 34 | 8.12 | 9 | 3 | 9 | 3.20 | 1.79 | 10.166 | 33 | .000 |
| RF28 | 34 | 3.82 | 3 | 1 | 7 | 2.21 | 1.49 | -4.614 | 33 | .000 |
| RF29 | 34 | 6.71 | 7 | 1 | 9 | 7.30 | 2.70 | 3.680 | 33 | .001 |
| RF30 | 34 | 6.06 | 5 | 3 | 9 | 3.21 | 1.79 | 3.447 | 33 | .002 |

The results show that Ts calculated are equal to SIG=0/000 and freedom degree DF=33 and the score calculated for Ts was greater than 1.96. In table 4-8 we saw that all risk categories except 1 (RC7 i.e. black swans or rare events) are probable to happen and thus the hypothesis 1 can be marginally rejected, however table 4-10 gives more insight as 13 risk factors under these categories are not excepted to happen (including risk factors 2, 3, 5, 6, 10, 14, 15, 16, 18, 19, 21, 22, 23 and 28) and others are probable to happen. Since in these cases error level calculated was smaller than 0.05 ($\alpha$=0.05) thus it can be claimed with %95 that H1 of the research has been confirmed and H0 rejected.

**Major hypothesis 2:** All scope risk categories and factors have significant impact on convergence outcomes if they occur.

*Table 4-11: Statistical tests for impact level of risk categories*

| Risk factors | Valid | Mean | Median | Min | Max | Variance | Standard deviation | T-value | DF | P |
|---|---|---|---|---|---|---|---|---|---|---|
| RF1 | 34 | 7.41 | 9.00 | 3.00 | 9.00 | 5.04 | 2.24 | 6.266 | 33 | .000 |
| RF2 | 34 | 6.53 | 7.00 | 3.00 | 9.00 | 6.07 | 2.46 | 3.618 | 33 | .001 |
| RF3 | 34 | 4.41 | 3.00 | 1.00 | 9.00 | 6.67 | 2.58 | -1.328 | 33 | .193 |
| RF4 | 34 | 7.41 | 9.00 | 3.00 | 9.00 | 5.04 | 2.24 | 6.266 | 33 | .000 |
| RF5 | 34 | 5.18 | 5.00 | 1.00 | 9.00 | 3.97 | 1.99 | .517 | 33 | .609 |
| RF6 | 34 | 4.00 | 3.00 | 1.00 | 9.00 | 8.55 | 2.92 | -1.995 | 33 | .054 |
| RF7 | 34 | 7.18 | 7.00 | 5.00 | 9.00 | 1.06 | 1.03 | 12.333 | 33 | .000 |
| RF8 | 34 | 7.76 | 9.00 | 3.00 | 9.00 | 3.16 | 1.78 | 9.076 | 33 | .000 |
| RF9 | 34 | 7.18 | 7.00 | 1.00 | 9.00 | 4.70 | 2.17 | 5.857 | 33 | .000 |
| RF10 | 34 | 4.76 | 3.00 | 1.00 | 9.00 | 6.97 | 2.64 | -.520 | 33 | .607 |
| RF11 | 34 | 6.12 | 7.00 | 3.00 | 9.00 | 3.93 | 1.98 | 3.289 | 33 | .002 |
| RF12 | 34 | 4.06 | 3.00 | 1.00 | 9.00 | 7.57 | 2.75 | -1.994 | 33 | .054 |
| RF13 | 34 | 6.53 | 7.00 | 3.00 | 9.00 | 5.35 | 2.31 | 3.856 | 33 | .001 |
| RF14 | 34 | 2.29 | 1.00 | 1.00 | 7.00 | 3.12 | 1.77 | -8.928 | 33 | .000 |
| RF15 | 34 | 7.76 | 9.00 | 1.00 | 9.00 | 5.34 | 2.31 | 6.978 | 33 | .000 |
| RF16 | 34 | 7.41 | 7.00 | 3.00 | 9.00 | 3.58 | 1.89 | 7.429 | 33 | .000 |
| RF17 | 34 | 8.12 | 9.00 | 5.00 | 9.00 | 1.74 | 1.32 | 13.768 | 33 | .000 |
| RF18 | 34 | 6.53 | 7.00 | 1.00 | 9.00 | 6.80 | 2.61 | 3.419 | 33 | .002 |
| RF19 | 34 | 7.76 | 7.00 | 5.00 | 9.00 | 1.22 | 1.10 | 14.621 | 33 | .000 |
| RF20 | 34 | 7.12 | 7.00 | 1.00 | 9.00 | 5.08 | 2.25 | 5.480 | 33 | .000 |
| RF21 | 34 | 6.65 | 7.00 | 1.00 | 9.00 | 4.96 | 2.23 | 4.311 | 33 | .000 |
| RF22 | 34 | 3.82 | 3.00 | 1.00 | 9.00 | 5.36 | 2.32 | -2.963 | 33 | .006 |
| RF23 | 34 | 6.00 | 7.00 | 1.00 | 9.00 | 8.55 | 2.92 | 1.995 | 33 | .054 |
| RF24 | 34 | 7.65 | 7.00 | 3.00 | 9.00 | 1.63 | 1.28 | 12.092 | 33 | .000 |
| RF25 | 34 | 7.47 | 7.00 | 3.00 | 9.00 | 3.41 | 1.85 | 7.803 | 33 | .000 |
| RF26 | 34 | 7.18 | 7.00 | 5.00 | 9.00 | 1.06 | 1.03 | 12.333 | 33 | .000 |
| RF27 | 34 | 6.12 | 7.00 | 1.00 | 9.00 | 5.38 | 2.32 | 2.810 | 33 | .008 |
| RF28 | 34 | 2.59 | 3.00 | 1.00 | 9.00 | 4.07 | 2.02 | -6.973 | 33 | .000 |
| RF29 | 34 | 6.82 | 7.00 | 3.00 | 9.00 | 3.24 | 1.80 | 5.907 | 33 | .000 |
| RF30 | 34 | 5.47 | 7.00 | 1.00 | 9.00 | 9.71 | 3.12 | .881 | 33 | .385 |

The results show that Ts calculated are equal to SIG=0/000 and freedom degree DF=33 and the score calculated for Ts was greater than 1.96 thus it can be claimed with %95 that for the hypothesis 2 the H1 of the research has been confirmed and H0 rejected in factor level too. It can be deduced that some of the risk factors including RF3, 5, 6, 10, 12, 14, 22, 23, 28 and RF30 have not significant impact on convergence outcomes and the remaining 20 have significant impact. Since in these cases error level calculated was smaller than 0.05 (α=0.05)

## Prioritization:

After probability and impact level values and indicators were calculated, it was time for rating and prioritizing the risks.

Based on previous tables, the amount of probability and impact for risk factors inserted in table 4-12:

Regarding the classification of the table 4-13, any risk factor that its product of probability and impact is greater than 3.2 is identified as high priority risk. Thus, based on (Table 4-13: Probability & impact amount) data, products of risk factors or risk rates calculated:

*Table 4-12: Risk factors priority rate*

| Risk factors | Valid | Probability | Impact | Priority (risk rate) |
|---|---|---|---|---|
| RF1 | 34 | 66.00 | 82.33 | 54.34 |
| RF2 | 34 | 64.00 | 72.56 | 46.44 |
| RF3 | 34 | 54.89 | 49.00 | 26.90 |
| RF4 | 34 | 75.78 | 82.33 | 62.39 |
| RF5 | 34 | 56.89 | 57.56 | 32.74 |
| RF6 | 34 | 53.56 | 44.44 | 23.80 |
| RF7 | 34 | 77.78 | 79.78 | 62.05 |
| RF8 | 34 | 87.56 | 86.22 | 75.49 |
| RF9 | 34 | 73.89 | 79.78 | 58.95 |
| RF10 | 34 | 53.56 | 52.89 | 28.32 |
| RF11 | 34 | 64.00 | 68.00 | 43.52 |
| RF12 | 34 | 68.00 | 45.11 | 30.68 |
| RF13 | 34 | 66.00 | 72.56 | 47.89 |
| RF14 | 34 | 35.33 | 25.44 | 8.99 |
| RF15 | 34 | 60.11 | 86.22 | 51.83 |
| RF16 | 34 | 57.56 | 82.33 | 47.39 |
| RF17 | 34 | 73.89 | 90.22 | 66.66 |
| RF18 | 34 | 50.33 | 72.56 | 36.52 |
| RF19 | 34 | 39.22 | 86.22 | 33.82 |
| RF20 | 34 | 82.33 | 79.11 | 65.13 |
| RF21 | 34 | 49.67 | 73.89 | 36.70 |
| RF22 | 34 | 46.44 | 42.44 | 19.71 |
| RF23 | 34 | 51.00 | 66.67 | 34.00 |
| RF24 | 34 | 82.33 | 85.00 | 69.98 |
| RF25 | 34 | 75.78 | 83.00 | 62.90 |
| RF26 | 34 | 71.22 | 79.78 | 56.82 |
| RF27 | 34 | 90.22 | 68.00 | 61.35 |
| RF28 | 34 | 42.44 | 28.78 | 12.21 |
| RF29 | 34 | 74.56 | 75.78 | 56.50 |
| RF30 | 34 | 67.33 | 60.78 | 40.92 |

The risk factors' priority levels are shown in table 4-16 with their normalized risk rates and their risk categories (sources).

Determining the priority is necessary for risk response planning. For this analysis the levels of risk priority were adopted from PMI (2010) and modified as follows:

1- High (priority) risks

2- Medium (priority) risks

3- Low (priority) risks

*Table 4-13: Priority rating of risk factors in ascending order*

| Risk rates | | | |
|---|---|---|---|
| **Risk factor** | **Risk rate** | **Normalized risk rate** | **Risk category (source)** |
| RF8 | 75.49 | 5.57 | RC4 |
| RF24 | 69.98 | 5.17 | RC8 |
| RF17 | 66.66 | 4.92 | RC6 |
| RF20 | 65.13 | 4.81 | RC7 |
| RF25 | 62.9 | 4.64 | RC9 |
| RF4 | 62.39 | 4.6 | RC2 |
| RF7 | 62.05 | 4.58 | RC3 |
| RF27 | 61.35 | 4.53 | RC10 |
| RF9 | 58.95 | 4.35 | RC4 |
| RF26 | 56.82 | 4.19 | RC9 |
| RF29 | 56.5 | 4.17 | RC11 |
| RF1 | 54.34 | 4.01 | RC1 |
| RF15 | 51.83 | 3.83 | RC6 |
| RF13 | 47.89 | 3.53 | RC5 |
| RF16 | 47.39 | 3.5 | RC6 |
| RF2 | 46.44 | 3.43 | RC1 |
| RF11 | 43.52 | 3.21 | RC5 |
| RF30 | 40.92 | 3.02 | RC11 |
| RF21 | 36.7 | 2.71 | RC7 |
| RF18 | 36.52 | 2.7 | RC7 |
| RF23 | 34 | 2.51 | RC8 |
| RF19 | 33.82 | 2.5 | RC7 |
| RF5 | 32.74 | 2.42 | RC2 |
| RF12 | 30.68 | 2.26 | RC5 |
| RF10 | 28.32 | 2.09 | RC4 |
| RF3 | 26.9 | 1.98 | RC1 |
| RF6 | 23.8 | 1.76 | RC3 |
| RF22 | 19.71 | 1.45 | RC7 |
| RF28 | 12.21 | 0.9 | RC10 |
| RF14 | 8.99 | 0.66 | RC6 |
| sum | 1355 | | |

The complete ratings are shown in the following graph by descending order.

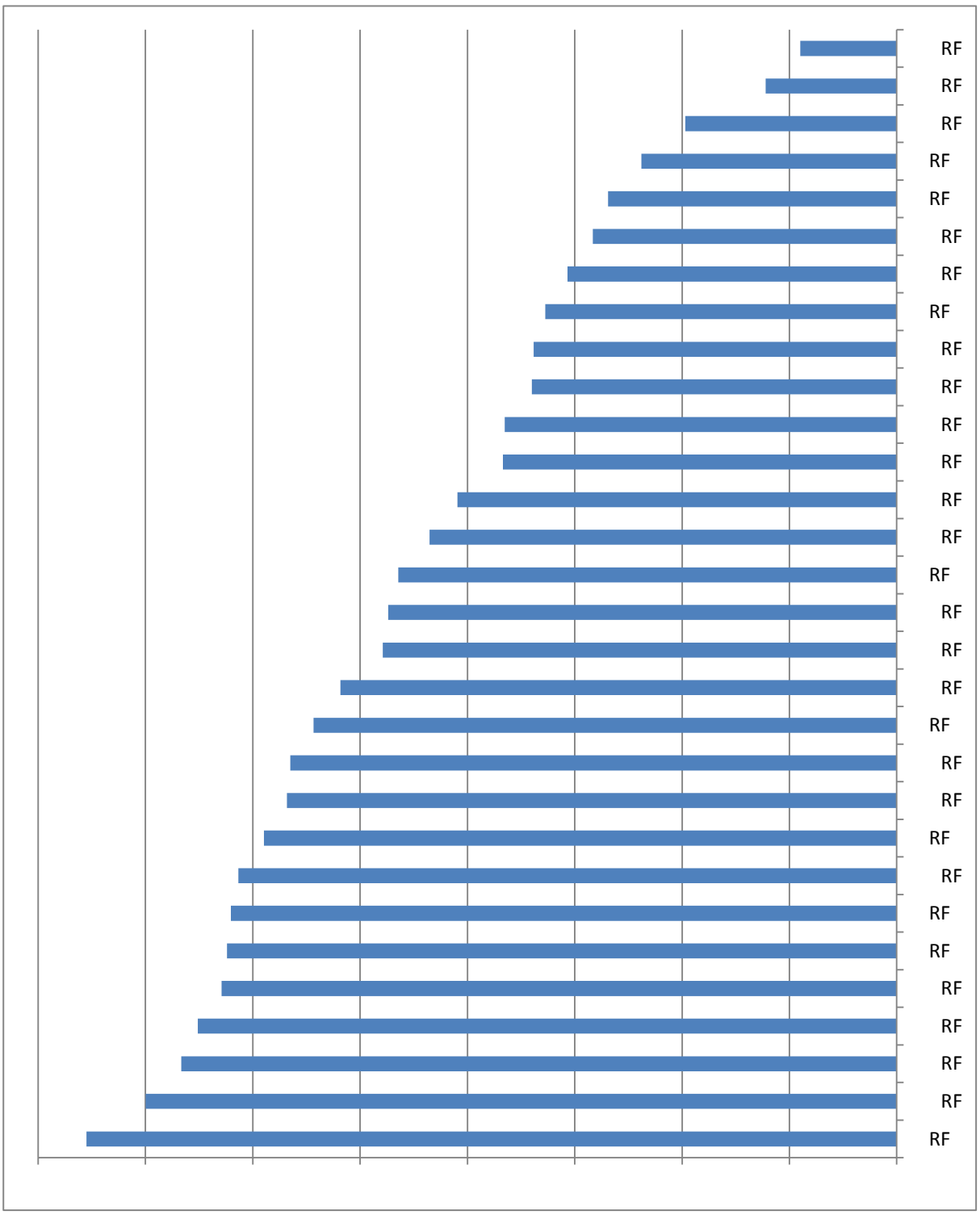



*Figure 4-8: Priority ratings of risk factors*

Based on the analysis of the matrix data hypotheses related to priority were tested.

**Major hypothesis 3:** All scope risk categories are of equal importance (priority) for convergence outcomes.

*Table 4-14: priority level of risk categories*

| Risk Categories | Average of ratings | Sum of ratings | Mean | SD |
|---|---|---|---|---|
| RC1 | 18 | 54 | 35.41 | 19.59 |
| RC2 | 14.5 | 29 | 37.74 | 12.18 |
| RC3 | 17 | 34 | 35.09 | 12.15 |
| RC4 | 11.667 | 35 | 44.25 | 15.91 |
| RC5 | 18.333 | 55 | 32.98 | 13.85 |
| RC6 | 15.25 | 61 | 35.68 | 13.17 |
| RC7 | 18.6 | 93 | 30.74 | 11.93 |
| RC8 | 11.5 | 23 | 41.65 | 13.78 |
| RC9 | 7.5 | 15 | 48.82 | 13.03 |
| RC10 | 18.5 | 37 | 30.26 | 13.53 |
| RC11 | 14.5 | 29 | 39.71 | 16.61 |

*Table 4-15: T tests for difference significance of risk categories priority level*

| Risk Categories | Mean | RC1 | RC2 | RC3 | RC4 | RC5 | RC6 | RC7 | RC8 | RC9 | RC10 | RC11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RC1 | 35.41 | | T=-.756 Sig=.455 | T=.113 Sig=.910 | T=-2.262 Sig=.03 | T=.618 Sig=.541 | T=-.07 Sig=.944 | T=1.291 Sig=.206 | T=-1.523 Sig=.137 | T=-3.513 Sig=0.01 | T=1.538 Sig=.133 | T=-1.149 Sig=.259 |
| RC2 | 37.74 | | | T=1.325 Sig=.194 | T=-2.23 Sig=0.033 | T=1.557 Sig=.129 | T=.654 Sig=.518 | T=2.667 Sig=.012 | T=-1.315 Sig=0.198 | T=-4.134 Sig=0.000 | T=2.639 Sig=.013 | T=-.554 Sig=.583 |
| RC3 | 35.09 | | | | T=-3.281 Sig=.002 | T=.855 Sig=.399 | T=-.27 Sig=.789 | T=1.945 Sig=.06 | T=-2.646 Sig=.012 | T=-5.899 Sig=.000 | T=2.078 Sig=.046 | T=-1.509 Sig=.141 |
| RC4 | 44.25 | | | | | T=4.436 Sig=.000 | T=3.174 Sig=.003 | T=4.834 Sig=.000 | T=.867 Sig=.392 | T=-1.441 Sig=.159 | T=4.57 Sig=.000 | T=1.269 Sig=.213 |
| RC5 | 32.98 | | | | | | T=-1.152 Sig=.258 | T=.911 Sig=.369 | T=-2.916 Sig=.006 | T=-5.997 Sig=.000 | T=1.166 Sig=.252 | T=-1.939 Sig=.061 |
| RC6 | 35.68 | | | | | | | T=2.196 Sig=.035 | T=-2.197 Sig=.035 | T=-5.053 Sig=.000 | T=2.084 Sig=.045 | T=-1.255 Sig=.218 |
| RC7 | 30.74 | | | | | | | | T=-5.679 Sig=.000 | T=-12.298 Sig=.000 | T=.190 Sig=.851 | T=-3.056 Sig=.004 |
| RC8 | 41.65 | | | | | | | | | T=-3.181 Sig=.003 | T=3.645 Sig=.001 | T=.635 Sig=.53 |
| RC9 | 48.82 | | | | | | | | | | T=6.566 Sig=.000 | T=2.748 Sig=.01 |
| RC10 | 30.26 | | | | | | | | | | | T=-3.643 Sig=.001 |
| RC11 | 39.71 | | | | | | | | | | | |
| Priority | | 7 | 5 | 8 | 2 | 9 | 6 | 10 | 3 | 1 | 11 | 4 |

Also, we can use Friedman test to determine mean rank.

*Table 4-16: Friedman test for risk categories mean rank*

| Risk Categories | mean | Standard deviation | Mean Rank | Priority |
|---|---|---|---|---|
| RC1 | 35.41 | 19.59 | 5.85 | 6 |
| RC2 | 37.74 | 12.18 | 6.21 | 7 |
| RC3 | 35.09 | 12.15 | 5.44 | 5 |
| RC4 | 44.25 | 15.91 | 7.78 | 2 |
| RC5 | 32.98 | 13.85 | 4.75 | 3 |
| RC6 | 35.68 | 13.17 | 5.40 | 4 |
| RC7 | 30.74 | 11.93 | 4.16 | 10 |
| RC8 | 41.65 | 13.78 | 7.12 | 9 |
| RC9 | 48.82 | 13.03 | 8.82 | 1 |
| RC10 | 30.26 | 13.53 | 4.13 | 11 |
| RC11 | 39.71 | 16.61 | 6.34 | 8 |

N=34, Chi-Square=67.373, df=10, Asymp. Sig.= .000

Chi-Square value indicates that risk categories significantly differ in mean. On the other hand, most of respondents have determined RC9 (Optimism bias) as the most important risk category.

**Hypothesis 3-1**: in white elephant category Future functionality and operability is the most important risk factor.

First, we calculate risk rate for all of respondent by multiplying Probability and impact of any risk factors. Then for determining risk factors mean rank, use Friedman test.

*Table 4-17: Friedman test for risk factors mean rank*

| Risk factors | mean | Standard deviation | Mean Rank | Priority |
|---|---|---|---|---|
| RF1 | 44.12 | 22.40 | 18.44 | 13 |
| RF2 | 37.29 | 23.30 | 16.03 | 16 |
| RF3 | 21.18 | 16.56 | 9.44 | 26 |
| RF4 | 49.82 | 17.18 | 20.94 | 8 |
| RF5 | 25.65 | 12.50 | 11.21 | 23 |
| RF6 | 19.47 | 16.89 | 8.13 | 27 |
| RF7 | 50.71 | 16.00 | 21.63 | 5 |
| RF8 | 61.47 | 21.33 | 24.31 | 1 |
| RF9 | 47.18 | 21.15 | 20.01 | 9 |
| RF10 | 24.12 | 21.25 | 11.15 | 24 |
| RF11 | 34.41 | 16.67 | 15.40 | 17 |
| RF12 | 25.18 | 18.54 | 11.13 | 25 |
| RF13 | 39.35 | 19.17 | 16.79 | 14 |
| RF14 | 7.06 | 7.16 | 3.10 | 30 |
| RF15 | 44.53 | 24.85 | 18.57 | 12 |
| RF16 | 37.82 | 22.34 | 16.54 | 15 |
| RF17 | 53.29 | 17.40 | 21.78 | 4 |
| RF18 | 27.24 | 23.63 | 11.44 | 22 |
| RF19 | 27.59 | 14.40 | 12.41 | 20 |
| RF20 | 52.82 | 23.43 | 21.93 | 3 |
| RF21 | 29.53 | 16.32 | 12.75 | 19 |
| RF22 | 16.53 | 14.78 | 7.84 | 28 |
| RF23 | 26.65 | 18.87 | 11.59 | 21 |
| RF24 | 56.65 | 19.40 | 23.29 | 2 |
| RF25 | 51.88 | 20.10 | 21.63 | 6 |
| RF26 | 45.76 | 15.10 | 19.40 | 10 |
| RF27 | 49.94 | 22.36 | 21.07 | 7 |
| RF28 | 10.59 | 10.18 | 4.60 | 29 |
| RF29 | 45.94 | 22.12 | 18.65 | 11 |
| RF30 | 33.47 | 22.39 | 13.78 | 18 |

N=34, Chi-Square=428.170, df=29, Asymp. Sig.= .000

Based on Friedman test, we reject null hypothesis that respondents have spotted equal priority among risk factors as they chose Future functionality and operability as the most important risk factor and there were significant difference in priority of other factors.

**Hypothesis 3-2:** In Immature concept category, low common understanding is the most important risk factor.

*Table 4-18: Friedman test for mean rank of immature concept category risk factors*

| Risk factors | mean | Standard deviation | Mean Rank | Priority |
|---|---|---|---|---|
| RF1 | 44.12 | 22.40 | 2.53 | 1 |
| RF2 | 37.29 | 23.30 | 2.09 | 2 |
| RF3 | 21.18 | 16.56 | 1.38 | 3 |

N=34, Chi-Square=25.8, df=2, Asymp. Sig.= .000

Based on Friedman test, we CAN NOT accept hypothesis that low common understanding is the most important risk factor In Immature concept category.

**Hypothesis 3-3:** In Black Swans category, Scope changes resulting from external dependencies is the most important risk factor.

*Table 4-19: Friedman test for mean rank of black swans category risk factors*

| Risk factors | mean | Standard deviation | Mean Rank | Priority |
|---|---|---|---|---|
| RF18 | 27.24 | 23.63 | 2.72 | 4 |
| RF19 | 27.59 | 14.40 | 2.90 | 3 |
| RF20 | 52.82 | 23.43 | 4.47 | 1 |
| RF21 | 29.53 | 16.32 | 3.01 | 2 |
| RF22 | 16.53 | 14.78 | 1.90 | 5 |

N=34, Chi-Square=49.494, df=4, Asymp. Sig.= .000

Based on Friedman test, we CAN NOT accept null hypothesis that Scope changes resulting from external dependencies is the most important risk factor in Rare events category.

**Hypothesis 3-4:** In Optimism bias category, overestimated funding is the most important risk factor.

*Table 4-20: Friedman test for mean rank of Optimism bias category risk factors*

| Risk factors | mean | Standard deviation | Mean Rank | Priority |
|---|---|---|---|---|
| RF23 | 26.65 | 18.87 | 1.13 | 2 |
| RF24 | 56.65 | 19.40 | 1.87 | 1 |

N=34, Chi-Square=18.939, df=1, Asymp. Sig.= .000

Based on Friedman test, we CAN NOT reject hypothesis that overestimated funding is the most important risk factor in Optimism bias category.

**Hypothesis 3-5:** In change management category, no change management procedure is the most important risk factor.

*Table 4-21: Friedman test for mean rank of change management category risk factors*

| Risk factors | mean | Standard deviation | Mean Rank | Priority |
|---|---|---|---|---|
| RF27 | 49.94 | 22.36 | 2.00 | 1 |
| RF28 | 10.59 | 10.18 | 1.00 | 2 |

N=34, Chi-Square=18.939, df=1, Asymp. Sig.= .000

Based on Friedman test, we CAN NOT reject hypothesis that no change management procedure is the most important risk factor in change management category.

**Hypothesis 3-6:** In stakeholder pressure category, gold plating is the most important risk factor.

*Table 4-22: Friedman test for mean rank of stakeholder pressure category risk factors*

| Risk factors | mean | Standard deviation | Mean Rank | Priority |
|---|---|---|---|---|
| RF14 | 7.06 | 7.16 | 1.16 | 4 |
| RF15 | 44.53 | 24.85 | 2.82 | 2 |
| RF16 | 37.82 | 22.34 | 2.65 | 3 |
| RF17 | 53.29 | 17.40 | 3.37 | 1 |

N=34, Chi-Square=58.604, df=3, Asymp. Sig.= .000

Based on Friedman test, we CAN NOT accept the hypothesis that gold plating is the most important risk factor in stakeholder pressure category.

**Hypothesis 3-7:** In Requirements engineering category, incomprehensive requirements is the most important risk factor.

*Table 4-23: Friedman test for Requirements engineering category risk factors*

| Risk factors | mean | Standard deviation | Mean Rank | Priority |
|---|---|---|---|---|
| RF11 | 34.41 | 16.67 | 2.16 | 2 |
| RF12 | 25.18 | 18.54 | 1.49 | 3 |
| RF13 | 39.35 | 19.17 | 2.35 | 1 |

N=34, Chi-Square=18.939, df=1, Asymp. Sig.= .000

Based on Friedman test, we CAN NOT accept the hypothesis that *Incomprehensive requirements* is the most important risk factor in Requirements engineering category.

# Chapter 5: Conclusion

## Introduction and overview:

Research aim comprised developing a framework for Olympics' Legacy aims' scope risk evaluation based on which the case study survey research questions could be answered, concerning what were the important risks in the concurrent convergence goal of the Legacy regeneration by identifying their probability and impact level.

The framework developed for the purpose was different because it directly evaluated risks for their impact on purpose areas and not the operational projects criteria. The mind-set provided the grounds for qualitative analysis of the common sense perceptions of promised aims rather than biased indicators or impair project objectives.

Objectivity for the framework was achieved as far as possible within limitations of this research by devising a specific questionnaire in which a comprehensive categorized list of intentional, behavioral, structural, functional scope risk factor were addressed by hybrid questions. The questions were hybrid since wherever possible the theme concept, outcome criteria (the project, business, macro aims), and the risk source elements were used in phrasing of the questions.

After pilot the questionnaire was administered online and validated for reliability. The data gathered was analyzed as discussed in chapter four.

In data analysis researcher felt that it was better to form some hypothetical judgments based on insight gained through literature review and draw conclusions of analysis based on these hypotheses.

Three major (for risk categories' probability, impact, and priority) and seven minor hypotheses (for risk factors' priority) were analyzed among all possible

variations and the results of the hypothesis testing and other conclusions are discussed further here:

*Table 5-1: Summary of hypotheses testing interpretations*

| Hypotheses | Result | Conclusion |
|---|---|---|
| **Major hypothesis 1:** All scope risk categories and factors are probable to happen for convergence outcomes. | H0 rejected in both levels | All risk categories except 1 (RC7 i.e. black swans or rare events) are probable to happen. However some risk categories (13 out of 30) are not except to happen and others are probable |
| **Major hypothesis 2:** All scope risk categories and factors have impact on convergence outcomes if they occur. | H0 rejected in both levels | All categories (except RC10 i.e. Change management) had significant impact on the convergence. In the factor level except 10 factors other 20 factors had significant impact on convergence. |
| **Major hypothesis 3:** All scope risk categories and factors are of equal importance (priority) for convergence outcomes. | H0 rejected | Most of respondents have determined RC9 (Optimism bias) as the most important risk category |
| **Hypothesis 3-1:** in White elephant category Future functionality and operability is the most important risk factor. | H1 supported | Future functionality and operability was evaluated to be not only the most important risk factor in white elephant category but in as the most important risk factor among all other factors. |
| **Hypothesis 3-2:** In Immature concept category, low common understanding is the most important risk factor. | H1 not supported | We CAN NOT accept hypothesis that low common understanding is the most important risk factor In Immature concept category. Actually it was RF1 (stakeholder's lack of understanding of their responsibility toward convergence) that was the primary factor in the category. |
| **Hypothesis 3-3:** In black | H1 not | The Scope changes resulting from |

| | | |
|---|---|---|
| swans category, Scope changes resulting from external dependencies is the most important risk factor. | supported | external dependencies was not the first important factor in the category. It was actually "Intangible deliverable problems that must be fixed" that was evaluated by the respondents as the most important factor in the category |
| **Hypothesis 3-4:** In Optimism bias category, overestimated funding is the most important risk factor. | H1 supported | We COULD NOT reject hypothesis that overestimated funding is the most important risk factor in Optimism bias category |
| **Hypothesis 3-5:** In change management category, no change management procedure is the most important risk factor. | H1 supported | We COULD NOT reject hypothesis that no change management procedure is the most important risk factor in change management category. |
| **Hypothesis 3-6:** In stakeholder pressure category, gold plating is the most important risk factor. | H1 not supported | we CAN NOT accept the hypothesis that gold plating is the most important risk factor in stakeholder pressure category |
| **Hypothesis 3-7:** In Requirements engineering category, incomprehensive requirements is the most important risk factor. | H1 not supported | We COULD NOT accept the hypothesis that incomprehensive requirements is the most important risk factor in Requirements engineering category |

## Discussing the findings of the research:

The results of the study were in line with previous research findings in a quite satisfactory number of cases. Scope risks sources like *team and customer pressure*, *poor requirements engineering*, *vague concept* and *vague delimitations* have been discussed in the literature (Sampson, 2011; Jennings, 2010), as to bring about categories of risk factors studied in this research. Among high priority risk factors identified in data analysis, *future*

*functionality* was the one which got the most critical attention in the literature and the survey result ranked it as number one important, probable risk for convergence theme, buying not only credit for the survey but also for the framework applicability .

Top 10 risk factors identified for the convergence theme are listed in following table:

*Table 5-2: Top 10 scope risk factors for convergence*

| Ranking | Top 10 scope risk factors for convergence |
|---|---|
| **1st** | RF8-Future functionality and operability considered for the legacy theme (convergence) outcome is exaggerated and unrealistic |
| **2nd** | RF24-Overestimating the amount of funding for the project |
| **3rd** | RF17-Un-managed downsizing of the scope by the project team, managers or contractors |
| **4th** | RF20-Intangible deliverable problems that must be fixed |
| **5th** | RF25-Work Breakdown Structure (WBS) for exact work to be done is not created |
| **6th** | RF4-It is not clearly stated which deliverables, functionalities, ingredients, … are out of the theme scope |
| **7th** | RF7-Different interpretations of primary expectations and promises |
| **8th** | RF27-No change management and control procedure for scope and requirements |
| **9th** | RF9-Future costs of keeping the legacy theme's outcome working and alive after the project product is delivered will be too excessive and not feasible for the city |
| **10th** | RF26-Design changes |

There is also high correlation between the results of this study and findings in the related literature in reporting optimism bias in terms of *overestimating the amount of funding* for the project, and *stakeholders lack of understanding of their responsibility toward convergence*, and *un-managed downsizing of the scope by the project team, managers or contractors* as the

risk factors with the important impacts on the Legacy and convergence outcome.

The critics and essays on convergence theme have stated severe difference in the stakeholders' attitude towards the convergence theme and expectations from its outcomes (Sampson, 2011), incomplete and incomprehensive requirements (Flyvbjerg, 2012). The results of this study also introduced *stakeholder pressure* to be top priority risk source with its sub category high risk factor i.e. *scope change* by *un-managed downsizing of the scope by the project team, managers or contractors* being assessed as the first important in the category and 3rd important among all risk factors.

# Recommendations

The evidence supporting the suitability of the developed framework can only be drown from the survey in the present research because of lack of any similar framework for comparison (to the researcher's best knowledge).

It can be claimed, therefore, that the proposed framework was successful in accomplishing its purpose which was enabling stakeholders to practically and effectively evaluate risks for scope of the work and outcomes of purpose areas of the Olympic Legacy ventures.

## Recommendations based on the findings:

Ironically, divergence of expectations can be traced in convergence function of the Legacy as discussed earlier. It is recommended to strengthen integration management mechanisms in the relevant projects with special focus on bringing closer the directions pursued by the government, borough, and residents and all stakeholders closer to an agreed upon future functionality and operability agenda and get a clear idea about the funding for that agenda.

As we have seen in conclusions most of the risk categories were identified by the respondents to be probable for the convergence function. This implies that serious decisions must be made so as to formalize the risk management change management and delivery management of the regeneration projects with focus on convergence theme.

It is highly recommended that an official review of the aims of the Legacy functions be performed based on the tools developed in this study with more specific goal articulation.

For reducing the ambiguity in convergence concept it is recommended that the medium level goals be explicitly defined. This is the gap between the extremes of either high level aims or too low level indicators.

## Recommendations for implementation and further studies:

The framework is entitled to complementary measures like risk factor identification in sub categories other than scope. However to evaluate scope risks it is recommended that the questionnaire tool be administered in the form of brain storming focus group for which the researcher did not have the possibilities.

Project managers engaged in Legacy projects can make use of the findings of this research to enrich their practical project risk management procedures and to prevent evident high priority risks identified here by forming focus group discussions on all probable scope risk factors with more details as they have already been in contact with some of them and can think suitable response measures to mitigate them.

Authorizing stakeholders can use the tools and the findings during their inspection and audit processes to promote confidence of achievement of the promised aims especially with regard to the important risk factor of down-sizing the projects by contractors. They may also use the framework to enhance delivery mechanism by determining criteria and metrics which address the most important risk factors.

Process model was not the main concern of this research as it only engaged in the first step of risk analysis, moreover the process models for risk management usually share common steps. However the researcher was impressed with Panama Canal expansion process model, adoption of which for this framework may constitute an interesting subject for further research projects.

Further study can be administering the survey questionnaire tool with modifications as a semi-structured interview template in which interrelations between risk factors and categories are accounted for in a way that conclusions can be made from two or more factor for a single risk.

Based on the late feedback from participants, those researchers interested in using the questionnaire battery developed in this research are recommended

to modify the tool to make it more appealing with fewer pages and less explanatory data on column headers. It is also recommended that subcategories of the themes receive separate questionnaire or at least separate columns in the same questionnaire.

In an overview of the purpose of this research, the journey, products and findings reached at in this dissertation, it might be suggested that real life and business value, applicability and practicality will constitute precious achievements accomplished during the task.

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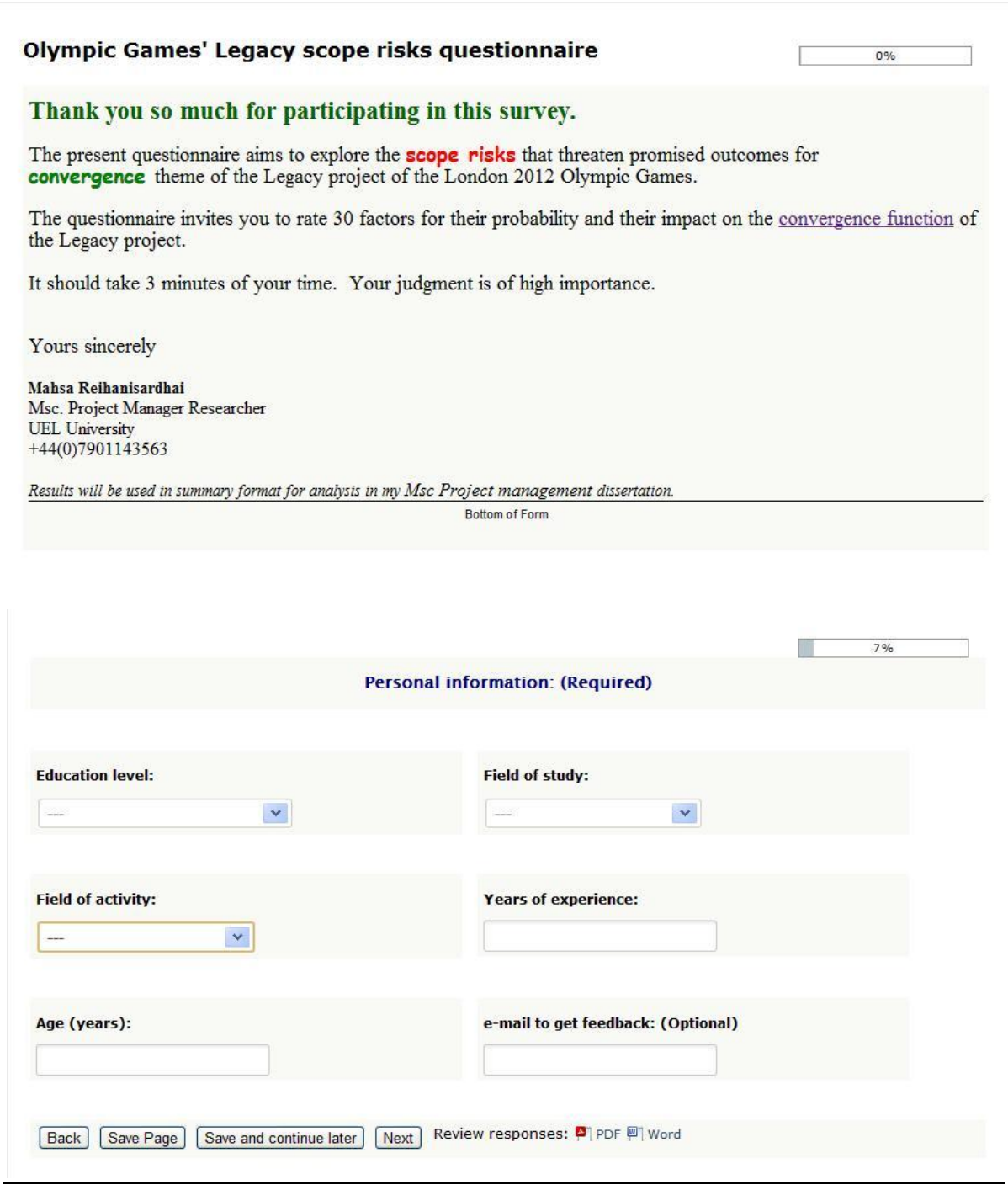
# Annex 1: Quadrant dimensional scope risk factors:

| Quadrant dimensional scope risk factors | | | |
|---|---|---|---|
| **Intentional** | **Behavioral** | **Structural** | **Functional** |
| disagreement between stakeholders over scope | Poor communication | lack of corporate technology road maps | un-managed scope alteration |
| Environment changes | Team pressure | no strategic alignment | expansion of scope |
| inadequate, inconsistent, immeasurable requirements or assumptions | constant changes in the requirements | change in stakeholder and organization | change in vision |
| Customer pressure | Little reference to scope statement | Project scope delimitations | different interpretations of primary expectations |
| Overzealous advocacy | lack of priority decisions and roadmap | Immature technology implemented | gold plating |
| too optimistic estimates and inadequate contingency | assumptions not clearly stated | Unrealistic baselines | Requirements instability |
| optimism bias in WBS planning & quality control | exclusions are not clearly stated (deliverables, functionalities, ingredients, links to sources, …) | Inadequate systems engineering | economic changes specifications |
| Scope evolution | immature scientific know-haw | the project was not aligned properly with the mission and goals | the sponsor came up with additional features |
| poor understanding of the quality and specifications of the product | Low common understanding of themes and concepts among project teams | poor milestone and activity scope definition | Teem adds unnecessary attractive features that was not requested by the customer and may not be confirmed |
| Agile development based on subjective quantifications | Inadequate training provided for stakeholders and project teams on technical specifications in implementation | Lack of change management mechanism | ambiguity in technical specifications of the outcome |
| Poor requirement definition | growing complexity of deliverables | System requirements document (SRD) | lack of metrics for judging quality and product delivery |
| no concept of | lack of incentive schemes | concept of operations | Occurrence of unexpected |

| | | | |
|---|---|---|---|
| operations, | e.g. no incentives to stick to the budget | (CONOPS) & statement of work(SOW) | technical issues |
| | missing baseline | RFP & contact data requirements list | Specifications & Measures for product delivery are not set |
| | reliance on contractor baseline estimates | The Product Breakdown Structure (PBS) has not been prepared | no description of the acceptance strategy |
| | Poor requirement engineering | no product accept or reject mechanism confirmed by stakeholders | no description of acceptance criteria |
| | Poor documentation | WBS for exact work to be done is not created or acted upon | conditions for delivery not set |
| | Poor requirement engineering | No agreed upon change management procedure and processes followed | |
| | Poor project management | delivery process is not defined | |
| | Immature specialty knowledge transfer | delivery authority not determined | |
| | Weak project manager or executive sponsor | no on-site inspections | |
| | poor delivery management | no laboratory analysis | |
| | poor registering & documenting the process & results of verification | no sampling of the products | |
| | poor communicating & archiving the results of verification | no trial operations | |
| | | no expert review | |

# Annex 2: The research questionnaire:

## *The online version of the questionnaire:*



**Olympic Games' Legacy scope risks questionnaire**

0%

**Thank you so much for participating in this survey.**

The present questionnaire aims to explore the **scope risks** that threaten promised outcomes for **convergence** theme of the Legacy project of the London 2012 Olympic Games.

The questionnaire invites you to rate 30 factors for their probability and their impact on the convergence function of the Legacy project.

It should take 3 minutes of your time. Your judgment is of high importance.

Yours sincerely

**Mahsa Reihanisardhai**
Msc. Project Manager Researcher
UEL University
+44(0)7901143563

*Results will be used in summary format for analysis in my Msc Project management dissertation.*

Bottom of Form

7%

**Personal information: (Required)**

**Education level:** ---

**Field of study:** ---

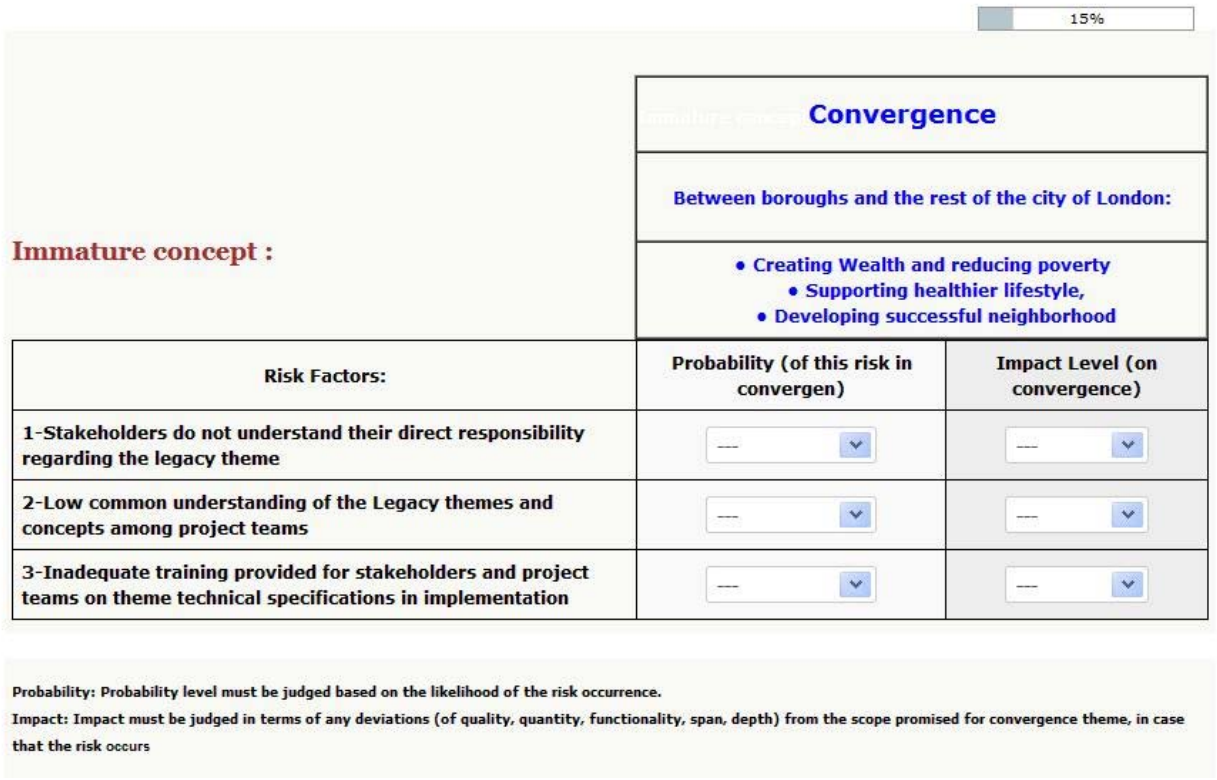
**Field of activity:** ---

**Years of experience:**

**Age (years):**

**e-mail to get feedback: (Optional)**

Back | Save Page | Save and continue later | Next | Review responses: PDF Word



15%

**Immature concept :**

**Convergence**

**Between boroughs and the rest of the city of London:**

- **Creating Wealth and reducing poverty**
- **Supporting healthier lifestyle,**
- **Developing successful neighborhood**

| Risk Factors: | Probability (of this risk in convergen) | Impact Level (on convergence) |
|---|---|---|
| 1-Stakeholders do not understand their direct responsibility regarding the legacy theme | --- | --- |
| 2-Low common understanding of the Legacy themes and concepts among project teams | --- | --- |
| 3-Inadequate training provided for stakeholders and project teams on theme technical specifications in implementation | --- | --- |

**Probability: Probability level must be judged based on the likelihood of the risk occurrence.**

**Impact: Impact must be judged in terms of any deviations (of quality, quantity, functionality, span, depth) from the scope promised for convergence theme, in case that the risk occurs**

The online questionnaire page 3 (above) format was repeated for each risk category in one page.

## *The excel version of the questionnaire:*

- **Probability Levels**: 1=Unlikely, 2=Possible, 3=Likely, 4=Expected, 5=Certain
- **Impact Levels**: 1=Very Low, 2=Low, 3=Medium, 4=High, 5=Very High

| **Scope Risk Categories** | | **Risk Factors** | | **Convergence between boroughs and the rest of the city of London** *• Creating Wealth and reducing poverty • Supporting healthier lifestyle, • Developing successful neighborhood* | |
|---|---|---|---|---|---|
| | | | | ***Probability*** | Impact level |
| 1 | **Immature concept** | 1 | Stakeholders do not understand their direct responsibility as regards the legacy theme | | |
| | | 2 | Low common understanding of the Legacy themes and concepts among project teams | | |
| | | 3 | Inadequate training provided for stakeholders and project teams on theme technical specifications in implementation | | |
| 2 | **Vague delimitations** | 4 | It is not clearly stated which deliverables, functionalities, ingredients, … are out of the theme scope | | |

| | | | | | |
|---|---|---|---|---|---|
| | | 5 | The project assumptions relevant to the theme are incomplete, inadequate, inconsistent, immeasurable, or ambiguous | | |
| 3 | **Documentation** | 6 | Little reference to scope statement | | |
| | | 7 | Different interpretations of primary expectations and promises | | |
| 4 | **White elephant** | 8 | Future functionality and operability considered for the legacy theme outcome is exaggerated and unrealistic | | |
| | | 9 | Future costs of keeping the legacy theme's outcome working and alive after the project product is delivered will be too excessive and not feasible for the city | | |
| | | 10 | Future revenue and financial gain targets expected to yield from the legacy theme's product after the delivery is too optimistic and will not be meat | | |
| 5 | **Requirements engineering** | 11 | Lack of metrics for judging quality | | |
| | | 12 | Requirements are not comprehensive | | |
| | | 13 | Requirements are not prioritized | | |
| 6 | **Stakeholder pressure** | 14 | Gold plating-Unnecessary attractive Features are added to the scope that was not requested by the regulatory stakeholder or owner and that may not be confirmed | | |
| | | 15 | Alteration of scope by the new UK government , IOC or various Olympic organizing bodies | | |
| | | 16 | The stakeholders order additional features that were out of scope | | |
| | | 17 | Un-managed downsizing of the scope by the project team, managers or contractors | | |
| 7 | **Rare events** | 18 | Legitimate scope requirements discovered late in the project | | |
| | | 19 | Scope changes necessary because of external dependencies | | |
| | | 20 | Intangible deliverable problems that must be fixed | | |
| | | 21 | Tangible deliverable problems that must be fixed | | |
| | | 22 | Legacy program-level defects that require scope shifts in the project | | |
| 8 | **Optimism bias** | 23 | Too optimistic and inadequate contingency time & cost | | |
| | | 24 | Overestimating the amount of funding for the project | | |
| 9 | **Planning & design** | 25 | Work Breakdown Structure (WBS) for exact work to be done is not created | | |
| | | 26 | Design changes | | |
| 10 | **Change management** | 27 | No change management and control procedure for scope and requirements | | |
| | | 28 | Overzealous advocacy and resistance to admit amendments or revisions advised by supervisory and audit authorities | | |
| 11 | **Delivery management** | 29 | Conditions, specifications and measures for the product delivery are not stated | | |
| | | 30 | Delivery verification authority is not determined or not acting effectively | | |

# Annex 3: Reliability tests results:

*Table A3-1: Reliability test for risk factors probability*

| **Cronbach's Alpha**= 0.867 | | | | |
|---|---|---|---|---|
| item | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
| RF1 | 166.1176 | 754.228 | .454 | .861 |
| RF2 | 166.2941 | 753.668 | .375 | .864 |
| RF3 | 167.1176 | 746.410 | .457 | .861 |
| RF4 | 165.2353 | 795.822 | .265 | .866 |
| RF5 | 166.9412 | 771.512 | .480 | .861 |
| RF6 | 167.2353 | 771.094 | .432 | .862 |
| RF7 | 165.0588 | 758.178 | .601 | .859 |
| RF8 | 164.1765 | 768.756 | .441 | .862 |
| RF9 | 165.4118 | 775.704 | .328 | .864 |
| RF10 | 167.2353 | 760.185 | .441 | .862 |
| RF11 | 166.2941 | 778.396 | .289 | .866 |
| RF12 | 165.9412 | 772.178 | .377 | .863 |
| RF13 | 166.1176 | 786.713 | .275 | .865 |
| RF14 | 168.8824 | 780.592 | .335 | .864 |
| RF15 | 166.6471 | 743.629 | .429 | .862 |
| RF16 | 166.8824 | 765.319 | .313 | .866 |
| RF17 | 165.4118 | 774.007 | .343 | .864 |
| RF18 | 167.5294 | 681.045 | .748 | .850 |
| RF19 | 168.5294 | 790.560 | .247 | .866 |
| RF20 | 164.6471 | 751.629 | .541 | .859 |
| RF21 | 167.5882 | 778.795 | .371 | .863 |
| RF22 | 167.8824 | 781.622 | .344 | .864 |
| RF23 | 167.4706 | 774.075 | .308 | .865 |
| RF24 | 164.6471 | 761.084 | .456 | .861 |
| RF25 | 165.2353 | 792.670 | .214 | .867 |
| RF26 | 165.6471 | 748.296 | .617 | .858 |
| RF27 | 163.9412 | 789.633 | .246 | .866 |
| RF28 | 168.2353 | 773.337 | .508 | .861 |
| RF29 | 165.3529 | 755.508 | .369 | .864 |
| RF30 | 166.0000 | 789.879 | .243 | .866 |

This test shows that, reliability for questionnaire is very good and not necessary to eliminate any question.

*Table A3-2: Reliability test for risk factors impact level*

| **Cronbach's Alpha**= 0.897 | | | | |
|---|---|---|---|---|
| item | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
| RF1 | | | | |
| RF2 | | | | |
| RF3 | | | | |
| RF4 | | | | |
| RF5 | | | | |
| RF6 | | | | |
| RF7 | | | | |
| RF8 | | | | |
| RF9 | | | | |
| RF10 | | | | |
| RF11 | | | | |
| RF12 | | | | |
| RF13 | | | | |
| RF14 | | | | |
| RF15 | | | | |
| RF16 | | | | |
| RF17 | | | | |
| RF18 | | | | |
| RF19 | | | | |
| RF20 | | | | |
| RF21 | | | | |
| RF22 | | | | |
| RF23 | | | | |
| RF24 | | | | |
| RF25 | | | | |
| RF26 | | | | |
| RF27 | | | | |
| RF28 | | | | |
| RF29 | | | | |
| RF30 | | | | |

This test shows that, reliability for questionnaire is very good and not necessary to eliminate any question.

# Annex 4: Risk factor rating by frequency and scale weighting

*Table A4-1: Risk factor probability rate=Frequency percentage by scale weighting*

| Risk factors | Weight of scale | Very likely | Likely | Neutral | Unlikely | Very Unlikely | Probability |
|---|---|---|---|---|---|---|---|
| | | **1.50** | **1.10** | **0.70** | **0.30** | **0.10** | |
| **RF1** | % of Freq. | 17.60 | 38.20 | 26.50 | 8.80 | 8.80 | |
| | **% F*W** | 26.40 | 42.02 | 18.55 | 2.64 | 0.88 | **18.10** |
| **RF2** | % of Freq. | 17.60 | 47.10 | 8.80 | 8.80 | 17.60 | |
| | **% F*W** | 26.40 | 51.81 | 6.16 | 2.64 | 1.76 | **17.75** |
| **RF3** | % of Freq. | 17.60 | 17.60 | 17.60 | 38.20 | 8.80 | |
| | **% F*W** | 26.40 | 19.36 | 12.32 | 11.46 | 0.88 | **14.08** |
| **RF4** | % of Freq. | 17.60 | 61.80 | 17.60 | 2.90 | 0.00 | |
| | **% F*W** | 26.40 | 67.98 | 12.32 | 0.87 | 0.00 | **26.89** |
| **RF5** | % of Freq. | 0.00 | 26.50 | 64.70 | 0.00 | 8.80 | |
| | **% F*W** | 0.00 | 29.15 | 45.29 | 0.00 | 0.88 | **25.11** |
| **RF6** | % of Freq. | 0.00 | 26.50 | 47.10 | 17.60 | 8.80 | |
| | **% F*W** | 0.00 | 29.15 | 32.97 | 5.28 | 0.88 | **17.07** |
| **RF7** | % of Freq. | 26.50 | 55.90 | 8.80 | 8.80 | 0.00 | |
| | **% F*W** | 39.75 | 61.49 | 6.16 | 2.64 | 0.00 | **27.51** |
| **RF8** | % of Freq. | 64.70 | 23.50 | 2.90 | 8.80 | 0.00 | |
| | **% F*W** | 97.05 | 25.85 | 2.03 | 2.64 | 0.00 | **31.89** |
| **RF9** | % of Freq. | 26.50 | 47.10 | 8.80 | 17.60 | 0.00 | |
| | **% F*W** | 39.75 | 51.81 | 6.16 | 5.28 | 0.00 | **25.75** |
| **RF10** | % of Freq. | 8.80 | 17.60 | 38.20 | 26.50 | 8.80 | |
| | **% F*W** | 13.20 | 19.36 | 26.74 | 7.95 | 0.88 | **13.63** |
| **RF11** | % of Freq. | 8.80 | 47.10 | 26.50 | 8.80 | 8.80 | |
| | **% F*W** | 13.20 | 51.81 | 18.55 | 2.64 | 0.88 | **17.42** |
| **RF12** | % of Freq. | 17.60 | 38.20 | 26.50 | 17.60 | 0.00 | |
| | **% F*W** | 26.40 | 42.02 | 18.55 | 5.28 | 0.00 | **23.06** |
| **RF13** | % of Freq. | 8.80 | 47.10 | 26.50 | 17.60 | 0.00 | |
| | **% F*W** | 13.20 | 51.81 | 18.55 | 5.28 | 0.00 | **22.21** |
| **RF14** | % of Freq. | 0.00 | 8.80 | 17.60 | 47.10 | 26.50 | |
| | **% F*W** | 0.00 | 9.68 | 12.32 | 14.13 | 2.65 | **9.70** |
| **RF15** | % of Freq. | 17.60 | 38.20 | 8.80 | 17.60 | 17.60 | |
| | **% F*W** | 26.40 | 42.02 | 6.16 | 5.28 | 1.76 | **16.32** |
| **RF16** | % of Freq. | 17.60 | 17.60 | 38.20 | 8.80 | 17.60 | |
| | **% F*W** | 26.40 | 19.36 | 26.74 | 2.64 | 1.76 | **15.38** |
| **RF17** | % of Freq. | 26.50 | 47.10 | 8.80 | 17.60 | 0.00 | |
| | **% F*W** | 39.75 | 51.81 | 6.16 | 5.28 | 0.00 | **25.75** |
| **RF18** | % of Freq. | 17.60 | 26.50 | 8.80 | 8.80 | 38.20 | |
| | **% F*W** | 26.40 | 29.15 | 6.16 | 2.64 | 3.82 | **13.63** |
| **RF19** | % of Freq. | 0.00 | 8.80 | 26.50 | 47.10 | 17.60 | |
| | **% F*W** | 0.00 | 9.68 | 18.55 | 14.13 | 1.76 | **11.03** |
| **RF20** | % of Freq. | 55.90 | 17.60 | 17.60 | 8.80 | 0.00 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **% F*W** | 83.85 | 19.36 | 12.32 | 2.64 | 0.00 | **29.54** |
| **RF21** | % of Freq. | 0.00 | 17.60 | 47.10 | 26.50 | 8.80 | |
| | **% F*W** | 0.00 | 19.36 | 32.97 | 7.95 | 0.88 | **15.29** |
| **RF22** | % of Freq. | 2.90 | 5.90 | 47.10 | 35.30 | 8.80 | |
| | **% F*W** | 4.35 | 6.49 | 32.97 | 10.59 | 0.88 | **11.06** |
| **RF23** | % of Freq. | 8.80 | 17.60 | 26.50 | 38.20 | 8.80 | |
| | **% F*W** | 13.20 | 19.36 | 18.55 | 11.46 | 0.88 | **12.69** |
| **RF24** | % of Freq. | 47.10 | 38.20 | 8.80 | 0.00 | 5.90 | |
| | **% F*W** | 70.65 | 42.02 | 6.16 | 0.00 | 0.59 | **29.86** |
| **RF25** | % of Freq. | 26.50 | 47.10 | 17.60 | 8.80 | 0.00 | |
| | **% F*W** | 39.75 | 51.81 | 12.32 | 2.64 | 0.00 | **26.63** |
| **RF26** | % of Freq. | 26.50 | 26.50 | 38.20 | 8.80 | 0.00 | |
| | **% F*W** | 39.75 | 29.15 | 26.74 | 2.64 | 0.00 | **24.57** |
| **RF27** | % of Freq. | 73.50 | 17.60 | 0.00 | 8.80 | 0.00 | |
| | **% F*W** | 110.25 | 19.36 | 0.00 | 2.64 | 0.00 | **44.08** |
| **RF28** | % of Freq. | 0.00 | 5.90 | 38.20 | 47.10 | 8.80 | |
| | **% F*W** | 0.00 | 6.49 | 26.74 | 14.13 | 0.88 | **12.06** |
| **RF29** | % of Freq. | 47.10 | 17.60 | 17.60 | 8.80 | 8.80 | |
| | **% F*W** | 70.65 | 19.36 | 12.32 | 2.64 | 0.88 | **21.17** |
| **RF30** | % of Freq. | 17.60 | 26.50 | 47.10 | 8.80 | 0.00 | |
| | **% F*W** | 26.40 | 29.15 | 32.97 | 2.64 | 0.00 | **22.79** |

*Table A4-2: Risk factor impact level =Frequency percentage by scale weighting*

| Risk factors | Weight of scale | **Very High** | **High** | **Medium** | **Low** | **Very Low** | **Impact level** |
|---|---|---|---|---|---|---|---|
| | | **0.80** | **0.50** | **0.30** | **0.20** | **0.10** | |
| **RF1** | % of Freq. | 55.90 | 26.50 | 0.00 | 17.60 | 0.00 | |
| | **% F*W** | 44.72 | 13.25 | 0.00 | 3.52 | 0.00 | **20.50** |
| **RF2** | % of Freq. | 38.20 | 26.50 | 8.80 | 26.50 | 0.00 | |
| | **% F*W** | 57.30 | 13.25 | 2.64 | 5.30 | 0.00 | **19.62** |
| **RF3** | % of Freq. | 8.80 | 26.50 | 8.80 | 38.20 | 17.60 | |
| | **% F*W** | 7.04 | 13.25 | 2.64 | 7.64 | 1.76 | **6.47** |
| **RF4** | % of Freq. | 55.90 | 26.50 | 0.00 | 17.60 | 0.00 | |
| | **% F*W** | 44.72 | 13.25 | 0.00 | 3.52 | 0.00 | **20.50** |
| **RF5** | % of Freq. | 8.80 | 17.60 | 55.90 | 8.80 | 8.80 | |
| | **% F*W** | 7.04 | 8.80 | 16.77 | 1.76 | 0.88 | **7.05** |
| **RF6** | % of Freq. | 8.80 | 26.50 | 8.80 | 17.60 | 38.20 | |
| | **% F*W** | 7.04 | 13.25 | 2.64 | 3.52 | 3.82 | **6.05** |
| **RF7** | % of Freq. | 17.60 | 73.50 | 8.80 | 0.00 | 0.00 | |
| | **% F*W** | 14.08 | 36.75 | 2.64 | 0.00 | 0.00 | **17.82** |
| **RF8** | % of Freq. | 55.90 | 35.30 | 0.00 | 8.80 | 0.00 | |
| | **% F*W** | 44.72 | 17.65 | 0.00 | 1.76 | 0.00 | **21.38** |
| **RF9** | % of Freq. | 35.30 | 55.90 | 0.00 | 0.00 | 8.80 | |
| | **% F*W** | 28.24 | 27.95 | 0.00 | 0.00 | 0.88 | **19.02** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **RF10** | % of Freq. | 17.60 | 17.60 | 8.80 | 47.10 | 8.80 | |
| | **% F*W** | 14.08 | 8.80 | 2.64 | 9.42 | 0.88 | **7.16** |
| **RF11** | % of Freq. | 17.60 | 38.20 | 26.50 | 17.60 | 0.00 | |
| | **% F*W** | 14.08 | 19.10 | 7.95 | 3.52 | 0.00 | **11.16** |
| **RF12** | % of Freq. | 8.80 | 26.50 | 0.00 | 38.20 | 26.50 | |
| | **% F*W** | 7.04 | 13.25 | 0.00 | 7.64 | 2.65 | **7.65** |
| **RF13** | % of Freq. | 38.20 | 17.60 | 26.50 | 17.60 | 0.00 | |
| | **% F*W** | 30.56 | 8.80 | 7.95 | 3.52 | 0.00 | **12.71** |
| **RF14** | % of Freq. | 0.00 | 8.80 | 0.00 | 38.20 | 52.90 | |
| | **% F*W** | 0.00 | 4.40 | 0.00 | 7.64 | 5.29 | **5.78** |
| **RF15** | % of Freq. | 64.70 | 26.50 | 0.00 | 0.00 | 8.80 | |
| | **% F*W** | 51.76 | 13.25 | 0.00 | 0.00 | 0.88 | **21.96** |
| **RF16** | % of Freq. | 44.10 | 38.20 | 8.80 | 8.80 | 0.00 | |
| | **% F*W** | 35.28 | 19.10 | 2.64 | 1.76 | 0.00 | **14.70** |
| **RF17** | % of Freq. | 64.70 | 26.50 | 8.80 | 0.00 | 0.00 | |
| | **% F*W** | 51.76 | 13.25 | 2.64 | 0.00 | 0.00 | **22.55** |
| **RF18** | % of Freq. | 38.20 | 26.50 | 17.60 | 8.80 | 8.80 | |
| | **% F*W** | 30.56 | 13.25 | 5.28 | 1.76 | 0.88 | **10.35** |
| **RF19** | % of Freq. | 41.20 | 55.90 | 2.90 | 0.00 | 0.00 | |
| | **% F*W** | 32.96 | 27.95 | 0.87 | 0.00 | 0.00 | **20.59** |
| **RF20** | % of Freq. | 38.20 | 47.10 | 5.90 | 0.00 | 8.80 | |
| | **% F*W** | 30.56 | 23.55 | 1.77 | 0.00 | 0.88 | **14.19** |
| **RF21** | % of Freq. | 26.50 | 47.10 | 17.60 | 0.00 | 8.80 | |
| | **% F*W** | 21.20 | 23.55 | 5.28 | 0.00 | 0.88 | **12.73** |
| **RF22** | % of Freq. | 2.90 | 17.60 | 23.50 | 29.40 | 26.50 | |
| | **% F*W** | 2.32 | 8.80 | 7.05 | 5.88 | 2.65 | **5.34** |
| **RF23** | % of Freq. | 38.20 | 17.60 | 8.80 | 26.50 | 8.80 | |
| | **% F*W** | 30.56 | 8.80 | 2.64 | 5.30 | 0.88 | **9.64** |
| **RF24** | % of Freq. | 35.30 | 58.80 | 0.00 | 5.90 | 0.00 | |
| | **% F*W** | 28.24 | 29.40 | 0.00 | 1.18 | 0.00 | **19.61** |
| **RF25** | % of Freq. | 47.10 | 38.20 | 5.90 | 8.80 | 0.00 | |
| | **% F*W** | 37.68 | 19.10 | 1.77 | 1.76 | 0.00 | **15.08** |
| **RF26** | % of Freq. | 17.60 | 73.50 | 8.80 | 0.00 | 0.00 | |
| | **% F*W** | 14.08 | 36.75 | 2.64 | 0.00 | 0.00 | **17.82** |
| **RF27** | % of Freq. | 17.60 | 47.10 | 17.60 | 8.80 | 8.80 | |
| | **% F*W** | 14.08 | 23.55 | 5.28 | 1.76 | 0.88 | **9.11** |
| **RF28** | % of Freq. | 2.90 | 5.90 | 5.90 | 38.20 | 47.10 | |
| | **% F*W** | 2.32 | 2.95 | 1.77 | 7.64 | 4.71 | **3.88** |
| **RF29** | % of Freq. | 26.50 | 47.10 | 17.60 | 8.80 | 0.00 | |
| | **% F*W** | 21.20 | 23.55 | 5.28 | 1.76 | 0.00 | **12.95** |
| **RF30** | % of Freq. | 26.50 | 26.50 | 17.60 | 2.90 | 26.50 | |
| | **% F*W** | 21.20 | 13.25 | 5.28 | 0.58 | 2.65 | **8.59** |

The probability's numerical values for the rating scales were:

| Probability | Value |
|---|---|
| Very Unlikely | Probability ≤ %9 |
| Unlikely | %10 ≤ Probability < %20 |
| Medium | %20 ≤ Probability < %30 |
| Likely | %30 ≤ Probability < %40 |
| Very Likely | %40 ≤ Probability |

The impact levels' numerical values for the rating scales were:

| Impact Level | Value |
|---|---|
| Very Low | Impact level ≤ %3 |
| Low | %4 ≤ Impact level < %8 |
| Medium | %8 ≤ Impact level < %12 |
| High | %12 ≤ Impact level < %16 |
| Very High | %16 ≤ Impact level |

*Table A4-3: Risk factor rating level in high, medium, and low risk areas*

| | | Impact | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Very Low ≤ | | Low | | | | Medium | | | | High | | | | Very high ≥ | | | | | | |
| Probability | | 2% | 3% | 4% | 5% | 6% | 7% | 8% | 9% | 10% | 11% | 12% | 13% | 14% | 15% | 16% | 18% | 19% | 20% | 21% | 22% | 23% |
| Very Likely ≥ | 44% | | | | | | | | rf27 | | | | | | | | | | | | | |
| | 40% | | | | | | | | | | | | | | | | | | | | | |
| Likely | 39% | | | | | | | | | | | | | | | | | | | | | |
| | 32% | | | | | | | | | | | | | | | | | | | rf8 | | |
| | 31% | | | | | | | | | | | | | | | | | | | | | |
| | 30% | | | | | | | | | | | | | rf20 | | | | | rf24 | | | |
| Neutral | 29% | | | | | | | | | | | | | | | | | | | | | |
| | 28% | | | | | | | | | | | | | | | | rf7 | | | | | |
| | 27% | | | | | | | | | | | | | | rf25 | | | | rf4 | | | |
| | 26% | | | | | | | | | | | | | | | | | rf9 | | | | rf17 |
| | 25% | | | | | | rf5 | | | | | | | | | | rf26 | | | | | |
| | 24% | | | | | | | | | | | | | | | | | | | | | |
| | 23% | | | | | | | rf12 | rf30 | | | | | | | | | | | | | |
| | 22% | | | | | | | | | | | | rf13 | | | | | | | | | |
| | 21% | | | | | | | | | | | | rf29 | | | | | | | | | |
| | 20% | | | | | | | | | | | | | | | | | | | | | |
| Unlikely | 19% | | | | | | | | | | | | | | | | | | | | | |
| | 18% | | | | | | | | | | | | | | | | | rf2 | rf1 | | | |
| | 17% | | | | | rf6 | | | | | rf11 | | | | | | | | | | | |
| | 16% | | | | | | | | | | | | | | | | | | | | rf15 | |
| | 15% | | | | | | | | | | | | rf21 | | rf16 | | | | | | | |
| | 14% | | | | | rf3 | rf10 | | | rf18 | | | | | | | | | | | | |
| | 13% | | | | | | | | | rf23 | | | | | | | | | | | | |
| | 12% | | | rf28 | | | | | | | | | | | | | | | | | | |
| | 11% | | | | rf22 | | | | | | | | | | | | | | | rf19 | | |
| | 10% | | | | | | | | | | | | | | | rf14 | | | | | | |
| Very Unlikely≤ | 9% | | | | | | | | | | | | | | | | | | | | | |

Low risk | Medium risk | High risk

# Annex 5: CPM prepared for the dissertation project accomplishment