A study of ICT risk management approaches in formal methodologies and practical application.

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Declaration

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own work, and has not been submitted as an exercise for a degree at this or any other university. I further declare that this research has been carried out in full compliance with the ethical research requirements of the School of Computer Science and Statistics.

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Abstract

Awareness of uncertainty and risk management in many sectors of personal, public and business activities have become one of the main challenges. When it comes to Information and Communication Technology (ICT) business sector, risk and uncertainty becomes even more relevant due to its fast evolution and complexity.

Efficient risk management in ICT projects has become one of the key awareness points for businesses involved or employing ICT (CJ Alberts, A Dorofee, 2002). There is a significant stream of research on risk management and mitigation, which resulted in a number of frameworks, recommendations and techniques aiming to make an ICT project manager's work more streamlined by following a proposed pattern in responding to a risk. Despite well-established project risk management processes, some ICT project managers perceive their application as ineffective to manage risks.

This research proposes to examine a case to investigate how ICT managers managed risks, their approaches, behaviours and actions. The focus is on differences between risk management techniques proposed by well-established project management guides and real actions undertaken by ICT project managers in response to risks in ICT projects. This will address the primary research question: "*Do current risk management practices, employed by ICT managers in complex ICT projects, differ from theoretical knowledge and how?".*

The research objective will be achieved using a case study based on a complex ICT programme, which was managed by the lead researcher between years 2014 and 2016. The research method is based on semi-structured interviews of ICT professionals involved in managing different parts of the selected case programme.

Survey data analysis confirmed that the risk management often deviated from the case programme guides and in some cases was different from what industry best practices prescribe due to different factors faced during the course of their projects. Identification of those factors was a secondary target of the research, which was completed and summarised.

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1. Introduction

1.1. Introduction

The application of knowledge in creation of certainty is a tendency of the human mind (Ahmed & Bakhsheshi, 2009). Awareness of uncertainty and risk management in many sectors of personal, public and business activities have become one of the main challenges. Frank Knight distinguished between two types of uncertainty: uncertainty risk, when we know the potential outcomes in future; and genuine uncertainty, which occurs when we don't even know the possible outcomes in advance. Genuine uncertainty occurs in complex systems, for example in the economy. Uncertainty risk is normally a result of application of knowledge, experience or information during the planning process (Knight, 1921).

When it comes to ICT, risk and uncertainty becomes even more relevant due to its fast evolution and complexity. As ICT is a constantly changing environment, effective risk management has become one of the key awareness point for businesses involved or employing its deliverables. Managers involved in this sector understand that circumstances change and unforeseeable events occur very often. While they can't read the future, they can make smart choices to prepare for it using information or knowledge available to them in a systematic manner. A systematic approach is the most common and is described by a number of well-known risk management methodologies and theories. Meyer, Loch & Pitch (2011) emphasise the need to establish improved project information system from the outset, developing a model with a 'rigorous language' that allows the Project Manager to judge the adequacy of project information.

ICT project management is a well-researched knowledge area with a number of established formal methodologies and techniques, which will be reviewed further in this research. Although they provide a comprehensive and systematic approach into what practices are necessary for an ICT project risk management to be effective, does the real-life practice follows these defined procedures in ICT projects?

The purpose of this research is to identify differences between real-life practical risk management approaches and recommendations in established practices (PRINCE2, PMP/PMI, COBIT5 and others). The current research is based on a case study of an ICT project implementation, which took place in a well-known insurance company. The research will review the details of risk management approaches in this implementation

through semi-structured interviews of case ICT programme participants. The results of this study will be compared to existing formal ICT risk management methodologies to identify gaps and potentially propose enhancements.

1.2. Research Background

The rationale for choosing this topic is based on researcher's experience in ICT projects delivery, requirements gathering, risks, scope and change management. During the course of the ICT projects the author has been managing it became clear that risk management and mitigation critical activity, which directly impact project's quality, timeline and cost.

A significant stream of research on risk management and mitigation, which resulted in a number of frameworks, recommendations and techniques aiming to make an ICT project manager's live easier by following a proposed pattern in responding to a risk. Despite well-established project risk management processes, some project managers perceive their application as ineffective to manage risks (Kutsch & Hall, 2005). The purpose of this research is to investigate how ICT project managers managed risks, their approaches and behaviours, in particular risk response actions in environments where project requirements change and evolve frequently.

Software development projects often have a poor delivery record with most delivering late and over budget, many being cancelled, and only a few delivering software that meets the customer's full requirements on-time and within budget (Love, Fong & Irani, 2005). A project's schedule and budget are determined and committed to in the early stages of the project when often little is known about the risks, business challenges and needs, which then reflect on changes to an existing ICT project.

Business opportunities and business needs are the most common drivers for the ICT projects to be initiated and delivered. The deliverables of such projects are often considered as a solution to current or future business problems or opportunities. ICT assets lead to business value through their impact on a business value chain, which consists of the sequence of processes that create value: dreaming up a solution, building that solution, and then delivering the solution as a service that meets the business need or capitalizes on the business opportunity (Curley, 2004).

In today's climate of cost cutting and efficiency targets, delivering the ICT change more effectively is a key objective (Davila & Wouters, 2004). This means delivering the right mix of programmes and projects, consistently, faster and at lower cost. The need

to deliver business strategy whilst ensuring value for money with reducing resources has focused attention on ensuring that business investment is spent on things that matter to an organization.

1.2.1. ICT Projects

A project is a temporary activity undertaken to create a unique product, service or result (Guide, 2001). It is temporary with a defined beginning and end in time, and therefore defined scope and resources. It is unique in that it is not a routine operation, but a specific set of operations designed to accomplish a singular goal. So a project team often includes people who don't usually work together, sometimes from different organizations and across multiple geographies.

The common definition of ICT projects is quite wide depending on the industry, project deliverables, business challenges, stakeholders involved and other factors. ICT projects could also be referred as IT projects of IS projects. Often Information Technology professionals apply three alternative meanings of the term ICT project from available material (Smyrk, 2007):

1. A project with at least one IS (Information Systems) or IT (Information Technology) component amongst its outputs;
2. A project undertaken within the IS/IT functional unit of a company;
3. Any project in which all outputs and deliverables take the form of IS/IT artefacts.

For the purpose of this research author decided to use only the third definition, where an IS/IT output as an artefact taking the form either of software or of computing infrastructure.

1.2.2. ICT Risk Management

Definition of risk was described by Hubbard as the probability of a loss, disaster or other undesirable event (Hubbard, 2009). This definition, however, lacks another angle of risk, which could be defined as a positive opportunity risk, which is proposed by PMI/PMP project management framework. This kind of risk is treated as an opportunity or gain, which is resulted from an unknown dependency, process or impact (OGC, 2005).

Risk Management is the identification, assessment, and prioritization of risks followed by coordinated and economical application of resources to minimize, monitor, and control the probability and/or impact of unfortunate events (Hubbard, 2009); or to maximize the realization of opportunities. Risk management's objective is to assure uncertainty does not deflect the endeavour from the business goals (Antunes & Gonzalez, 2015).

ICT risk is a risk related to ICT, and is a new term due to an increasing awareness that information security is simply one part of a broader risks that are relevant to ICT. ICT Risk is generally defined as the combination of the probability of an event and its consequence (Piccoli, 2013). COBIT 5 for Risk defines ICT risk as business risk, specifically, the business risk associated with the use, ownership, operation, involvement, influence and adoption of IT within an enterprise (Bernard, 2012).

According to Office of Government Commerce, project failure could be determined by a number of business and ICT alignment factors, including: lack of clear links between the project and the organisation's key strategic priorities including agreed measures of success; lack of clear senior management ownership and leadership; lack of effective engagement with stakeholders; lack of skills and proven approach to project management and risk management; lack of effective project team integration between clients, the supplier team and the supply chain and others. All these factors at the very beginning could be considered as risks to ICT projects, and require systematic risk management activities around them. When dealing with uncertainty and ambiguity, project managers are often use the well-established risk management practices, but some perceive these practices as not effective for managing the unknown within their projects.

According to the standard ISO 31000 the process of risk management consists of a number of steps including:

- Identification of risks in a selected domain of interest;
- Mapping risk scope, objectives and stakeholders;
- Defining a framework for the activity and agenda for risk identification;
- Developing an analysis of risks;

- Developing mitigation or solution of the risk response within the resource and timeframe boundaries.

As prescribed by PRINCE2, risk management purpose is to identify, assess and control uncertainty and, as a result, improve the ability of the project to succeed. Management of risks must be systematic and should not be based on a chance. It involves proactive management, control and mitigation with the aim to make a cost-effective decision if a risk is materialised.

The most common limitation of risk management is time consumed and uncertainty involved in the process. This is especially significant, when a particular piece of work is on standby before the risk is considered as complete, mitigated, closed or intensively ignored. Often this impacts an ICT project's schedule and cost in a negative manner. Project managers while managing an ICT project are therefore impacted by the ambiguity and face dilemma to either continue towards completing the assignments or wait until the uncertainty is addressed.

For the purposes of this research, ICT risk definition will be aligned to the COBIT5 ICT risk description, where ICT risks are closely tied in with business values and expectations. This ICT and Business connection is the key for the research undertaken for this thesis, as the frequent changes in ICT projects are closely related to Business changes.

1.3. Research Question

This research investigates if there is a gap between established industry best practices in managing risks in ICT projects (discussed in Chapter 2) and real-life actions undertaken to minimise risks impacts by ICT managers (discussed in Chapter 3). To the best knowledge of the researcher there has been a number of researches (Ahmed & Bakhsheshi, 2009 and others), which tried to address difficulty of the risk management. Although they provide a fully comprehensive and systematic results and recommendations into what practices are necessary for an ICT project risk management to be effective and why they are effective; there is an overall lack of consistency in ICT risk management research with different definitions, dependent variable ambiguity and variations in the type of impact measured. The below reviewed academic literature supports the view that the use of formal processes, defined procedures, and frequent points of risk evaluation are generally related to more effective practice. However, as per practical application of the risk management

techniques by the researcher, real-life practice doesn't often follow these defined procedures depending on circumstances and impacts to an ICT project.

The research is justified for a number of reasons. First, the high cost and strategic importance of many ICT projects, which means that evaluation risks of these projects is important (Smithson & Hirschheim, 1998). Second, IT projects continue to experience high failure rates (Love, Fong & Irani, 2005).

The primary question being asked in this research is: "*Do current risk management practices, employed by ICT managers in complex ICT projects, differ from theoretical knowledge and how?*" This question will be addressed by studying the well-known theories and examining the actual practices based on case study. The question addressed by this research is of interest, significance and value for both research and practitioner communities. In particular, improvements to the risk management in ICT projects may lead to more effective project management and improve the rate of ICT project success.

This study contributes new knowledge with respect to the following key points:

1. What practices are being used by ICT managers to manage risks in complex ICT projects?
2. Recommendation on how the industry best-practices could be enhanced.

As per the author's experience, there is a link between effective risk management practices and project success. In the context of this research, investigated risk management real-life practices will highlight and potentially enhance decision making and knowledge application to solve problems in other ICT projects.

1.4. Justification of the Research

ICT has revolutionized business operations in the recent decade. In shaping the structure and functions of work organizations modern information technology is considered one of prime movers among all industries (Prencipe, Davies & Hobday, 2003). With growing demand for quality computer systems, managing risks during various stages of creation and deployment of information systems becomes key element to success. The exploration of how experienced managers approach the risk management provides understanding of well-established processes that are not always being applied in practice. The research aims to find differences between formal methodologies and real practical application of risk management. Determining

strategies to address risks in ICT projects can aid researchers and practitioners in developing better project risk management techniques and can also be used to develop further training programs for those managers, who are just starting managing complex ICT projects. The research will also contribute to the field of ICT project management body of knowledge.

1.5. Research Design

The overall approach of this research will follow a qualitative paradigm. Denzin and Lincoln (1994) define qualitative research as: "*a multi-method in focus, involving an interpretive, naturalistic approach to its subject matter. This means that qualitative researchers study things in their natural settings, attempting to make sense of or interpret phenomena in terms of the meanings people bring to them. Qualitative research involves the studied use and collection of a variety of empirical materials based on a case study, personal experience, introspective, life story interview, observational, historical, interactional, and visual texts-that describe routine and problematic moments and meaning in individuals' lives*". Creswell (1994) defines it as "*an inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. The researcher builds a complex, holistic picture, analyses words, reports detailed views of informants, and conducts the study in a natural setting*".

The above definitions do not contradict each other and will be used as the basis for the current research. It will begin with a single focus on ICT risk management. The study will include detailed methodological approach to data collection, data analysis, and report writing. This will verify the importance and actuality of the research question. To ensure latest actual data is used for the research, semi-structured interviews have been organised with ICT professionals participated and managed complex ICT projects. These interviews have explored risk management decisions made by ICT project managers during their projects and examined how these decisions deviated from well-established frameworks drown from standard risk management guides typically recommended to practitioners.

The thesis has:

- Explored industry best-practices of ICT project risk management;
- Identified best suitable research approach to answer the research question;

- Identified risk management practices applied by ICT managers involved in the case ICT programme;
- Analysed the research data gathered; and
- Provided research results and proposed further research.

1.6. Dissertation Roadmap

The dissertation is constructed as follows:

- Chapter 1 provides background information on the study. It also introduces the research topic and research objectives. The scope of the research and the beneficiaries are discussed along with the rationale for the study.
- Chapter 2 consists of bodies of literature review.
- Chapter 3 describes the research ontology and methodology adopted for this research. It discusses the methods by which the research was conducted, how the participants were accessed and the process used to gain ethical approval.
- Chapter 4 describes and analyses the data gathered during the research.
- Chapter 5 provides conclusions and proposal for future work.

2. Literature Review

2.1. Literature Review Introduction

A review of past literature is a crucial endeavour for any academic research (Webster & Watson, 2002). One of the main reasons for conducting the literature review is to enable researchers to find out what is already known in the academic and well established literature and guides. Webster and Watson (2002) criticized the Information Systems (IS) field for having very few theories and outlets for quality literature review. Moreover, they noted that the IS field may greatly benefit from effective methodological literature reviews that are "*strengthening IS as a field of study*". An effective literature review should analyse quality literature, provide foundation to a research topic, provide a firm foundation to the selection of research methodology, and demonstrate that the proposed research contributes something new to the overall knowledge. The output of the literature review process should demonstrate that the proposed research contributes something new to the overall body of knowledge.

The below literature review was completed by analysing key ICT project management theories, knowledge databases and industry-accepted risk management frameworks. The identification of relevant literature was based on an examination of papers through manual review. The aim of the literature analysis was to investigate the available information related to ICT risk management techniques, experiences, guidelines and theories.

This chapter will summarise current literature, research and what others have done in the topics of the dissertation, including the application area and in the various methodologies applied. These methodologies primarily based on existing knowledge, gathered from experiences of other project managers involved in software development.

- Section 2.2 will expand the definition of knowledge.
- Section 2.3 will explain the connection between ICT risks and business value chain.
- Section 2.4 will expand the definition of ICT project management;
- Section 2.5 will review the ICT Risk Management in Public Literature.

- Section 2.6 will cover the ICT Risk Management Industry Best Practices.
- Section 2.7 will conclude the literature review.

2.2. Definition of Knowledge

Recognizing the importance of knowledge as an organizational asset, Thomas Watson, the legendary CEO of IBM, once stated, "*All the value of this company is in its people. If you burned down all our plants, and we just kept our people and our information files, we should soon be as strong as ever.*" As defined by Piccoli, knowledge can be seen as a blend of actionable information built over time based on accumulated experiences and the understanding of a phenomenon (Piccoli, 2013).

When it comes to knowledge there are different kinds of knowledge and different ways of acquiring each kind. On one side is theory and on the other side is the practical application of theory generating personal practical knowledge. Learning process is directly related to different ways of acquiring available knowledge. Practical knowledge and theoretical knowledge both are important phases of learning.

The key knowledge is always based on information currently available for such planning. Information is a "*fuzzy*" concept, which has become the subject of economic analysis in the past 100 years (Rose, 1999). Thus for the purpose of this thesis, the following definition will take precedence: information is that which can be exploited to reduce uncertainty in decision-making (Rose, 1999). Uncertainty is defined as the dispersion of individuals' subjective probability (or belief) distributions over possible states of the world (Hirshleifer, 1973). Therefore, information is a message that potentially can reduce uncertainty in an environment if applied correctly. In some cases, uncertainty also creates a market for information. When people are uncertain about future events, quality of products or services, they look to source information to reduce uncertainty (Fisher & Kingma, 2001). In this sense, information decreases the risk involved in complex environments. As defined by Bruce Kingma, risk is the potential for loss when uncertain future events may cause economic harm (Fisher & Kingma, 2001).

As the current research aim was to investigate how real-life risk management practices differ from practices proposed by the industry accepted frameworks, it's important to describe what is practical and theoretical knowledge. Theoretical knowledge provides historical research information about a topic to help understand why one technique works where another fails. It's often an essence of the experience of others. It can often lead to a deeper understand of a concept through seeing it in

context of a greater whole and understanding the why behind it. Theoretical knowledge can be communicated as theoretical descriptions, theoretical definitions, theoretical hypotheses, and theories. Theoretical knowledge of a subject is knowledge of the principles and ideas of the subject. This type of knowledge is gathered from the books and research papers on a subject.

Within this research, theoretical knowledge is defined as a knowledge obtained from academic papers, well-established theories and techniques currently available in the area of the research.

Practice, in turn, can be approached as an array of human activities that are "*embodied, materially mediated arrays of human activity centrally organized around shared practical understanding*" (Schatzki, Knorr-Cetina & Von Savigny, 2001). This means that practice depends on shared skills, understandings and assumptions. Practice, therefore, refers 'not only to what one does, but also to how one thinks about what one and others do (Raelin, 2005). Practical knowledge can also be defined as the ability to put into effect previously acquired knowledge in specific circumstances. Practical knowledge helps acquire the specific techniques that become the subjective experience. It is much closer to the actual day-to-day work than theoretical knowledge. Where theory is often taught in the ideal of a vacuum, the practical is learned through the reality of life, practical knowledge can often lead to a deeper understanding of a concept through the act of doing and personal experience. It may include breaking established rules and the creation of alternatives to solve problems. It is often subjective, since it includes personal experience, feelings, intuition and social factors.

By the researcher's experience, sharing and learning practical knowledge is often a challenge. Some researchers like Leonard and Swap addressing knowledge transfer in their Deep Smarts idea, when in order to transfer judgment and knowledge of experienced people, it is necessary to use active learning strategies, such as guided observation problem-solving and experimentation. While an experienced person might be unable to explain how a particular action is done, he or she might successfully cope with the tasks because of the subjective experience been gathered in the past. Learning-by-doing, learning-by-experimenting and learning-by-failing techniques for sharing can be adequate.

2.3. ICT Risks in Business Value Chain

To address objectives of this research concerning the ICT Risk Management, it's also important to demonstrate one of the common driver of the risk in ICT projects – business risk. Business risk is a factor, which can directly and indirectly impact progress, change objectives and other factors of the project.

Enterprises exist to create value to their stakeholders. Value creation means realising benefits at an optimal resource cost while optimising business risks. Benefits may take many forms, e.g. financial for commercial enterprises or public service for government entities. Alignment with ICT and business risk optimisation are one of the key areas of value creation in most firms. The alignment between business processes and supporting software systems is currently a top research topic. It's important to expand this area of ICT and business collaboration to display connections and drivers of the ICT industry. Nowadays business around the globe understand that they can't be competitive on their markets if their business and ICT strategies are not aligned. Alignment only exists when goals, activities and processes of a business organisation are in harmony with information systems supporting them. In literature, different terms are used to refer the alignment concept: Porter called if *fit* (Porter, 1996); Ciborra identify it as *bridge* (Ciborra, 1997); it's also called integration (Weill & Broadbent, 1998)*; harmony* (Luftman, Papp & Brier, 2000) and others.

A view of business and technological alignment defines at which degree the information technology mission, objectives, and plans, support and are supported by the business mission, objectives, and plans (Carvalho & Sousa, 2008). Key tasks of such alignment is to identify and match strategic touch points between business and information systems. Several approaches were proposed to address the alignment task. One of the first model was SAM – Strategic Alignment Model (Henderson & Venkatraman, 1993). Different studies were later performed for evaluating these models. For example, the SAM model was used in financial service firms for determining if it was useful to assess strategic alignment between IT and business. In the general aspects concerning modelling was debated and a modelling issue was proposed. In particular, the VMOST – Vision, Mission, Objectives, Strategies and Tactics – analysis was treated to split the business strategy into the main components of vision, mission, goals, strategies and tactics, and the BRG – Business Rules Group – model was proposed for modelling the organization's systems. De Castro proposed the MDA – Model Driven Architecture – tool was used to support the alignment

management, and meta-models were proposed for representing the entities involved in the alignment analysis (De Castro, Marcos & Vara, 2011).

One of the first papers, addressing integration of business processes with information technology was Painter et al.'s work (Painter, Fernades, Padmanaban & Mayer, 1996). Major contribution of the paper is that it recognises ICT as an intermediate layer between business processes and information technology. However, in this paper, ICT is not treated as the main driver for business value, instead it's seen as business enabler supporting operations.

2.4. Definition of ICT Project Management

As per the researcher's experience, ICT project management is a broad area of knowledge and skills with wide range of literature, theories and recommendations of best approaches to plan and manage ICT projects of any size and complexity, offering extensive set of established practices and procedures to be followed in order to achieve desired project output. Projects are separate to business-as-usual activities, requiring people to come together temporarily to focus on specific project objectives. As a result, effective teamwork is central to successful projects (Piccoli, 2013).

As defined by Cambridge Dictionary, a project is a piece of planned work or an activity that is finished over a period of time and intended to achieve a particular purpose. ICT projects are often different to traditional project management techniques because a high level of dependencies and unknown about software development approaches, design, testing and issues related to deployment to business environment (Piccoli, 2013). The key participants of any ICT projects are Project Manager, appointed to manage the execution of the project; Project Sponsor, who is ultimately responsible for organising the commercial part of the project stream; and project team, responsible for creation of a requested solution (Dolan, 2010). For the purposes of the current research, author will not be paying attention to the commercial aspects of ICT project management, so the role of Business Sponsor will not be expanded here.

ICT project management includes overseeing projects for software development and implementation, hardware installation, network maintenance, cloud computing, business analytics and data management projects and ICT services implementation (Piccoli, 2013). Normally managing projects consists of the project management life-cycle with specific phases outlined in the below list (Mulcahy, 2011).

- Initiation is the stage, where project is being officially started by Business Sponsor. The stage requires a project manager to be appointed and goal of the project defined.
- Planning stage is kicked next. It requires the project manager and the project team work together to plan all of the needed steps to reach a successful project conclusion. The project planning processes are iterative in nature and it's expected that planning will happen often throughout the project.
- Execution – once the project plan has been created, the project team goes about executing the project plan to create the deliverables of the project. The project can shift to project planning as needed throughout project execution.
- As the project is being executed by the project team, the project manager monitors and controls the work for time, cost, scope, quality, risk, and other factors of the project. Monitoring and controlling is also an ongoing process to ensure that the project addresses its targets for each project objective.
- Closing is the last phase of an ICT project which comes at the end of each phase and at the end of the entire project. Project closure happens to ensure that all of the work has been completed, is approved, and ultimately transferred ownership from the project team to operations.

Project management also contains knowledge areas to manage the project scope, schedule, people management, costs management, quality assurance, communications, risk management, procurement and others (Mulcahy, 2011). These back up a better control over project work streams. The most challenges ICT project managers face are related to balance schedule, quality and cost to deliver scope of the project (Figure 1).

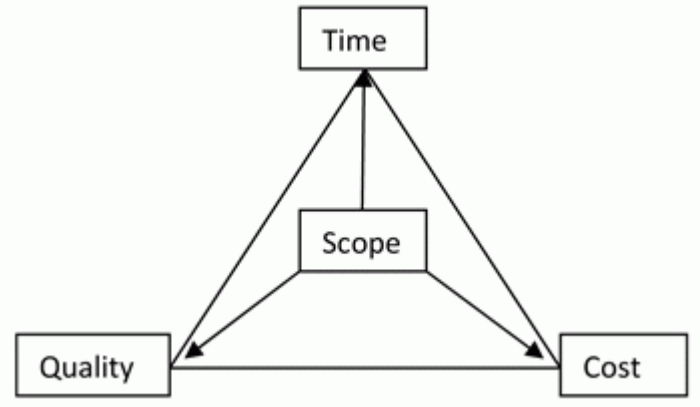

Figure 1 ICT Project Management triangle (Phillips, 2013)

There are several different approaches to managing an ICT project that affect the project life cycle. They designed to reduce risks, improve control over the project execution and timeline. There is a number of IT project management life cycle types exist, and most of them could be divided into two categories: waterfall and agile (Wysocki, 2011).

Waterfall is a traditional project management approach to manage ICT projects. It name represents the nature of the approach as the project “waterfalls” down the phases (Hass, 2007). It is divided into phases, which are executed in sequence, but never in parallel. Appointed project manager and the project team first define the project scope, project schedule, and expected project costs before the project execution begins. As part of the project planning it’s typical for the phases of the project to be defined in advance.

Agile refers to an iterative, incremental method of managing the design and build activities of engineering, information technology and other business areas that aim to provide new product or service development in a highly flexible and interactive manner (Highsmith, 2009). It promotes adaptive planning, evolutionary development, early delivery, and continuous improvement, and it encourages rapid and flexible response to change (Alliance, 2006).

These software development life cycles use the concept of phases to move the project work forward (Highsmith, 2009). A phase describes the type of work that will take place in that portion of the project. The project manager, the organizational requirements, and even customer requirements can influence what type of project life cycle the project manager will adapt in the project.

By the researcher's experience, the above reviewed life-cycles influence project management style and risk management approaches throughout the projects.

2.4.1. Risk Management in Waterfall and Agile Projects

In respect of choosing a methodology for an ICT project, a project manager can either follow the organisation standard or in some cases switch to another one, which could fit the project purpose. A traditional methodology for ICT projects for many years was "waterfall", which could be described as a heavily planned set of sequenced milestones throughout the project. "Agile" is a relatively new approach, which is more adaptive to external changes. It employs less planning, but more interactions with more frequent interim results review. Figure 5 below displays the difference visually.

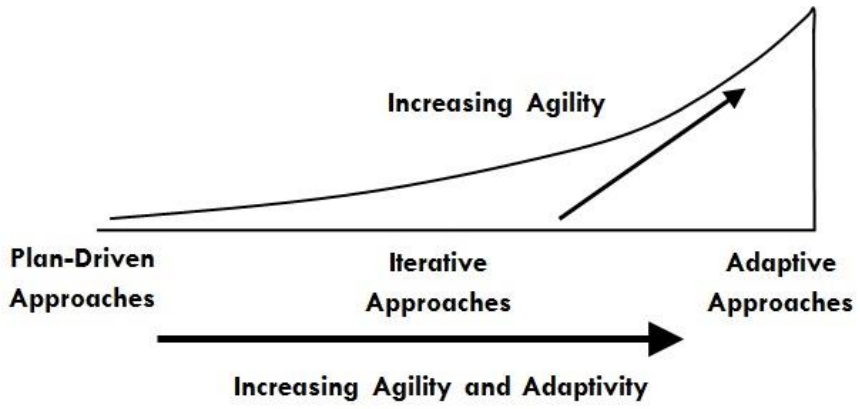

Figure 2 Comparison between Waterfall and Agile management approaches

It is common to select an approach for each project individually to ensure projects objectives could be delivered in the most effective manner. It is also common to use combined approach, where waterfall is used for overall commitment to a client, and agile is in use for internal iterative software development approach. This combination brings best from both methodologies in managing overall project and low level risks.

Waterfall model is when each project phase takes place in sequence, so that progress flows steadily downwards like a waterfall (Hass, 2007). In this traditional approach the requirements of the project are typically well-defined in advance of an active phase of the project. Waterfall approach often being associated with PRINCE2 and PMP/PMI project management frameworks, that will be reviewed further in this thesis. However, these frameworks could also be applied for more flexible approaches,

like Agile. Pros of waterfall approach could be expressed, but not limited to, the following way:

- Potential issues that would have been found during development can be researched and expanded during the initiation/design phase. If appropriate an alternative solution for project delivery could be selected before any code is written.

- During the active phase, the development process often is better documented, since this methodology places greater emphasis on documentation like requirements and design. It provides an additional reassurance and confidence that the project can deliver the expected result.

- Because the waterfall process is a linear it is easier to understand and follow, especially for non-technical resources or those new to software development.

However, there is downside of this approach, which could be expressed in ambiguity in the exact needs of the business sponsor, as they may shift with time and technologies could be changed or improved, which would require an additional effort to keep up to the market (Wysocki, 2011). Another problem is related to solution design, which often can't predict how the newly built system will be consumed. This often leads to another issue, which is related to changes of the requirements during the course of the project. It is common that business environment is evolving quite fast, which impacts the projects expected outputs. This means risks should always be identified and monitored throughout the course of the project, which often requires quite a lot of effort and micro-management. Normally the changes can't easily be incorporated due to the complexity of planning related to the overall management.

Project failure would be associated with failing to deliver the requirements within the agreed cost and schedule allocated for the project (Agarwal & Rathod, 2006). The approach works well, when it is possible to accurately define the requirements of the project before it starts and three is a reasonable level of certainty about the project risks and ambiguity level. However, the downside of this approach is that it's not always possible to plan risks well ahead and estimation about risks likelihood might not be accurate.

More adaptive **Agile** approach is best in situations where it is more difficult to define detailed requirements for the project at the beginning, and there is far less certainty of

what is required to produce the appropriate business output. Simply by employing Agile, ICT projects could reduce some of the risks associated with uncertainties which could lead to scope-creep, by reviewing business requirements and adapting to them more frequently.

Instead of extensive planning and design up front, Agile methodologies allow for changing requirements over time by using cross-functional teams, that incorporate planners, designers, developers and testers (Highsmith, 2009). They normally work on short iterations (Figure 6) of the product over fixed time periods. The work is organised in to a backlog that is prioritised in to exact priority order based on business value (Schwaber, 2004). And being delivered more often to client or business sponsor for a review and amendment, if needed. The goal of each iteration is to produce a working product, which can be demonstrated to stakeholders. Feedback can then be incorporated into the next or future iterations.

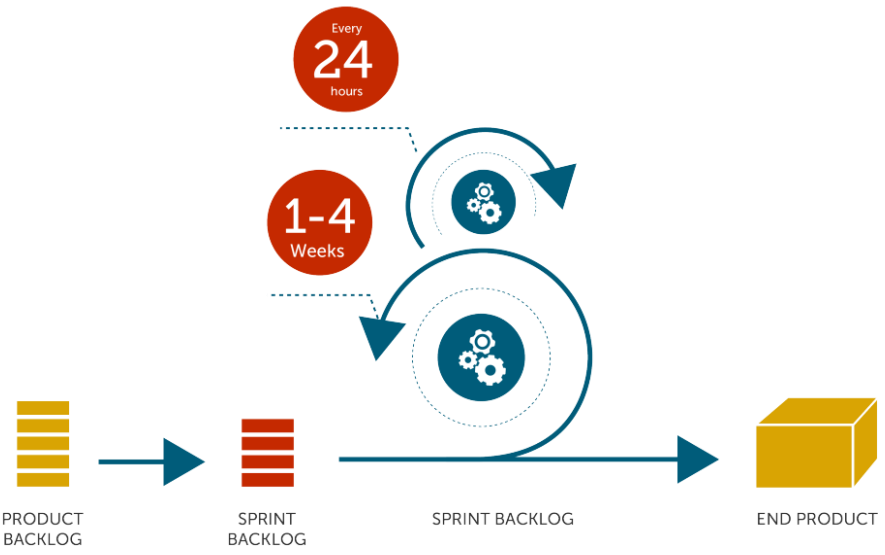

Figure 3 Agile methodology: project deliverables life-cycle (Bowes, 2014)

Agile methodologies have a number of advantages, like (Highsmith, 2009):

- Working software is delivered much quicker.
- There is closer collaboration between ICT project team and the business stakeholders.
- Changes to requirements can be incorporated at any point of the process.
- It gives the opportunity for continuous improvement for live systems.

- It is highly transparent.

The downside of Agile methodology is based on complexity of management the short iterations, which often are difficult to understand by new member of ICT project team of business stakeholders. It also requires adjustments of some business processes in an organisation, which should follow the short-term iterations. Another problem is related to project documentation, which often being compromised towards the working software. This impacts the overall project knowledge, which stays within the ICT team.

2.5. ICT Risk Management in Public Literature

As described by G. Piccoli, IT risk management is a process by which the firm attempts to identify and measure information systems risks related to systems security. The process is needed to identify the optimal mitigation strategy for various ICT security threads. Piccoli specifically stating, that such security risk management is an exercise with no revenue creation or return on investment. Instead, it limits the possibility that future negative fallout will happen. Because the results of the security risk management are difficult to gain funding for, especially when competing with other ICT related streams, like systems enhancements and ICT product development; it's often quite hard for ICT managers to allocate enough resources to risk management activities. A recommended approach for forward-looking ICT professionals is to treat and present ICT risks as possible scenarios, where business may suffer from financial losses. Quantification and analysis of these losses, increases awareness of various ICT risks and sometimes backs up additional contingency in ICT projects to deal with uncertainties, security issues and other risks.

Piccoli also refers to risk management procedures, like risk assessment and risk mitigation (Piccoli, 2012). Definition of which does correspond to PRICE2, PMP and other frameworks, which will be expanded further in this research.

As presented by Richard Heeks in his Risk Management practices review, ICT projects are open to two key risks: quality related problems and failure to manage processes within wider ICT infrastructure while applying a change (Heeks, 2006). R. Heeks proposes to have the risk management activity to be part of overall ICT management strategy. A reference to risk registers, mitigation plans also exists in his papers, which is a widely-accepted hands-on approach. One of the key definitions, outlined in his paper, is difference between ICT management and control and risk

management. In particular, risk management is looking into the future and raising questions like: what could go wrong or what if one part of an ICT system fails. Professional managers dedicate time and efforts into brainstorming these questions, which often result in specific plans to avoid uncertainty and plan for worst case scenarios. This activity called risk analysis and its definition in the paper has the same meaning as described in the previous paragraphs of this research. As presented in Heeks paper, risk analysis leads to a risk management plan, which is a statement of the risk and intensity of the risk management to be applied (Heeks, 2006). The paper also presents key activities, like risk assessment, impact analysis, prioritisation, mapping to business processes and business objectives, identifying risk responses and risk owners, and so on.

Another important risk factor, referred by Heeks, is quality management. Quality management directly refers to quality of the overall ICT system, and when managed poorly, have a great chance to negatively impact on business benefits, expected from this system. According to ISO standards, quality is "*the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs*" (Cadle & Yeates, 2004).

Given the many problems that continue to occur in the ICT project arena, the question of how project risk management is handled in the ICT field is clearly of interest and is the aspect of ICT project management focused on in this thesis. Larson and Gobeli state that project failure is related to poor planning and lack of organisational support; lack of top management engagement, poor definition of user requirements, unrealistic timelines and inadequate budgets (Larson & Gobeli, 1989). Cannon (1994) and Whittaker (1999) argue that a definition of project failure varies amongst organisations, but they all measure failure in terms of budget overruns; time overruns; and failure to deliver promised functionality. Jiang, Klein and Ellis (2002) suggest that project failure is directly related to managerial inability to manage time and budget constraints. In this research, project failure definition will follow Cannon and Whittaker, as budget and time overruns and the inability to deliver the promised functionality.

Many ICT project management researches argue that stricter application of project management techniques in risk identification and management, is the best way of dealing with uncertainties typical to software development project management (Keil, Cule, Lyytinen, & Schmidt, 1998). Risk management in many forms is widely used in software project management. Normally it's applied to the whole project life cycle from initiation to production deployment and project closure.

There are many definitions of risk management. McLeod and Smith's definition suggests that project risk comprises chance encounters with events that may prevent the achievement of the project goal (McLeod & Smith, 1996). Philips explains risk management as a set of tasks that address any potential problem in a project, and includes risk planning to deal with possible problems and appropriate actions (Phillips, 2004). Schwalbe explains that risk management is a set of principles whereby the project manager continually assesses risks and their consequences, and takes appropriate preventive strategies (Schwalbe, 2000). Within the current research, author defines risk management as the sequence of actions occurring throughout the project life cycle and which the project manager continually assesses the potential negative effects of uncertainties and provides strategies and responses to minimize their effects on the project. Risk assessment should occur throughout the project life cycle. The work associated with the risk management task varies with the size of the project, and its importance to the business.

Alter and Ginzberg explored various options of uncertainty assessment in ICT projects (Alter & Ginzberg, 1978). They proposed to treat ICT changes as special kind of organisational change and that the ICT discipline would benefit if theories of organisational change were adapted by relevant project managers. They identified eight risk factors relevant to IT projects and suggest risk-reduction strategies for each of them as outlined in Table 1 below.

Type of risk	Proposed mitigation
Lack of user participation or involvement	Motivate users to participate and obtain commitment
Multiple users and designers have different view of what the project will deliver	Motivate users to participate and obtain commitment
Staff turnover	Obtain management support, and offer training for new system
User requirements unclear and too broad	Adopt modular approach, prototype system
Lack of Top Management support	Broadcast progress, motivate organisation
No prior experience with systems	Keep systems simple

Unpredictable impact - inability to understand how all stakeholders will accept the new system	Obtain management support
Technical problems cause cost blowout due to lack of understanding of new system.	Keep system simple, use a modular approach

Table 1 Risk mitigation (Alter & Ginzberg, 1978).

The proposed mitigation actions against risks in Table 1 are not complete and can vary depending on size, complexity and industry. From author's experience there are much more to the mitigation strategies, which could be proposed, adopted and managed. Organisations are often expecting to acquire the latest ICT technologies to increase benefits and ensure future-proof systems are in use. However, often new technologies are riskier to implement and run. It's common for companies, when running for the latest technologies, ignoring potential risks associated with them. Boehm proposes that early detection and management of risk will lessen the long-term costs and result in fewer failed projects (Boehm, 1991). He proposes that risk management is a tool designed to better manage the project life cycle and that risk assessment is an ongoing process that must occur throughout the project.

Schwalbe explains that risk management is often left without appropriate attention in ICT project management (Schwalbe, 2000). He states that risk management ensures that the project scope matched to realistic schedules, cost and performance expectations. Schwalbe proposes four parts of risk management:

- Risk identification
- Risk quantification
- Risk response development
- Risk response control.

According to Schwalbe, risk management should be costed and included in the total cost of the project. The success of the project is often measured by the project manager's ability to implement the following three element of Risk Management: avoidance, acceptance, and mitigation.

As a summary of examination of theoretical knowledge review, risk management is treated as one of the most important activities in ICT project management. The

literature proposes common strategies for preparing, assessing and managing risks. Many writers have proposed, tested and evaluated methods for improving risk management in ICT projects and minimising overall risks. A common approach is to ensure risks are identified and assessed. And then controlled throughout the whole ICT project by associated managers. It's also common to recommend early risk assessment, which helps evaluating project future and prepare for possible problems, which reduces the likelihood of project failure.

2.6. ICT Risk Management Industry Best Practices

ICT knowledge area contains many risk management frameworks, streamlining the quality and risk management processes. The most common frameworks are described further in this thesis.

2.6.1. Capability Maturity Model (CMMI)

One of these, of particular relevance to information systems, is the Capability Maturity Model Integration (CMMI) approach. Capability Maturity Model Integration provides a framework for improving the processes organizations use to develop and deliver products for their customers (Team, 2002). The process improvement concepts embedded in CMMI are based upon sound process management principles used in manufacturing communities for years (Gallagher, 2002). These principles have been successfully applied in software and systems engineering process improvement, and are codified for product development in CMMI. CMMI is widely used for development of software products and customised information systems, which takes a particular and process-oriented approach. This is a multi-stage framework, which consists of focusing on process improvement, process control and measure. Each step has its own definition and lead to set of processes.

This model also includes operational risk management procedure, which could also be adopted by ICT project managers in their projects to manage risks. The key aspect of this model is to identify potential problems before they occur, so that risk-handling activities may be addressed and planned as needed across the project milestones. In addition, risk identification and prioritization techniques could be adopted to justify of new ICT systems within an organisation.

The model proposes specific practises to manage risks, which consist of:

- Preparation for operational risk management, including determination of risk sources and categories, defining risk parameters and establishing an operational risk management strategy.

- Identification and analysis of operational risks, which includes identification, evaluation, categorisation and prioritisation of risks.

- Mitigation of risks where managers must develop and implement mitigation plans.

As part of the model, risk management is proposed to be managed from the very beginning of the projects, often at the contract level, which differentiate this model from other well-adopted best practices. This early risk management is tied in with vendor management in service organisations, which is one of the common approaches to outsource expertise, resources and technical development in ICT projects. Table 2 below describes the practices proposed by the model in detail.

Specific Practice	Definition
Determine risk sources and categories	To develop categories of risks that could disrupt the service organisation's ability to meet service performance objectives.
Define the parameters to analyse and categorise risks	To help manage resources and to protect service levels and objectives.
Establish risk management strategy	To implement risk mitigation strategy based on identified threats.
Maintain risk and mitigation log	To enable risk details tracking
Monitor status of each risk regularly	To ensure appropriate time for mitigation is selected.
Develop common risk mitigation plan	To reduce time dedicated for common risk management.

Table 2 Interpretation of Risk Management in Interpreting Capability Maturity Model (Herndon, Moore, Phillips, Walker &West, 2003)

Although the Capability Maturity Model Integration (CMMI) approach is designed for operational risk management, it's important to flag that any operational risk can impact an ICT project that the organisation is running. It also important to merge operational and project risks within an organisation to ensure integrity of risk management is cross operational.

2.6.2. Cobit 5 Framework

The ISACA organisation consists of professionals that are the trusted source of information technology knowledge, standards and certification. The organisation developed a well-established management framework Cobit 5. Cobit 5 is a comprehensive framework for managers that assists in achieving their objectives for the governance and management of enterprise information technology (ISACA, 2013). This framework was developed by ISACA, who is a well-established group of the professionals involved in information security, assurance, risk management and other governance aspects.

Throughout the other Cobit 5 guidelines, risk management is part of the foundation of the framework. The framework defines risk as the probability of an event and its consequence (ISACA, 2013), that enterprise objectives are not met. The framework defines ICT risk as business risk, specifically, the business risk associated with the use, ownership, operation, involvement, influence and adoption of IT within an enterprise (Bernard, 2012). IT risk consists of IT-related events that could potentially impact the business. IT risk can occur with both uncertain frequency and impact and creates challenges in meeting strategic goals and objectives.

According to Cobit 5 framework, risk is not always to be avoided. Running any business is about taking risk that is consistent with the organisation risk appetite. This means that many business endeavours require ICT risks to be taken into account, which should support the overall organisational risk management strategy. Organisations exist to create value, so the value creation is very common an organisational governance objective. According to Cobit 5 framework, value creation means realising benefits at an optimal resource cost while optimising risk (ISACA, 2013). The Figure 4 displays value creation as presented by the framework.

Figure 4 Cobit 5 Business value creation (ISACA, 2009)

Risk is generally known as a combination of the probability of an event and its consequence (Guide, 2009). Consequences are that organisational goals are not met. The framework categorises risks as follows:

- IT benefit/value enablement risk, which is associated with missed opportunities to use technology to improve efficiency or effectiveness of business processes.
- ICT programme and project delivery risk, which relates to the contribution of ICT to new or improved business solutions. Normally presented as projects and programmes as part of organisational investment portfolios.
- ICT operations and service delivery risk, which is associated with all aspects of the business as usual performance of ICT systems and services.

Prior to implementing this framework, each entity, organisation and location had its own set of risk management processes. Cobit 5 is targeting to develop and manage a single list of risk controls within an organisation. Organisational policies should be aligned with the risk appetite. Cobit 5 states that policies are a key component of an enterprise's system of internal control, whose purpose it is to manage and contain risk. As part of risk governance activities, the enterprise risk appetite is defined, and this risk appetite should be reflected in the policies. A risk-averse enterprise has stricter policies than a risk-aggressive enterprise.

2.6.3. PRINCE2 Framework

PRINCE2 framework was initially developed in response to a number of major project failures within government-sponsored ICT projects in United Kingdom of Great Britain. It was released in 1986 by the Office of Government Commerce UK and since then is one of the widely-accepted project management framework in the world.

The framework proposes a process-based approach to project management, providing an easily adopted and scalable method for the management of all types of projects. The model consists of four integrated elements:

- Principles. Seven good practices which need to be implemented to ensure the success of a project.

- Themes. Seven aspects of project management that must be continually addressed.

- Processes. A series of management activities to be undertaken by the team. Each process provides checklists of recommended activities, products and related responsibilities.

- Tailoring PRINCE2 to the project environment. As it should be tailored to reflect organizational and project-specific needs.

These elements are integrated with proposed by the methodology risk management approach. According to the framework risk management maintains a balance of focus on threats and opportunities, with appropriate management actions to minimize or eliminate the likelihood of any identified threat occurring, or to minimize its impact if it does occur, and to maximize opportunities (Dolan, 2010). The framework is proposing the risk review and tracking activity to be embedded within the project's life cycle and have a supporting procedure and structures to ensure that the appropriate levels of attention are being applied, with evidence of interventions and changes made to manage risks. The key difference from other frameworks, is that PRINCE2 proposes to focus on tracking the triggers that create risks.

According to the framework, risk is an uncertain event or set of events that, shout it occur, will have an effect on the achievement of objectives (Dolan, 2010). It is divided into two:

- Threat, which could have a negative impact on objectives; and

- Opportunity, used to escribe an uncertain event that could have a favourable impact on objectives.

This differentiate PRINCE2 from few other frameworks, in the sense that PRINCE2 also manages risks, which could impact the project in a positive way.

As a starting point for organisations, the framework proposes an identification of corporate or programme processes and policies to be applied, before a risk management strategy could be defined. This includes identification of current strategic or long-term risks, and risks on lower level, like project or process (Figure 5). An overall organisational risk policy should contain criteria like risk appetite, an organisation's unique attitude to towards risk taking which dictates the volume of risk that could be taken; and processes defined by a number of best-practice steps that managers could

undertake in order to manage a risk. The next step is to align PRINCE2 risk management recommendations with current organisational strategies and processes. This might require their re-definition and additional acceptance by all relevant parties. The framework proposes that key decision on risk management is done by the dedicated project Board or appointed Steering Committee, who are presented with different risk mitigation options and impacts associated with these options. The output of Steering Committee decision is an exception report, which describes actions agreed and additional resources proposed.

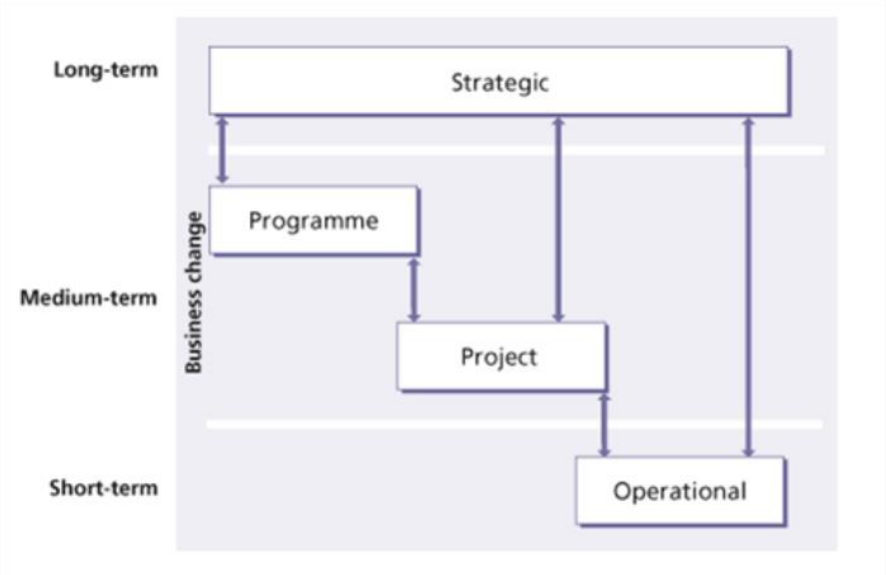

Figure 5 Organisational perspectives (Bentley, 2010).

The PRINCE2 approach is based on Management of Risk principles, which consists of the following points (Bentley, 2010):

- Understanding of the project context;
- Involvement of stakeholders;
- Establishing clear objectives;
- Developing the risk management approach;
- Reporting on risks on a regular basis;
- Define clear rules and responsibilities;
- Establishing a support structure for risk management;

- Monitoring for early warning indicators;
- Establishing a review cycle and look for continual improvement of processes.

The framework proposes these activities as part of the organisational or project risk strategy. It is recommended to have risk management strategy defined per each project including the means of risk control. The purpose of the strategy is to display how risk management is embedded into the overall management of a project. The framework also proposes a close involvement of project board. The board consists of business, financial, technical and other stakeholders interested in getting the project completed within its boundaries. The board must demonstrate its attitude towards risk taking, which reflects on the amount of risk that could be considered for the project. PRINCE 2 framework proposes to capture this information in a form of risk tolerances. And when the tolerance is exceeded, it's proposed to raise an exception to bring a situation to the attention of the board (Bentley, 2010).

The framework also proposes a number of artefacts to manage risks. The most important is risk register, purpose of which is to capture and maintain information on all of the identified risks and opportunities. The register can contain (Bentley, 2010):

- Risk owner
- Risk category, description and other relevant information
- Risk probability and impacts
- Risk mitigation plan or options
- Risk actions
- Risk early warning indicators

Such register is a quite common artefact, which is in use by many organisations including the ones working in ICT. Project manager is normally the key person to maintain the risk register.

PRINCE2 framework also proposes to manage early warning indicators, which are relevant to the project. The indicators could include performance data, progress comparison, requirements and change request tracking, defects tracking and so on. When risk occurs, PRINCE2 advises on a number of responses that could be

undertaken by the project team to reduce negative impact to the project. The responses are defined as (Bentley, 2010):

- Avoid risk, which means changing some aspect of a project in order to avoid the risk
- Reduce risk by managing its probability towards reducing the impact
- Fall-back, which is a reactive form of “reduce” response with no impact on likelihood
- Transfer response is when the responsibility over the risk is transferred to a third party, who is expected to manage it and in case of materialisation, absorb the impact
- Accept represents a decision to accept the risk and its impact, normally agreed by the project board
- Sharing risk is another form of response, where an organisation or a project is sharing the risk or opportunity with a third-party vendor
- Exploit response is normally applied to opportunities and proposes to seize it to ensure it to happen and the impact will be realised.
- Enhance response is also applied to an opportunity, with a purpose to enhance it probability and impact.
- Reject an opportunity is another response, which could be undertaken by the project team.

PRINCE2 framework also proposes to include risk budget into overall project budget. Depending on complexity of a project, risk budget could represent a significant part of the overall budget. Risk budget is a specific fund, which is dedicated to manage risk responses against threads and opportunities. The risk budget must be planned in advance of each project and should purely depend on project complexity and identified preliminary risks. The assumption is that risk budget is consumed over the course of the project (Bentley, 2010).

Overall PRINCE2 framework is widely accepted set of best-practices to manage different type of projects in various industries. This framework provides a great sense

of control over project and ensures all aspects are addressed. However, it is not tailored to a specific organisation or a project, and proposes to be adopted in order to maximise its effect.

2.6.4. PMI Framework

Project Management Institute (PMI) offers a comprehensive certification program for practitioners involved in project management of any level, skillset and educational background. The Project Management Professional (PMP) credential is accredited by the American National Standards Institute (ANSI) against the International Organisation for Standards (ISO) 17024.

A project manager must always handle many things to accomplish a project, including project constraints like time, cost, risk, scope, quality, resources, customer satisfaction, and any other factors that limit options. One of the major parts of PMP practice is risk management in projects, which presents a set of best practices to identify, communicate, maintain and mitigate risks. As per the framework, risk management includes risk management planning, risk identification, the qualitative and quantitative analysis of risks, risk response planning, and monitoring and controlling the risk responses (Mulcahy, 2011). Risk management is designed to increase the probability and impact of opportunities on the project (positive events), while decreasing the probability and impact of threats to the project (negative events).

This best practice program also includes terms like:

- Uncertainty, which is an important piece of information management and directly impacts the risk analysis and mitigation planning. As per the program, uncertainty is a lack of knowledge about an event that reduces confidence in a specific topic or further planning exercise.

- Risk factors represent probability of an event, range of possible outcomes, expected timing and anticipated frequency of risk events.

- Risk averse is a description of group of people or a person, who is not risk tolerant and doesn’t want to take a risk.

- Risk tolerance, which is a degree of risk that is acceptable to an organisation or a project. Risk threshold is part of risk tolerance and addresses a specific point at which risk becomes unacceptable.

The framework includes inputs and outputs of risk management (Mulcahy, 2011). The inputs might be details of project background, historical records from previous similar projects, lessons learned, company processes and procedures, organisational risk tolerances and thresholds, project resources management approaches, work breakdown structure and others. These inputs are very project specific and must be identified by the project team at the very beginning.

Between the inputs and outputs there is a risk management process, which the framework proposes to follow in order to keep control over the events and manage them to mitigate or eliminate risks. The proposed risk management planning process is number one step. It answers the question of how much time should be spent on risk management based on the needs of the project. It also answers questions such as who will be involved and how the team will go about performing risk management. Company procedures and templates related to risk, such as standard probability and impact matrices, are identified as part of this process and then adapted to the needs of the project.

The outputs of the risk management process could be categorised the following way:

- Methodology to define how the risk management will perform for the particular project.
- Roles and responsibilities would address practical question of who will do what.
- Budgeting section includes the cost of the risk management process, as it's a major part of the process overall in order to avoid or reduce threats and taking advantage of opportunities.
- Timing section of the plan would describe when it is more appropriate to take an action against risks or opportunities.
- Risk categories to ensure common risks could be addressed in a similar manner, eliminating double efforts.
- Description of impact and probability to ensure risk rating has its structure and is common between the project team.
- Stakeholder tolerances to ensure they are captured and adhered to.

- Reporting formats to propose a format in which risks and opportunities are presented and tracked.

However, all these outputs won't mitigate risk for a project manager. It's up to the manager to employ them and use at a particular moment in time in order to address the upcoming events that might impact the project. It's all down to the actual process of risk management, which is outlined in the methodology. The process consists of a number of steps (Mulcahy, 2011):

- Risk identification includes activities like project documentation review including contracts, requirements, expectations and schedule. It also includes other information gathering techniques like brainstorming and interviewing of stakeholders. A project manager, if he has been given enough resources, could also complete SWOT analysis, which would present all weak and strong parts of the project. As an output of this risk identification activity, the framework proposes to create a risk register, where all the risk relevant information would be kept and tracked.

- The next step is qualitative analysis, which includes risks probability and potential impacts to the project. It is a subjective analysis, which require a common understanding of the project inputs and outputs, as well as involvement of the entire project team. Probability impact matrix is one of the outputs of this activity. The matrix may be used to sort or rate risks to determine which ones warrant an immediate response and which ones should be put on the watch list. Another way to perform qualitative analysis is to complete risk data quality assessment to understand which risk have enough information and which ones are uncertain. This helps identifying follow-up actions like data review.

- Quantitative analysis involves numerical analysis of the probability and impact. This analysis is not subjective, but is based on known facts, which are presented in a form of numerical evaluation, which is easy to digest and manage. Although it's presents a greatly appreciated overview, it's not always possible to complete especially in ICT projects, when many parts are ambiguous. Monetary analysis is one of the most common way to complete the quantitative assessment, which improves ranking of risks.

- Plan risk responses activity is based on the above mentioned outputs and is only performed once enough information is gathered in order to be adequate. The main question project managers should focus on is “what should be done about each risk or opportunity?”. To answer this question, managers can propose risk response strategies to either avoid, mitigate, transfer or accept the risk. These risk responses are very similar to the ones presented in PRINCE2 framework. An output of this activity is not only updated risk register, but update project plan to incorporate contingency when required and amend work breakdown structure. Additionally, project documentation must be updated to flag all the necessary information and actions identified.

- Monitoring and controlling the risks is the activity performed during the course of the project and is essential to the overall risk management. The framework proposes a number of low-level activities to keep track of risks, which include: workarounds, when an action is required to get the project back on track if a risk has materialised; risk reassessment, which prescribes periodical review of risk management plan and adjust action plan as required; risk audits to identify lessons learned from previous risk mitigation actions; reserve analysis, which represents a review of remaining risk assigned resources; status meetings to flag any upcoming risks and opportunities and address any actions required by the project team.

All the results of the activities could be incorporated into the overall project risk register, which may become the key artefact for effective risk management. Other project documentation must also be kept up to date, especially project plans and work breakdown structure. Another best practice requires the project manager to constantly learn from organisational risk mitigation lessons in order to manage project risks effectively. However, it’s a quiet time consuming process, to which a manager might not have enough time.

2.6.5. ISO 31000 Risk Management Standards

ISO 31000 is a family of standards relating to risk management designed by the International Organization for Standardization (ISO). The purpose of ISO 31000 is to provide principles and generic guidelines on risk management. The standard seeks to provide a universally recognised approach for practitioners and companies employing risk management processes to replace the huge amount of existing

standards and methodologies. Using ISO 31000 can help organizations increase the likelihood of achieving objectives, improve the identification of opportunities and threats and effectively allocate and use resources for risk treatment (Purdy, 2010). Organizations using it can compare their risk management practices with an internationally recognised benchmark, providing sound principles for effective management and corporate governance.

The aim of this standard is to enable all strategic, management and operational tasks of an organisation to be aligned to a common set of risk management approaches and objectives. It also applies to individual projects within an organisation including ICT type projects (Purdy, 2010). ISO 31000 defines risk in a different manner as the other frameworks and standards do. The difference is in the concept of how the risk is seen by the organisation or a project: it is no longer a probability of loss or gain, but the effect of uncertainty on objectives. Uncertainty is presented as the most influential aspect of risk and risk management. This aspect is further explained in a number of most common grouping, as (Purdy, 2010):

- Risk information is not available yet,
- Risk information is available, but not accessible,
- Risk details are of unknown accuracy,
- Risk is subject to differing interpretations, or
- Risk involves a range of possibilities.

The standard is aligned with its own sequence of steps to support organisation’s continuous improvement. It proposes the four steps of Plan-Do-Check-Act (PDCA), which is interpreted as:

- Developing a clear organisational risk framework,
- Implementing the framework actions or plan as it was designed,
- Verifying the objectives are clearly set and communicated, and
- Acting to track or modify the framework plan in response to new information to keep the project or initiative on track.

It is common in many organisations to manage opportunities separately from risk management. However, the ISO13000 is treating these two possibilities in a similar manner, so the term Risk is covering both positive and negative consequences. Basically it represents a change of change to the originally agree scope of work or result of work. The standard brings another term, which wasn't used before, Risk Treatment. It's defined as a process to modify risk. Risk treatment process to deal with negative consequences is treated as risk mitigation. The one to deal with positive is being called as pursuing a risk.

The process of risk management is outlined in Figure 6 below.

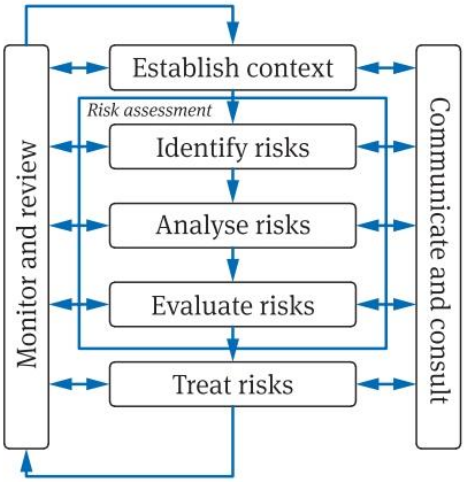

Figure 6 ISO 31000 Risk Management process (Purdy, 2010)

The risk management process is very similar to PRINCE2 and PMP processes and is presented in a number of key milestones that require to be planned and completed in order to comply with the proposed process. Risk identification is a number one step, which requires to be completed by the whole project team in order to be adequate. The output of this process is a risk profile document, which presents the overall risks and standard approaches to manage them. Risks are also mapped to the business or goal area so that any investment required to mitigate the risk is taken into account by the relative business area owner. Risk analysis is normally done in parallel to identify the ones require close attention by management. Risk responses also presented in the output. ISO 31000 specifies a list of risk responses, which are similar to the ones outlined in previous sections of this thesis. These are:

- Avoiding the risk by deciding not to start or continue with the activity that gives rise to the risk.

- Accepting or increasing the risk in order to pursue an opportunity.
- Removing the risk source.
- Changing the likelihood.
- Changing the consequences.
- Sharing the risk with another party or parties (including contracts and risk financing).
- Retaining the risk by informed decision.

Risk treatment is presented in ISO 31000 as the activity of selecting and implementing appropriate measures to address the risk. It includes as its major element, risk mitigation, but extends further to risk avoidance, risk transfer or other response. Any risk response is required to be managed and communicated appropriately between the project stakeholders, as these measures sometimes falling outside of normal project or operational pattern.

It also important to flag, that ISO 31000 recognises the importance of two-way communication about risks and risk management. It prescribes monitoring and review of performance and communication to ensure effectiveness is at an adequate level.

The ISO 31000 standard also prescribes a number of additional roles in an organisational risk management. Depending on the nature of the organisation, the risk management function may range from a part-time risk manager, to a single risk champion, to a full-scale risk management department. Responsibilities of these new roles are also proposed in the framework.

Overall the standard was originally tailored to operational organisation with its own means of controlling and managing risks, that are expected to be aligned with the standard. However, most organisations nowadays have a number of parallel improvement projects running and some of them are ICT related. Which means that the overall organisational standard aligned with ISO 31000 must be followed in these projects.

2.6.6. Risk Register as the key artefact of risk management

As per the researcher's experience, all the above reviewed risk management practices, frameworks and methodologies have may common points. The most

common artefact, that is proposed to be used for risk management is risk register. It's also common to refer to risk register in other project management and risk management literature. Williams proposes that risk register has to have two roles (Williams, 1997):

- Repository of knowledge;
- Starting point for the reporting, analysis and planning.

Chapman and Ward provide even further usage approach by proposing that risk register must also have classification or risks, their analysis bullet points, impacts to different parts of the project, key assumptions, assignees and owners of risks, mitigation plans and responses (Ward & Chapman, 1997). This proposes, that all other risk related artefacts to base on the risk register.

Within previously described PRINCE2 and PMI/PMP frameworks, risk register content is quite common, however it is also advised that the risk register must be aligned with a project objectives and structure. Thus, risk register from project to project might be different with different key elements and analysis types. Until now, key components of comprehensive risk management document are in scope of wide discussion. The most common components of risk register are:

- Dates. As risk register is a living document, so the dates when a risk has occurred or when it might impact a project is important.
- Description of risk is another key component, which supports better communication between project team in terms of risks and impacts.
- Risk type is used to categorise risks. Types could be based on where the risk originates, or what it might impact. Examples of risk types could be: business, project, scope, schedule, external and so on.
- Probability normally presented in a percentage, which comes from analysis of a risk and describes likelihood of occurrence of the risk, if it's not mitigated or actioned.
- Risk severity describes how critical is the risk in terms of impact to a project. It is a result of an assessment result, which improves the understanding of risk and helps prioritise risks in the register.

- Owner of the risk is an important part of the register, as it describes an individual or a team, responsible for the risk mitigation or action.

- Status or risk is used to keep track of current, future and closed risks.

As mentioned above, it's important to include key risk details which are relevant to a project and type of software development life-cycle chosen to run the project.

Criticism of risk register normally comes from multi-functional projects, where different parts of a project or a programme manage risks and maintain risk registers separately. Although managers of those parts could have a sense of control, often such projects lack of centralised risk register.

2.7. Literature Review Conclusion

From the above literature review it can be concluded that some material has been produced both within academia and in popular literature. Academic literature is presented by well-established risk management methodologies, which describe the processes and procedures of actual risk management in ICT projects. It has a full set of recommendations, artefacts and boundaries, within which a risk manager is expected to act towards mitigation of a risk effect on project. Popular literature, however, is more critical towards the risk management procedures proposed in the academic papers and theories. Some papers flag the fact that actual risk identification process isn't well defined. It is also noted that the existing literature does not reflect what is actually happening in ICT risk management practice. How managers choose the right approach to manage risks in their ICT projects, how they react to potential impacts of the risks, how and when they identify risks and what are the actual steps are taken to manage them. From the researcher's experience, it is common to follow some established guideline presented in one of the best-practice methodologies, but there is much more to risk management than just following a set of steps.

Pender is one of the ones, who is critical of PMI/PMP risk management practice. He indicates that since this practice is based on probability theory, it doesn't include other project management aspects, like the ones listed below (Pender, 2001):

- People's subjective attitude to uncertainties;

- Subjective manner of surprise acknowledgement;

- Project or technology complexity, which creates ambiguity;

- Human limitations of information processing.

Pender concludes "*that the underlying assumptions of the probability-based approach show limited applicability a theoretically sound foundation for the management of imprecision would include fundamental uncertainty, ignorance and fuzziness"* (Pender, 2001).

The research focuses on identifying the real actions and drivers that risk managers undertake while working with ICT related risks. Specifically, it focuses on activities of identifying the risks and follow-up actions until a risk is moved to another stage: either materialise into an issue, or being fully mitigated. The intention of the research is to gather the experiences and actions of the ICT project and risk managers involved in managing software development projects, and compare these with what has been written in the existing literature.

3. Methodology and Fieldwork

3.1. Introduction

This chapter describes the research approach, ontology, methodology and methods adopted.

3.2. Research Concept

The literature review examined the best practices in ICT industry to manage risks. To confirm the thesis problem and reveal potential gap between real-world risk management actions, and best-practices outlined above, current chapter will describe the research methodology, that will be employed to achieve the thesis target and answer the question: “Do current risk management practices, employed by ICT managers in complex ICT projects, differ from theoretical knowledge and how?”. This chapter describes the research philosophy and methods considered as part of this study. It describes a number of methods and the rationale for selecting case study research strategy over other research strategies.

A widely accepted research concept was developed by Saunders *et al.* (2009), which was called “*research onion*” (Figure 7). It is visually described in the following figure, which shows that the concept of the research onion model could be easily employed by a researcher.

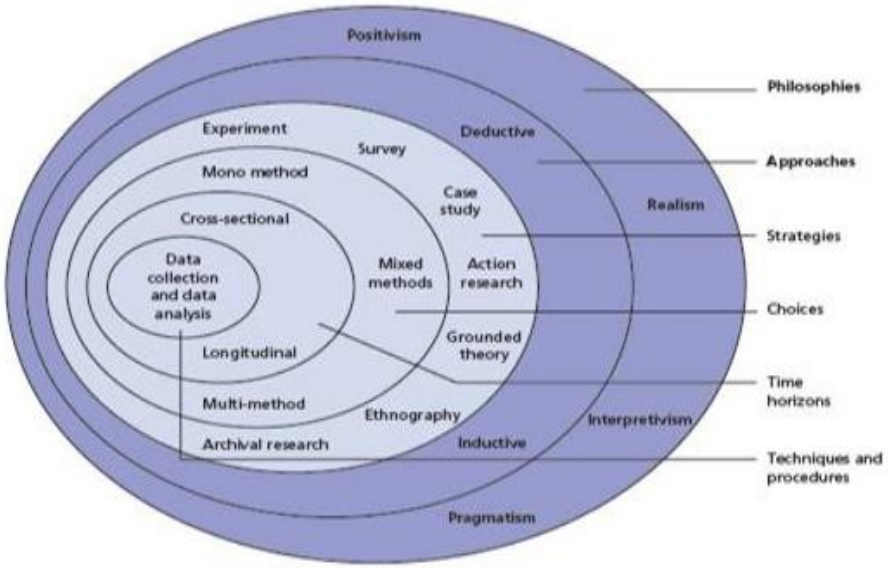

Figure 7 Research Onion, as proposed by Saunders et al. 2009.

3.3. Research Methods

Determining an appropriate research methodology is the key element in a research study. It dictates approach to the entire process of a research study, from theoretical underpinnings to data collection and analysis, and extending to developing the solutions for the problems investigated. Identifying the research methodology that best suits a research in hand is important, not only as it will benefit achieving the set objectives of a research, but also as it will serve establishing the credibility of the work. It is important in a master's study that there is consistency between research questions, methodological and theoretical approaches (Churchill and Sanders, 2007). Saunders defined research strategy as "*the general plan of how the researcher will go about answering the research questions*" (Saunders, 2009).

There are different research strategies available, from which a researcher may select. Although various research strategies exist, there are large overlaps among them. So the important consideration would be to select the most suitable strategy for a particular research study. Some of the common research strategies used in business and management are experiment, survey, case study, action research, grounded theory, archival research, cross sectional studies, longitudinal studies and participative enquiry. They are all based on a widely accepted research pillars as presented in the Figure 8 below.

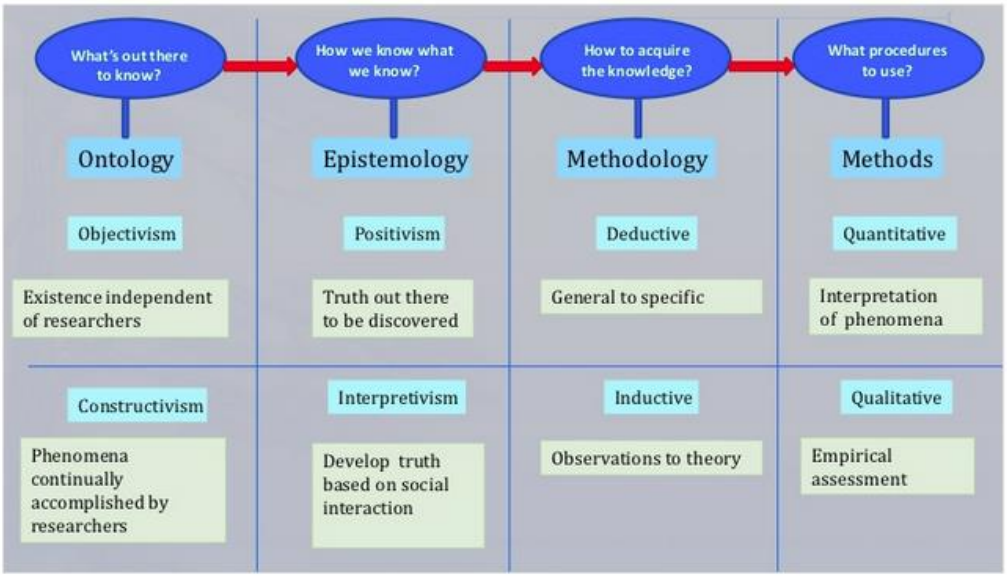

Figure 8 Widely accepted research structure and methods

3.3.1. Ontology

An academic research starts with a question to identify the unknown. It is a quite intuitive and natural question, which prescribes **ontology**, as the first step of an academic research. Ontology is divided into two philosophical theories: **objectivism**, which prescribes that existence or outside world is independent of a researcher, who simply overseeing a phenomenon he'd like to research about; and **constructivism**, which advises that the world is made by people and that these constructions should be the driving forces investigated in social science research. The key difference of constructivist paradigms is that a researcher's constructed reality is so powerful to influence their behaviour, that any external reality is relatively unimportant. It allows a research to concentrate on a phenomenon in its environment without linking it to possible external influences. But in some cases, there is no way of comparing the multiple constructed realities of different researchers. Many academic researchers find this as a complete stop in researches. Some of them have tried to come out of the dead end by applying negotiations between researchers with different realities to arrive at some shared understanding. But the results of these negotiations are always subjective.

Constructivism was chosen for the current study, as the study is concentrated on a particular risk management techniques applied in a separate environment of the ICT programme selected.

3.3.2. Epistemology

As described by Yin (2003), research philosophy is an important part of every research. It describes how data is being collected, analysed and understood (Yin, 2003); it is also the first layer of Saunders' research onion. There are number of philosophies, that could be used for a research. Saunders, Lewis and Thornhill (2009) propose positivism, interpretivism, realism and pragmatism. They all could be used for a research in the ICT field. Essentially, ontology is "*reality*", epistemology is the relationship between that reality and the researcher and methodology is the technique used by the researcher to discover that reality. A paradigm reflects a researcher's understanding of the nature of existence that is beyond "*logical*" debate because each paradigm is "*rational*" within its own constructed logic (Lincoln & Guba, 1985). According to Kuhn a paradigm is the understanding and intellectual structure on which the research in a field is based (Kuhn, 1996).

Epistemology is the next step a researcher need to take in order to help answering the question "*how we know what we know?*". This step gives a selection of two competing theories: positivism and interpretivism. Differences are well illustrated by Pizam and Mansfield (2009) in Table 3 below.

Assumptions	Positivism	Interpretivism
Nature of reality	Objective, tangible, single	Socially constructed, multiple
Goal of research	Explanation, strong prediction	Understanding, weak prediction
Focus of interest	What is general, average and representative	What is specific, unique and deviant

Table 3 Positivism and Interpretivism differences as illustrated by Pizam and Mansfield (2009)

Positivism is a philosophical theory or paradigm, that is based on natural phenomena, which states that the information derived from actual experience interpreted through logic forms a source of authoritative knowledge (Larrain, 1979). Positivism is based on empiricism due to the fact that the data is being gathered through senses (Macionis & Gerber, 1999). Researchers who adopt positivism are gathering real experience data to develop a hypothesis that could be proven or unproven by a theory. Structured quantitative methods are commonly used for this purpose, as the outputs of such method could be measured and results could be clearly demonstrated (Sounders, Lewis & Thornhill, 2009). Within the scientific research, positivism is one of the strongest paradigm that is commonly being used in science and business school researches (Orlikowski & Baroudi, 1991).

However, the positivism paradigm has been criticised for its exclusion of the discovery dimensions in inquiry and the under-determination of theory (Deshpande, 1983). For example, some assumptions of positivism may be appropriate in a physical science, but may be inappropriate when approaching a complex social science phenomenon. In simple words, any social phenomena might not be researched fully using only positivism paradigm, as such research results might not produce adequate outputs.

Interpretivism involves the researcher to interpret elements of the study. It assumes that access to reality is only through social constructions like language, shared meanings, shared instruments and understanding (Myers, 2013). According to

interpretivist approach, it is important for the researcher as a social actor to appreciate differences between people (Collins, 2010). Moreover, interpretivism studies usually focus on meaning and may employ multiple methods in order to reflect different aspects of the issue. Interpretivism is "*associated with the philosophical position of idealism, and is used to group together diverse approaches, including social constructivism, phenomenology and hermeneutics; approaches that reject the objectivist view that meaning resides within the world independently of consciousness*" (Collins, 2010).

Main disadvantage of interpretivism is associated to subjective nature of the research approach, as primary data is being gathered can't be generalised, as is based on personal or individual viewpoint.

Realism paradigm's philosophical position is based on reality that exists independently of the researcher's mind, that is, there is an external reality (Bhaskar, 1978). This external reality consists of abstract things that are born of people's minds but exist independently of any one person, it "*is largely autonomous, though created by us*" (Magee, 1985). Realism refers to this external reality as consisting of structures that are themselves sets of interrelated objects, and of mechanisms through which those objects interact (Sobh & Perry, 2006). As an example, an ICT project manager, while managing project's risks, can't do what they want to do in a post-modern fashion, as they must aim to meet the needs of an external expectations. In simple words, realists believe that there is a real world out there to research. It is also common for realists to believe that the external world around them is different to how they personally perceive it (Riege, 2003). Therefore, the desire of realism research is to develop a "*family of answers*" that covers several contingent contexts and different reflective participants (Pawson & Tilley, 1997). Realism has its own imperfections, in the sense that the realism view of an external reality implies that a search for just one negative result to disprove a theory may not be as appropriate in realism research in the social sciences as it is in the physical sciences (Yin, 1984). Instead of looking for single instances, realism research should be consistently asking why a result has been found, because the observed findings are merely "*outcroppings*" of a deeper, unobserved and unobservable reality (Neuman, 1994), or the tip of an iceberg (Gummesson, 2000).

Pragmatism is a philosophical tradition from, which was established in XIX century. It rejects the idea that the function of thought is describe, present understand the reality (William, 1909). Instead it prescribes that thought is to be used to predict, resolve a problem or action. Among pragmatists, it's very common to treat study philosophical topics from their practical usage. The philosophy of pragmatism "*emphasizes the*

practical application of ideas by acting on them to actually test them in human experiences" (Gutek, 2013). Pragmatism focuses on a "*changing universe rather than an unchanging one as the Idealists, Realists and Thomists had claimed*" (Gutek, 2013). This paradigm uses both qualitative and quantitative research methods to understand a social question.

Overall the theories might be useful for social science phenomena research, like psychological aspects of decision making under heavy stressed situations. In such research, findings will be related to individual views of the world or a particular behaviour. However, as stated above, the worlds of different people are very hard to compare (Bazeley, 2004). In order to select the appropriate research paradigm, all the above research pillars were considered. As per Tuli, positivism is more scientific and used to prove a theory; in turn, Interpretivism is used to study the reality of behaviours (Tuli, 2011).

Current research is based on human interactions and actions, with the aim to explore how human affect the reality, thus the research is based on a social science. Due to the nature of interpretivism, which based on naturalistic data collection methods, such as interviews and observations, it was selected as the current study research approach. It will help understanding the approaches used to manage risks in the selected case study ICT programme based on individual knowledge and experiences of the programme participants.

3.3.3. Methodology

There are two widely accepted research methods exist: deductive approach and inductive approach. **Deductive** reasoning works from the more general to more specific data analysis, where the research conclusion follows logically from the available facts. A deductive research start with a social theory of interest to the researcher, and test its implications with gathered data.

Inductive method works the other way, moving from specific observations to broader generalisations and theories. Conclusions of this research type are most likely based on available facts and it involves a degree of uncertainty. A researcher, who applies this type, begins by collecting data that is relevant to the research. Analysis of the gathered data would include identification patterns in the data to develop a theory to explain the discovered patterns. However, while inductive reasoning is commonly used in scientific research, it is not always logically valid because it is not always

accurate to assume that a general principle is correct based on a limited number of cases. Table 4 below displays the research type differences (Alexandridis, 2006).

Attribute	Deductive	Inductive
Direction	1. Theory, 2. Hypothesis, 3. Observation, 4. Confirmation.	1. Observation, 2. Pattern, 3. Tentative hypothesis, 4. Theory.
Focus	Prediction changes, validating theoretical construct, focus on general behaviour, testing assumptions, predicting future behaviour.	Understanding dynamics, emergence, resilience, focus on individual behaviour, constructing alternative predictions.
Quantitative research method	Structural equation modelling	Exploratory data analysis
Qualitative research method	Qualitative comparative analysis	Grounded theory

Table 4 Data analysis patterns comparison (Alexandiris, 2006)

The current research is based on inductive reasoning method, as this method is based on an observation of a real world phenomenon, which leads to a larger universal hypothesis and comparison to a previous researchers and widely accepted theories. In this context, the research aims to prove that ICT risk management best-practices are not complete, and real world risk management practices are more wide and comprehensive.

3.3.4. Research Methods

Research methods could either be based on quantitative or qualitative research strategies. It's common for a researcher to question which research methodology to choose for a research. **Quantitative** researchers use numbers and large samples to test theories, and **qualitative** researchers use words and meanings to build theories. Sometimes researchers combine these two methodologies (Borch & Arthur, 1995). However, it's common when combined, the research results might contradict each other. As per Zikmund differences are as described in the Table 5 below.

Research aspect	Quantitative	Qualitative
Common purpose	To test hypothesis or specific question	Discover ideas, used in exploratory research with general research objects
Approach	Measure and Test	Observe and Interpret
Data Collection	Structured response categories provided	Unstructured, free-form data collection
Research independence	Researcher uninvolved observer. Results are objective.	Researcher is intimately involved. Results are subjective.
Samples	Large samples to produce generalizable results	Small samples
Most often used	Descriptive and casual research designs	Exploratory research designs

Table 5 Differences between quantitative and qualitative research strategies (Zikmund, Babin, Carr & Griffin, 2010).

Advantages of the **quantitative** research method are:

- Easiness of research implementation,
- Quick data gathering,
- Precise numerical research data,
- Useful for large sampling size,
- Relatively faster to analyse research data,
- Easiness in interpreting the research data.

However quantitative research method has its own limitations, like gathered research data is often too general and doesn't reflect individual cases; research results might not be in-depth of the research question; research results could be bias, as researcher is verifying the data against a pre-defined theory, but not building a theory on the research results.

In turn, qualitative research method is an alternative, which is perfect to study in-depth individual cases, as well as:

- It is useful to describe complex phenomena,
- It is also useful for a specific environment, context and condition,
- It includes personal experiences of phenomena,
- Since it's based on quality of the research data, it is more dynamic and flexible,

The main limitation of qualitative research method is that its findings often only applicable to a specific case and potentially could not be generalised. Also, it's more complex to gather data due to emphasis on its quality.

As the current research is based on a selected case ICT programme to study ICT risk management practices and experiences that were applied in it, qualitative research method was chosen. Its advantages will allow describing details of the techniques used to manage ICT risks and compare them with the ones prescribed in industry established best-practices. Method limitations, however, won't allow applying the research results to the general ICT risk management practices, as the results are very specific to the selected case study.

3.3.5. Scientific research methods

Scientific research method summarises laboratory experiments, field experiments, surveys, case studies, forecasting and grounded research. A scientific approach was selected for the current research (Recker, 2012). Therefore, it's important to describe the key differences between them.

Laboratory experiments are tailored to control and study a small number of variables intensively. Such experiments identify precise relationships between chosen variables via a designed laboratory situation, using quantitative analytical techniques, with a view to identifying correlations. This approach, however, is limited as identified relationships exist in a real world due to oversimplification of the experimental situation and the isolation of such situations from other external possible variables.

Field experiments are good to generate more real life results. But as a negative point it lacks control over the experiment as environmental variables could impact the experiment process and overall results.

Case study research method is used to describe relationships which exist in reality, usually within a single organization. This type of research is helpful to capture a local situation in greater detail and with respect to more variables. A negative point of this research type, similar to field experiments, is lack of control, although in a different manner - variables are defined by the actual case study, but not by the research. And such research interpretations might be explained and understood differently by different people.

Grounded theory research looks for patterns in collected situational data. Its aim is to discover any unexpected patterns through utilization of large bodies of situational data not having individual significance. Instead of starting with a theory, researcher start with an area of study and what is relevant to that area is allowed to emerge (Glaser, 1967). Negative aspect of this type of research is it's sensitive to thoroughness and skills of individual researcher, which sometimes might not be sufficient to conduct a reasonable academic research.

Action research is normally employed when the researcher participates directly in a project. It captures the local situation in greater detail and with respect to more variables. As a result, it improves practitioners' practice. Results of such research provide practical value to study group or project, as well as add to theoretical knowledge and enhances competencies of local participants. This research, however, have its restrictions, like it's tied to a single project and organization, it lacks control over variables and openness of interpretation.

A case study was selected as the research method of the current thesis in order to concentrate on a particular ICT programme risk management approaches.

3.4. Methodology of the Current Research

The current research is aimed to study the activities pertaining to risk management in ICT projects and how they were actually managed, what processes were employed in practice. The need of this research is coming from the lead researcher experience in managing multiple ICT projects, where part of the overall management was addressing ICT risks in different manners. During the course of the ICT project management, it was identified that risk management isn't always done as per the most common best-

practices presented in the field. This is addressed by imperical study into actual ICT risk management practices and the factors influencing ICT project participants in their choice of application of risk management strategies. Another aim of the research is extending the general knowledge of the nature of the practical ICT risk management. The output of the research is expected to be a comparison between what's proposed in the common literature and on practice.

3.4.1. Current Research Question

A well-defined and specific research question is the key in making decisions about study design and subsequently what data will be collected and analysed (Haynes, 2006). Defining the research questions is one of the most important step to be taken before a research study could commence. Research question then contributes to the research method adopted, which is the key for any academic writing.

The challenge in developing a research question is in determining which practical uncertainties could be studied and also rationalizing the need for their investigation. Knowledge about the subject of interest can be investigated in many ways. Appropriate methods include systematically searching the literature, in-depth interviews with experts in the field and studying live practices and phenomena. It is important to understand what has been studied about a topic to date in order to further the knowledge that has been previously gathered on a topic. Haynes suggests that it is important to know where the boundary between current knowledge and ignorance lies (Haynes, 2006).

In depth study about the current research topic have generated a number of questions, which then were analysed to determine of either they all or subset of them could be answered within a particular research. The questions have been prioritised to primary and secondary.

The research topic is "*A study of ICT risk management approaches in formal methodologies and practical application*". It was decided to evaluate this topic via the main question: "*Do current risk management practices, employed by ICT managers in complex ICT projects, differ from theoretical knowledge and how?*". The following sub-quests were identified as the most appropriate to achieve the thesis objective:

- What risk management techniques ICT project managers were employing within their risk management activities?

- Do their practices deviate from common risk management techniques presented in well-known risk management frameworks?
- If it will be proven, that real-life practices are different, then why are they different?

3.4.2. Research Procedure

To meet the purposes of the current research, the following research methods were selected:

Ontology	Constructivism
Epistemology	Interpretivism
Methodology	Inductive method
Research Type	Qualitative
Research Method	Case study
Data Gathering	Semi-structured interviews

Table 6 Research methods adopted for current research

A case study was selected as the main research procedure for the current thesis. As defined by Saunders et al., a case study is a research study that involves the empirical investigation of a particular contemporary phenomenon within its real life context, using multiple sources of evidence (Saunders, 2007). As per Yin, a case study design should be considered when (Yin, 2003):

- The focus of the study is to answer “how” and “why” questions;
- Behaviour of the studied phenomena can’t be manipulated by the researcher;
- Contextual conditions are important and need to be covered within the study;
- Not clear boundaries between phenomena and context.

There is a number of case study types exists, but the most common are single case study and multiple case study. From their names, the main difference is how much data will be gathered within a research per each type. For the current research, a single case study was selected in order to concentrate on what exactly happened in the risk management theme within a selected case programme.

To justify the current selection, there is a number of advantages using a case study as a research method. First of all, the data examined in the research is often conducted within the context of its use (Yin, 1984). An experiment is a contrast type, which isolates phenomena for a particular study outside if its natural environment (Zaidah, 2003). The outputs of experiments often need to additionally proved in real-live scenarios. Often obtaining a real-live prove is a highly complex exercise. Second, variations in terms of intrinsic, instrumental and collective approaches to case studies allow for both quantitative and qualitative analyses of the data. While Yin cautions researchers not to confuse case studies with qualitative research, he also notes that "*case studies can be based … entirely on quantitative evidence*" (Yin, 1984). Third, the data generated using a case study research method, by its nature, not only helps exploring phenomena, but also help explain the complex connections of the phenomena which is being studied.

3.4.3. ICT programme selected for the case study

The ICT programme selected for the case study, was initiated by an Africa based insurance company in 2013. The purpose of the programme was to deliver a new cloud based insurance policy administration system, which aimed to replace the existing outdated system. The programme involved 13 vendors around the Globe, which had their own dedicated ICT management and teams. The 13 vendors were working on different parts of the solution design, development, testing and delivery. The programme was identified as critical for the company and was under a constant review by the senior company management. It was also identified as risky due to the large number of integration between different ICT systems onshore and offshore. Main risks were also related to:

- Competitive markets, which always challenge existing ICT set-up and infrastructure.

- ICT maintenance issues, which require excessive solution management.

- Many concurrent ICT projects with various budgets, sizes, complexity and customers.
- Uneven distribution of ICT project management knowledge throughout the organisation, resulted in application of different techniques by ICT professionals in managing ICT projects.
- Challenging ICT goals, which often put current projects at very tight budgets, increasing risks of failure through delays and misalignments with business needs.
- Complex ICT systems integration, which impacts stability of delivered systems.
- Fast business processes changes, driving constant ICT improvements and changes.

Although main risks were well known, not all the key risks were identified at the very beginning of the programme. Most of them have been discovered and managed during the course of the programme by the vendors and the main programme management team. The programme was successfully completed in May 2016. The lead researcher joined the programme at the very beginning of its active phase late 2014 and was involved in it until April 2016.

The researcher, being an appointed responsible project manager to the case programme, has access to the details of the resources assigned to the programme. The case programme resource list maintenance has been a responsibility of the lead researcher thus the details of the list are available to him. Personal contact details of the case programme prospective participants were obtained from verbal conversations directly with them during the initial introduction to the research. Research participants were selected based on their initial verbal agreement to participate in the research.

The case study interview method was used to investigate the research questions of this study. Details of sample method of responders and the interview method is explained below. In order to build quality contrast information from the interviews, a purposeful sampling approach (Miles & Huberman, 1994) was selected. A sample of 15 ICT managers was selected within a wide range of ICT organisations, who were delivering to the programme selected for the case study. The amount of ICT

professionals selected is considered sufficient to build a full picture of the risk management practices they've employed during the course of their projects.

The ICT managers, selected for the interviews, were sought as recognised professionals of the industry with wide range of experiences managing complex ICT projects. The researcher considered titles like project manager, development and testing manager and release manager have a sufficient level of knowledge in management of ICT related risks in their projects.

3.4.4. Data collection

Qualitative case studies are based on semi-structured interviews' data, observations and various supporting documents (Merriam, 2002). Semi-structured interview method was selected for the current research. Interviews were conducted with the selected participants and lasted from one hour to one and a half hour each. Interview recording was mostly based on notes. But some, more complex ones, were recorded electronically, in order to be analysed at a further stage more thoroughly. With some responders, additional short interviews were conducted in order to get more detailed information about their experience.

The survey was organised in four sections:

1. The first section consisted of number of questions to identify the interviewee participation in the risk planning and management within the case programme. This section also addressed the participant's background and expertise in the addressed topic. It was important to confirm at the very beginning that the participant is able to bring quality data to the survey.

2. The purpose of the second section was to gather interviewee's feedback related to the risk management techniques they've learned from industry standard best-practices. And if they've been used within the case programme delivery.

3. The third set of questions aim was to reveal factors that influenced risk management practices within the ICT projects.

4. The fourth section was designed to address survey participants' other experience that might be valuable to the current research.

3.4.5. Survey Participants

The interviews were targeted at a narrow team of project managers, development team leads and product owners, involved in the case ICT programme. The main reason for selecting the case programme is based on active participation of the lead researcher in the role of overall implementation project manager. The role prescribed full planning and control over the programme aspects like schedule, resources, handling issues, managing risks, scope and others.

The participants of the case study were selected from the external and internal members of the case ICT programme, who were actively managing different parts of its scope. The lead researcher had selected 15 ICT professionals. And out of 15 selected, 9 participated in the interviews (Table 7). The interviews were completed in little more than three months, between 15th May 2016 and 17th August 2016. The interview contents and questions were fully approved by Trinity College Dublin Ethics Committee, and were fully completed and documented.

Participant ID	Role in the programme	Vendor	Duration on Case Programme	Type of interview
01	Project Manager	Vendor 1	Dec 2014 – Aug 2015	Face-to-face interview
02	Development Lead	Vendor 2	Nov 2014 – Mar 2016	Email interview
03	Project Manager	Vendor 3	Jan 2015 – Nov 2015	Phone interview
04	Systems Architect	Vendor 4	Nov 2014 – Mar 2016	Face-to-face interview
05	Project Manager	Vendor 5	Feb 2015 – Feb 2016	Phone interview
06	Project Manager	Vendor 6	Nov 2014 – Dec 2015	Phone interview
07	Development/Testing Lead	Vendor 7	Dec 2015 – Feb 2016	Email interview
08	Project Manager	Vendor 8	Dec 2014 – Jan 2016	Email interview
09	Project Manager	Vendor 9	Dec 2014 – Dec 2015	Phone interview

Table 7 Characteristics of the intervewees and their involvement in the case programme

Since not all participants were occupying the project management roles, it's important to display their spread across various roles, which is displayed in the figure below.

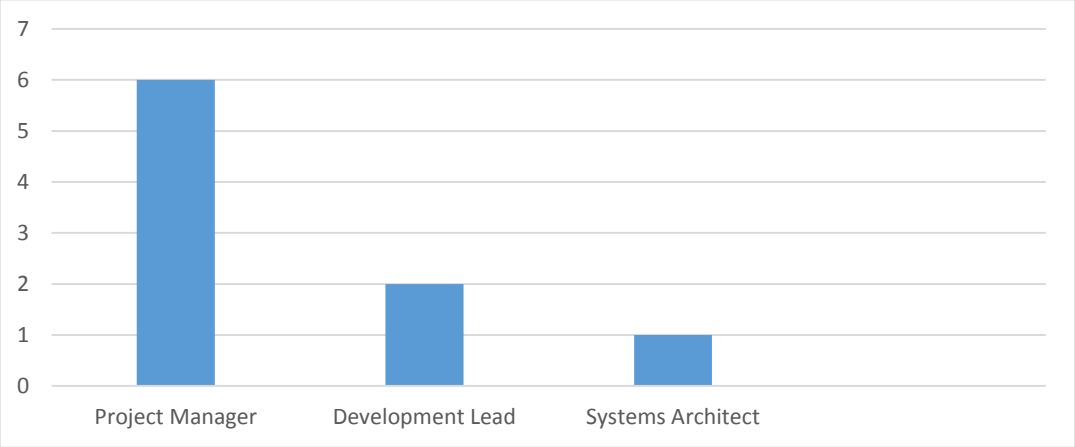

Figure 9 Distribution of participants across roles

As displayed in the Figure 9, 66% of the participants are ICT project managers, and rest are development, testing and solution architecture leads. All these professionals were actively managing their software deliveries for the case programme, including issues and risks management. They've been participating in the reoccurring project planning and risk mitigation meetings, which were focused on improving the overall visibility of issues and risks identified during the programme, to ensure all teams and their deliverables are aligned with risk mitigation planning, risk responses and responsibilities.

3.4.6. Limitations of the Research Approach

A case study, as a research method has its own advantages and limitations. It's important to ensure the limitations of the selected research method are reviewed and taken into account.

Yin (2009: 14-15), has expressed a great concern in using a case study as a research method. His concern was based on the absence of a systematic procedures for the research. Maoz suggested that *"the use of the case study absolves the author from any kind of methodological considerations. Case studies have become in many cases a synonym for freeform research where anything goes*" (Maoz, 2002). His suggestion is especially relevant in the context of a single-case study, where a phenomenon is being analysed in one single environment.

3.5. Data Analysis

Survey data is only valuable, when analysed and understood. In order to complete the interviews' data analysis, qualitative content analysis procedure was chosen. It was

decided to follow three step process: description and summary, analysis and interpretation (Miles & Huberman, 199).

Within the **description** stage, interview data was gathered and summarised on a question-by-question basis. Since the survey questions were the same for all the interviews, it was easier to summarise the data using a structured Excel table. The table contained four main parts reflecting the interview question categorisation. A brief memo was created per each set of questions from each respondent, which was helping to understand overall experience and practices within the analysis stage. The **analysis** stage included qualitative data review to ensure the information is well structured and is ready for interpretation. The main structure was based on the four question sets of the survey:

- To identify of the interviewee background and project management experience outside of the case programme.
- To reveal the level of participation in the case ICT programme, to ensure the level of involvement in the managerial decision making within the programme was suitable for the research.
- To describe the real-life risk management processes that were undertaken to manage risks within the case ICT programme by the interviewee, as well as to reveal any deviations that took place during the course of the programme or project.
- To address other risk management experiences that could be relevant to the current research.

This presented good grounds for the **interpretation** stage of the data analysis. The main aim of the interpretations stage was to understand key actions and procedures that were followed by the survey responders while managing risks in their ICT projects.

The most complex was to transcript the informal responses into manageable data for analysis. Thus lead researcher made his own interpretations of the information gathered in order to structure the survey responses. Data analysis occurred concurrently, as in most qualitative studies.

3.5.1. Information Systems Theory Applied

Data of the current research has been analysed using one of the information systems theories, widely presented and developed by various theorists of ICT research. One of the main objectives of the current research is to understand the reasons why ICT managers don't often follow the well-established industry standards in risk management of their projects. There are many models that have been proposed to describe managers' behaviour in different situations within ICT industry. The most widely accepted is Contingency Theory.

There are many forms of the contingency theory, but in summary it's a class of behavioural theory that state that there is no one best way of managing, organising or leading. Fiedler stated that an effective leadership style for one organisation might not be applicable for another. He is arguing the fact that a leader can apply the same skills to management of different organisations, and stating that leader's first target is to identify which management style will help the most. (Fiedler, 1964).

Contingency theory can also relate to decision making (Vroom and Yetton, 1973), which links the effectiveness of a decision procedure with a number of aspects of the situation:

- The importance of the decision quality and acceptance,
- The amount of relevant information possessed by the leader and subordinates,
- The likelihood that subordinates will accept an autocratic decision or cooperate in trying to make a good decision if allowed to participate,
- The amount of disagreement among subordinates with respect to their preferred alternatives.

Scott describes contingency theory in the following manner: "*The best way to organize depends on the nature of the environment to which the organization must relate*" (Scott, 1981). The main ideas of the theory were well described by Morgan (Morgan, Gregory & Roach, 1997):

- Organizations are open systems that need careful management to satisfy and balance internal needs and to adapt to environmental circumstances.

- There is no one best way of organizing. The appropriate form depends on the kind of task or environment one is dealing with.
- Management must be concerned, above all else, with achieving alignments and good fits.
- Different types or species of organizations are needed in different types of environments.

Contingency Theory, as part of the overall organisational theory, is also applicable to management of information systems (MIS), where similar management targets would apply. As described by Weill, (Figure 10) organisational performance is dependent on contingency variables. When it comes to MIS, information systems variables also apply in order to achieve desired management result.

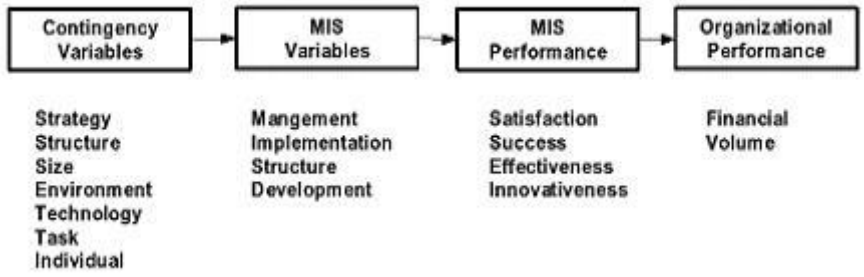

Figure 10 Representation of Contingency Theory in MIS Research (Weill, Olson & Marorethe, 1989)

The selection of the Contingency Theory was based on the survey data analysis results in attempt to explain the behaviour of ICT managers in managing risks within their projects of the case ICT programme. Although there is a clear fit of the selected theory to the survey data results, it's also important to state, that the contingency theory wasn't developed further after mid-1980s, as not many theorists have contributed to it since then. This, however, doesn't allow to use the theory for the current research data analysis, as it explains the behaviour of the responders of the survey.

3.6. Conclusion

The current chapter has described the philosophies of research methods, which were explored and research methods were selected. As a philosophical viewpoint constructivism was selected, as the study is concentrated on a particular risk management techniques applied in a separate environment of the ICT programme selected. The research is based on a social science and naturalistic data collection

methods, so interpretivism, was selected as the current study research approach. It will help understanding the approaches used to manage risks in the selected case study ICT programme based on individual knowledge and experiences of the programme participants.

Since the research is based on an observation of a real world phenomenon, which leads to a larger universal question and comparison to a previous researchers and widely accepted theories, the most suitable would be the inductive method.

To meet the research objectives, a case study was selected to gather the data for the research, which is based on qualitative research method. Its advantages will allow describing details of the techniques used to manage ICT risks and compare them with the ones prescribed in industry established best-practices.

The analysis phase, being one of the most important in the current research, has its own risk of being inadequate if each data source would be treated independently and the findings reported separately. This is not the purpose of the current case study, as the lead researcher has ensured that the data has analysed and summarised in an attempt to understand the overall patterns of risk management in the selected case ICT programme, not the various parts of it.

4. Findings and Analysis

4.1. Introduction

The current chapter is aimed to present findings and data analysis of the data gathered during the research. The chapter's aim is to answer the research question "*Do current risk management practices, employed by ICT managers in complex ICT projects, differ from theoretical knowledge and how?".* In order for the question to be addressed, a survey with case study ICT program participants was completed.

4.2. Survey Details

As stated in the previous chapter, the ICT programme selected for the case study, was initiated by an Africa based insurance company in 2013. The purpose of the programme was to deliver a new cloud based insurance policy administration system, which aimed to replace the existing outdated system. The project involved 13 vendors around the Globe, which had their own dedicated ICT management and teams. The 13 vendors were working on different parts of the solution design, development, testing and delivery and the purpose of the overall programme was to join their deliverables into one system, that is ready to be used by end users.

The lead researcher was part of the programme management team and had access to all vendors, their project plans, their risks and issues registers and status reports. The case programme resource list maintenance has been a responsibility of the lead researcher thus the details of the list are available to him. Research participants were selected based on their initial verbal agreement to participate in the research. The participants of the case study were selected from the external and internal members of the case ICT programme, who were actively managing different parts of its scope. The lead researcher had selected 15 ICT professionals. And out of 15 selected, 9 participated in the interviews. Interviews were conducted with the selected participants and lasted from one hour to one and a half hour each. Interview recording was mostly based on notes. But some, more complex ones, were recorded electronically, in order to be analysed at a further stage more thoroughly. With some responders, additional short interviews were conducted in order to get more detailed information about their experience.

The interviews were completed in little more than three months, between 15th May 2016 and 17th August 2016. The interview contents and questions were fully approved by Trinity College Dublin Ethics Committee, and were fully completed and documented.

The survey was based on set of questions, which were developed to answer the main research objective. The survey questions were divided into four groups to ensure response data is easy to summarise and analyse. According to the requirements of the ethics committee, all survey participants had the option to skip questions, so not all the questions were answered by the participants. Small amount of questions was skipped on request, which, however, didn't impact the survey quality.

4.3. Survey Summary

Data, gathered during the interviews was analysed and presented in the next sections of the current research. The analysis of the participants' responses has been compared against the information that is available in the existing literature. The key of the research is to identify how close the risk management approaches were to the approaches mandated by the previously reviewed literature, best practices and theories.

4.3.1. Interviewee Background Questions

Interviewee background questions were designed to identify the interviewee project management background outside of the case programme and to gather risk management techniques interviewee learned from industry standard best-practice trainings in the past. This set of questions was developed with a view to confirm survey data quality based on the correct selection of the survey participants.

Question 1: *How many years of ICT management experience do you have?*

Survey participants' response analysis is displayed in the Figure 11 below.

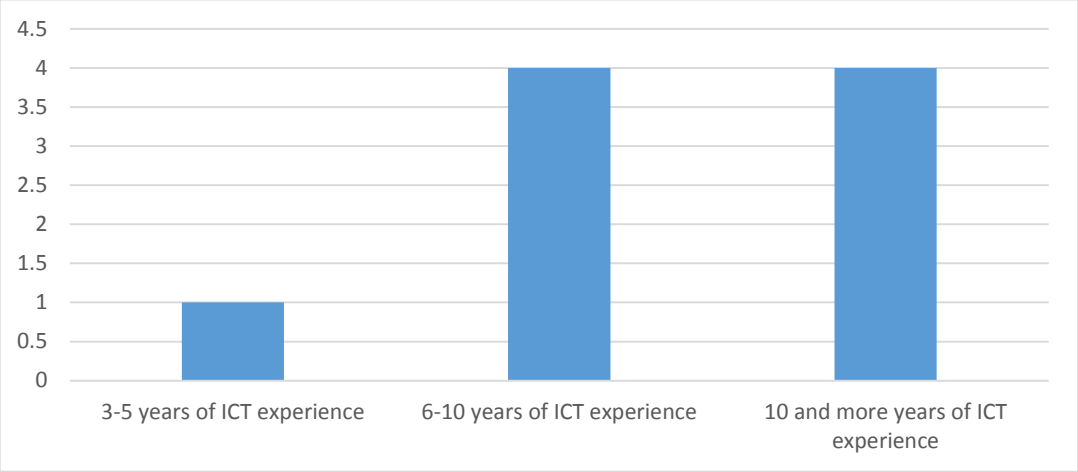

Figure 11 Distribution of participants across their ICT management experience.

The ICT experience analysis shows that 90% of the participants have more than six years of experience in managing ICT projects. And only one gathered up to five years. This proves that the selection of the survey participants is adequate and relevant to the objectives of the current study. It also confirms the survey data is trustworthy.

Question 2: *What are the industry best-practices you have learned and applied in the past, outside of the current case programme? Could you also describe any additional risk management trainings you had in the past?*

As risk management expertise is critical for the current survey, it's level needed to be confirmed within the survey responders. Question 2 was designed to ensure survey participants have an adequate level of risk management expertise.

All survey participants had gone through project management training in the past. Most of them are PMP/PMI certified professionals and others have a combined training based on either PRINCE2, Agile or another dedicated project management training (Figure 12). Although the interview participants were using different software development approaches during their participation in the case programme, risk management practices they've employed were at an adequate level.

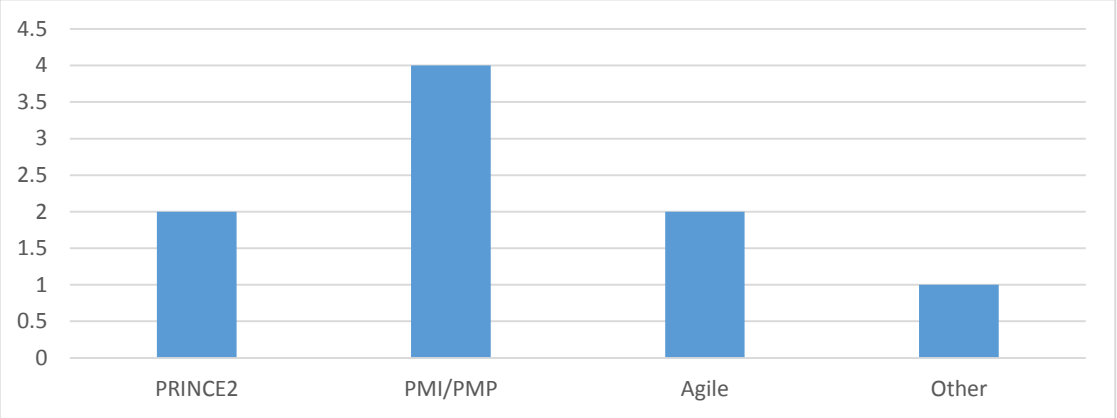

Figure 12 Distribution of participants by their project management training

It was also important to explore what software development life-cycle methodology learned by the participants, as it also impacts the risk management experience.

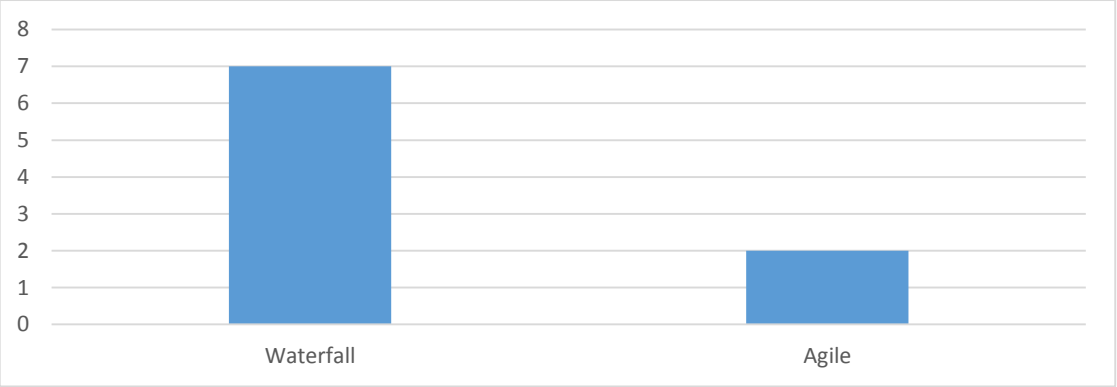

Figure 13 Project management methodology used by the participants in the case project

As displayed in Figure 13, most of the participants were working under waterfall methodology. The reasons for this were quite different, but they could be summarised by the nature of their previous experience, where they had to work in more traditional environment.

None of the survey participants had a dedicated risk management training in the past. All risk management knowledge was obtained from the industry well-established project management methodologies like PRINCE2 and PMP/PMI, and real-life practice. Six survey participants described their risk management practice as situational, as it wasn't the key element of their project management experience. Risks mostly were managed as part of the regular reporting, which included different kinds of risk registers with risk details, possible mitigation actions, risk owners and other risk related data.

4.3.2. Interviewee Participation in the Case ICT Programme Questions

This set of questions was developed to reveal interviewee participation in the case ICT programme to understand the level of involvement in the managerial decision making within the programme.

Question 3: *What was your role in the case ICT programme?*

As stated in the previous sections of the current research, the case IT programme was deemed critical for the success of the organisation. It was also identified quite risky from the very beginning, as the scope of the programme deliverable included not only software development, testing, acceptance and production deployment of a new policy administration system, but also creation of subsequent software, services and integration points between them in order to be joined together as a whole system at different phases of the programme. Thus, participant's role is an important index of management influence and skills that were applied in the case ICT programme.

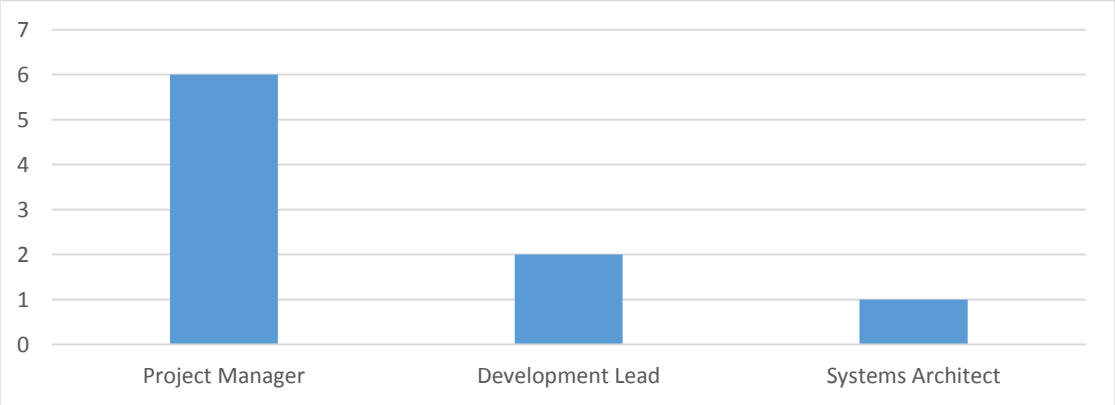

Figure 14 Roles of the survey participants in the case ICT programme.

Within the case ICT programme, role of project manager includes full professional responsibility to deliver the agreed scope within the agreed schedule and cost. As per the survey data, 66% of the responders were occupying project management roles (Figure 14), where key objectives were to manage project members, project scope, schedule, costs, risks and issues.

One third of the responders were occupying development lead and systems architect roles, which, within the case programme, were management roles. These roles' objectives were in most cases similar to project management roles, but with some specific focus. Focus of development and testing leads was to manage a dedicated team of IT engineers, which also included issues and risks management. Systems

architect, participated in the survey, was managing a technical team of IT engineers, and was also responsible for technical scope, issues and risks management.

In summary, all survey participants confirmed risk management was part of their roles in the case programme with professional responsibility to deliver agreed scope.

Question 4: *Please describe the size of the team you were managing within the case ICT programme and your project.*

As per the survey responses, the importance of the ICT project team to participate in the risk management activities was identified early in the programme. Risk management not only included identification, but also management of risks. As a summary of the responses, it was common for the case programme for ICT managers to appoint a risk owner to a particular risk or set of similar risks within their project team. The risk owners then were involved in risk mitigation planning, management of activities related to assigned risks and were responsible for minimising the risk impact to projects they were involved in. Figure 15 displays the sizes of ICT professional teams survey respondents were managing.

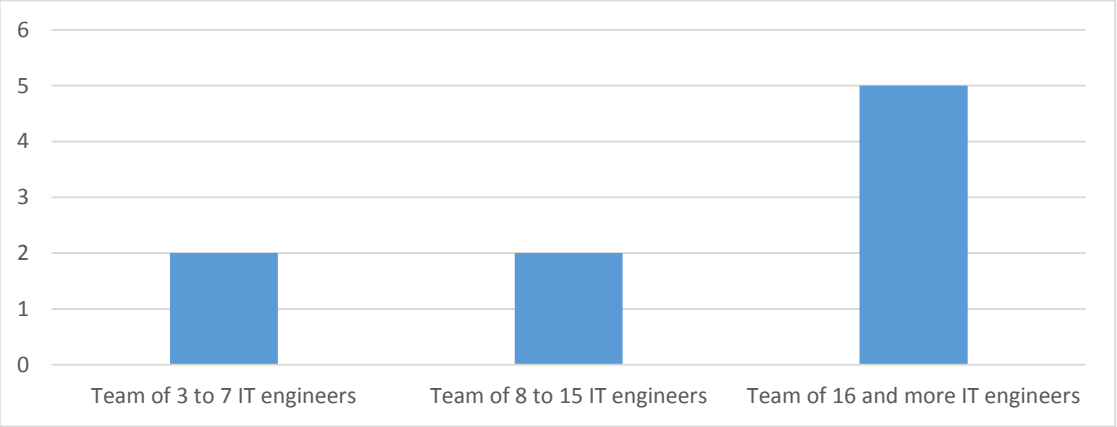

Figure 15 Sizes of the ICT project teams, survey respondents were managing.

In accordance to the question responses, the size of the project team impacted risk management within a project, as it allowed bigger teams to manage open risks more effectively due to their capacities. This however, wasn't consistent between the project teams, as some team members weren't familiar with established risk management approach, which had effect on the quality of risk management.

Question 5: *Please describe the level of risk management responsibility you had within the case programme and your project.*

To summarise the responses of 8 survey participants, their risk management responsibility was at an adequate level. Due to the nature of their roles, they all confirmed criticality of predicting possible risks and forecasting possible impact to their project and the case programme from the very beginning.

One respondent, however, mentioned that although he was officially responsible for managing dedicated to him project, risk management was at minimal level, due to the criticality of his project solution and deadlines for the overall programme.

4.3.3. Factors Influenced Risk Management Approach Applied in the Case Programme

Questions of the third and fourth sections were developed to reveal the real-life risk management processes that were undertaken to manage risks within the case ICT programme by the interviewee. It was important to capture deviations from established organisational, programme or industry best-practices in risk management, as well as factors that influenced the deviations.

Question 6: *Was the project and risk management methodology, you've applied within the case ICT programme, influenced by the organisational standard? If it was, what was the industry best practice the standard was based on?*

With this question, researcher wanted to pinpoint a level of organisational influence on selection of a software development life-cycle by a project. As ICT projects are very different to each other, a development and project management approaches are often selected to meet a specific project requirement, mitigate risks or match business sponsor expectations.

As stated in the previous sections, the case ICT programme consisted of a number of ICT projects, which were managed by set of selected vendors. Two thirds of the programme vendors were established within the same organisation and were working under the same set of ICT project management environment. This environment, however, wasn't strict and allowed a project to select its own path towards completion.

The six survey participants were representing different IT departments within the same organisation, and it was expected their responses would be the same. In summary, the confirmed the choice of software development life-cycle was mandated by the organisational standard and was based on adopted PMP/PMI model. As described in the previous chapters of the current research, this model has a comprehensive set of risk management rules, that allow its practitioner to manage identified risk more effectively. All six responders confirmed they were following the PMI/PMP risk management guides in their practice at a level mandated by the organisation. They also confirmed the development life-cycle was based on waterfall (explained in the previous chapter). Selection of waterfall was based on the requirements gathering and approval process, that was in place at the very beginning of the programme. Since the deliverables were clearly seen by the business sponsors, it was obvious to document detailed business and systems requirement well in advance, which supported the selection of waterfall.

The rest of the survey respondents were working in external organisations. Two of them responded differently to the ones summarised above, in the sense that their organisations were more flexible in adopting a project management and risk management approaches. They were following an agile model of software development and delivery of their systems, which was driven mostly by the matureness of these teams to adopt more flexible life-cycle approach, as well as programme requirement to deliver software in iterations for more flexible testing.

And finally, one survey respondent, working for an external to the case programme company, described the selected project management approach as waterfall, which was based on PRINCE2 model. As per his response, the selection was based on the established organisational project management pattern.

In conclusion, selection of project management model in 80% of the cases was influenced by the organisation where the project team was working. Software development life-cycle was mostly influenced by the programme requirements, rather by an organisational rules. This, in turn, influenced the risk management approaches, that were followed.

Question 7: *Please describe the level of risk management that was applied within your project.*

Responders confirmed that due to the programme reporting requirements, all participants had to produce common risk management artefact during the course of their projects, which was based on risk register (described in the previous chapter). The risk register included details of risks, their severity, mitigation, possible impact and owners. The risk register was embedded into the status reporting artefact, which was submitted for analysis to the programme management on a regular basis. The purpose of the artefact was to track risks in order to eliminate or minimise impacts to the overall programme. This, however, was the only common point between all the survey respondents' feedback.

Three survey respondents had common approach to risk management, where the process was set around the programme mandated risk management artefact. They confirmed that the risk register was used to create an action plan to address additional controls to reduce the risks to an acceptable level. The additional controls were then presented as set of actions or changes to project schedule, advise on potential cost increase or propose a mitigation plan to address identified risks. Regular project team meetings were in place in order to identify, track and address project risks. These respondents confirm the risk management was at an adequate level.

An interesting response was given by one respondent, where he described that the project not only was reviewing risks within the team, but also followed a specific PMI/PMI framework prescription to appoint a dedicated risk manager within the team, who's role was to continuously analyse technical risks, propose solutions and mitigation plans, and shared the risk knowledge with the rest of the project team. It was possible to appoint a dedicated risk manager, as the project team was large enough to allow for additional time to manage increased ambiguity.

Four responders admitted that they were only following the programme guide to manage risks, which often did impact on their project in a negative way. They all confirmed the reasons were related to the availability of time and resources to pay close attention to risk management and mitigation planning. Often they faced a dilemma, whether to allocate time to overcome continuous issues or to dedicate a reasonable amount of time to predict and prepare for risks in advance. This was related to quite a large amount of issues due to the complexity of their project deliverables and high rate of changes discovered during the course of their projects.

The last respondent, who was working for an external vendor, advised that risk management was minimal in his project, as the size of the deliverable and complexity of the solution wasn't critical for the overall programme.

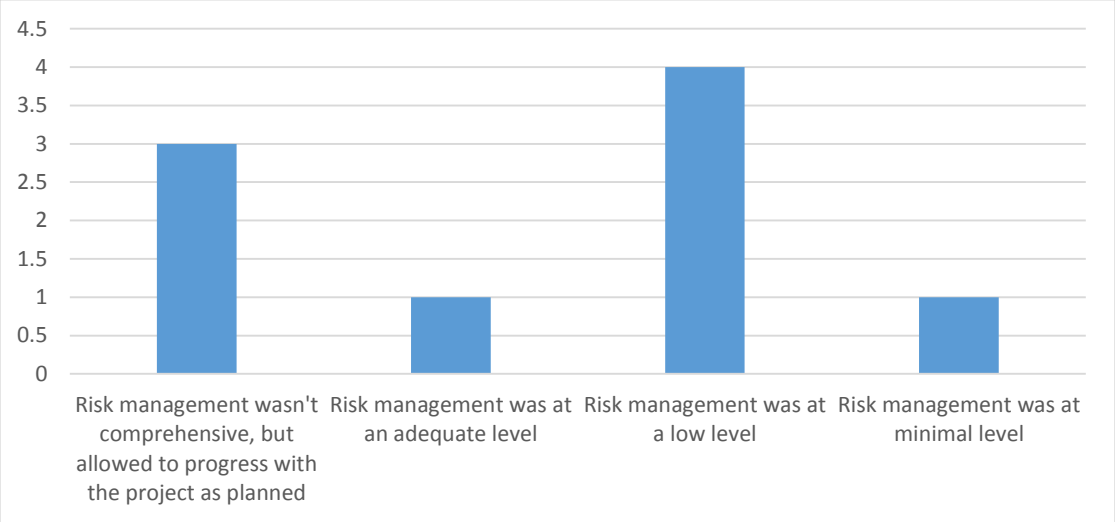

Figure 16 Satisfaction with risk management results by the programme participants surveyed.

Figure 16 summarises the survey responses for Question 7. Only one respondent was completely satisfied with the level of risk management applied. Other respondents advised on different reasons for the lower level of risk management within their project. These reasons will be revealed within the next survey questions.

Question 8-12: *Description of the factors that influenced the risk management approach followed by survey participants.*

In order to complete the analysis of factors that impacted the risk management approaches undertaken by the survey participants, survey questions 8 to 12 were summarised below.

All the survey percipients confirmed that during the course of their projects, risk management was uneven with many deviations from the organisational and common risk management processes. Therefore, the responses for the Questions 8 to 12 were analysed in a slightly different approach. Instead of concentrating on each response, researcher concentrated on the factors mentioned in the survey responses in order to understand level of their influence and occurrence.

It was noted, that the decision to choose a life-cycle either based on organisational standard, or, in some cases, to address most critical risks and requirements. The two survey participants, who were following more flexible development life-cycle method,

described the factors that influenced the development method they've selected the following way:

- Due to the complexity of the solutions and high rate of ambiguity, project managers identified that there is a high risk of requirements changes (scope creep) and delayed requirements risk. The vendors of those systems come up with a more agile software development approach, which allowed to address initially missed or delayed requirements by regular scope reviews and systems' feature development prioritisation. It was noted by the responders, that a waterfall model would not allow addressing new or changed requirements more effectively. This also applies to another identified possible problem – risk of requirements error, as the overall solution had quite a large number of integration points, it was important to have a possibility of amending the technical requirements more frequently.

- A technology risk, was also mitigated by applying agile model, which allowed to amend the base ICT technology during the course of the projects in order to ensure the final solution is based on the latest available and more secure ICT technology.

- Security Risk. Waterfall projects don't provide a product that can be tested for security until well into the projects. Agile projects produced testable product every few weeks. Flexible projects were capable of delivering interim solutions more often in order to allow for early security testing and acceptance.

- Cancellation cost was also addressed by the above selection. As mentioned by the two responders, waterfall methodology may significantly delay the discovery that a project doesn't fit for purpose. Factors that could potentially influence a decision to cancel the projects could be identified earlier in agile project.

Four survey participants advised the following risk factors, which were mitigated at the very beginning of their projects by the choice of development method.

- Risk of incompleteness of a solution was among the most critical, as due to the nature of the project deliverables, as they could not be used unless delivered fully. It was even more critical for the integration points delivery, as

incomplete link between IT systems could lead to an increased volume of issues during integration testing.

- Risk of underestimation was also addressed by the selection of waterfall life-cycle at the very beginning. Since most of the requirements were identified for the projects, it was easier to estimate the solution as a whole by following a step-by-step approach.

The three remaining survey participants were especially concerned with the risk of poor quality, which influenced a mitigation decision to follow waterfall approach. They've advised, that waterfall method is normally well structured, which improves the testing of the solution and allows to review and accept the system once it's fully developed. It was also noted, that within agile projects, risks of poor quality output are higher, as short iterations could pass on unknown software defects, which often could only be identified at a solution acceptance testing by the business unit.

All other risk factors, which were dealt differently to the prescribed organisational or best-practice guides are summarised below.

- Denial of risk was mentioned by three out of nine survey participants. The denial was mostly related to fear of negative exposure to business sponsors. In this case, risks weren't included in any risk management artefacts and planning of risk mitigation was neglected. One survey respondent also mentioned that sometimes risks weren't brought to project or programme management's attention to preserve good relationship with programme stakeholders. This also didn't support the programme risk management guide, nor the established risk management best-practices.

- Delay in making key decisions to manage risks by business and project stakeholders was mentioned by 7 survey participants. Quite high rate of occurrence was related to a large team of the decision makers within the programme, who, took too long time to analyse the impacts and agree on a solution or a decision. Although such risks were mostly adequately managed, delayed decision didn't allow to fully follow a mitigation plan, which impacted projects' schedules and costs. One respondent also advised, that delays in making risk mitigation decisions by the management were also related to additional goals, which were external to the project, but had to be taken into consideration.

- Another risk that was mentioned by most of the survey participants related to frequently changing priorities. Seven responders mentioned, that management of these kind of risks was taking too much time in many cases, and often was neglected by them. Five survey respondents admitted, that it was too difficult to track priority changes within their projects and time allocated to manage these risks was an excessive burden.

- Lack of risk management practice within the project team was another factor, which influenced the risk management processes within some of the projects. Six survey respondents mentioned that due to the different level of risk management knowledge within their project teams, risks weren't often brought to team's attention and were left unattended until they materialise or impact the project. This also relate to lack of communication within the project teams, which was reported by five survey participants. In order to address this, four out of six survey respondents advised that they had to establish regular team reviews of risks and issues, which took form of brain-storming meeting sessions with the project team members. This, however, wasn't a normal practice within the programme projects.

- As per most of the responses, contingency planning was part of the case programme risk management recommendation, as well as part of the most common risk management best-practices (reviewed in previous chapter). So such planning was expected to be completed by the managers of programme projects on a regular basis. Although most of the survey participants confirmed this was part of their normal practice, three of them advised that often it was not possible to realistically include an adequate contingency due to the complexity of estimation and strict budget and schedule boundaries. Thus, risk management wasn't complete in this regard.

- Challenges in addressing risks were also commonly reported by the survey responders. As a summary of three responses, finding a risk owner was often difficult for the risks, which were meant to be addressed by business stakeholders of the projects or overall programme. As per their responses, ICT and business sides of the programme often weren't connected and communication was at a poor level. Thus, risk management was incomplete due to the external factor.

- Another factor, which influenced risk management, mentioned by some of the responders, was stakeholders' expectations management. As a summary of four responses, the complex technical environment of the programme didn't allow business stakeholders to fully appreciate some technical aspects of risks that could impact projects. In particular, in order to secure a programme management decision to address such risk, the four survey participants advised that they had to deviate from the risk management approach they were following by creating and maintaining additional documentation for each technical risk in order to ensure common understanding of cause and impact is shared with broader team.

- As reported by four survey participants, not clear organisational risk management strategy also influenced the risk management activities. As a summary of the four respondents, organisational risk management wasn't clearly prescribed from the very beginning of their projects, which influenced changes to the risk management approaches that were established at the beginning of projects.

- Ambiguity was another factor, which impacted the risk management processes within the case programme. Six ICT professionals surveyed, confirmed that risks related to ambiguity were only documented in risk registers, but had no clear actions, owners, or even descriptions in some cases. These risks weren't managed until more information was obtained. Often, risks had to materialise in order to understand the details of them and minimise the impacts to projects.

4.4. Summary of Findings

This section presented the detailed analysis of the survey data gathered for the research. In order to address the research objective, case study survey questions were directly linked to the research question. The survey questions allowed the researcher to:

- Identify of the interviewee background and project management experience outside of the case programme.

- Reveal the level of participation in the case ICT programme, to ensure the level of involvement in the managerial decision making within the programme was suitable for the research.

- Describe the real-life risk management processes that were undertaken to manage risks within the case ICT programme by the interviewee, as well as to reveal any deviations that took place during the course of the programme or project.

Twelve survey questions were developed to address the research objective. They all were answered by the selected participants in full. As part of the research findings, survey participants' risk management experiences were analysed to ensure their responses contain quality data for research analysis. Although not all the survey responders were occupying project management roles, all of them were at an adequate managerial level to be responsible for risk management within their projects. All survey participants had a project management training in the past and confirmed their experience was at an adequate level to manager risks within their projects. Also all of them confirmed that risk management was part of their regular management practice within the case ICT programme. Responders also referred to learning from the standard risk management methodologies mandated on the programme level. One of the interesting points taken during the survey was that survey respondents mostly were following their own experience while dealing with risks.

Survey data analysis showed, that:

- All responders confirmed that the risk management often deviated from the case programme guides and in some cases was different from what industry best practices prescribe due to different factors faced during the course of their projects.

- Factors, influenced the deviations in risk management application within the projects of the case ICT programme, were identified and their impact analysed.

In conclusion, the research confirmed that risk management in ICT projects didn't fully followed the established industry best-practices or organisational guides, due internal and external influences on ICT projects. It was noted, that for effective risk management, ICT professionals had to deviate from the guides and find a best suitable process to match a particular type of risks.

4.5. Survey Data Analysis Against the Selected IS Theory

Contingency Theory was chosen to explain and understand the research findings. As described in section 3.5.1, the theory places emphasis on matching the best leadership approach to specific situations (Northouse, 2013). The key of the theory is to find pinpoint that the right management approach must be tailored to fit a particular situation, environment or organisation.

Survey respondents confirmed, that they had to adjust to specific circumstances in order to address ambiguity and risks within their projects more effectively. It was concluded, that there was no "*one best way*" in risk management, that could fit all risky or ambiguous situations. Thus, the research results match with Contingency Theory, as in order for risk management practices to be successful, they should be tailored to fit for purpose. The research findings could also propose, that risk management in ICT projects should consider creation of a set of additional risk management processes to manage exceptional risks.

5. Conclusions and Future Work

5.1. Introduction

This chapter will summarise how the research data and its analysis answered the research question and contributed to the body of knowledge.

5.2. Answering the Research Question

The current research proposed to examine a case ICT programme to investigate how ICT managers managed risks, their approaches, behaviours and actions. The focus was on differences between risk mitigation techniques proposed by well-established project management guides and real actions undertaken by project managers in response to risks in ICT projects. The primary research question: “Do current risk management practices, employed by ICT managers in complex ICT projects, differ from theoretical knowledge and how?” was adressed by the case study based on a complex ICT programme, which was managed by the lead researcher between years 2014 and 2016. Semi-structured interviews with ICT professionals, involved in managing different parts of the selected case programme, allowed to gather valuable real-life risk management experience.

Survey data analysis confirmed that the risk management often deviated from the case programme guides and in some cases was different from what industry best practices prescribe due to different factors faced during the course of their projects. Identification of those factors was a secondary target of the research, which was completed and summarised.

5.3. Contribution to the Body of Knowledge

The current research contributed to the body of knowledge by describing risk management practices that industry best-practices, like Capability Maturity Model (CMMI), Cobit 5 Framework, PRINCE2, PMI and ISO 31000 propose. The descriptions could be used by the existing or just establishing companies as a guide to manage ICT related risks.

The research further gathered and analysed the survey data, gathered from ICT project managers, which confirmed that for successful risk management, it’s not enough just to follow the best-practices. They must be tailored to an organisation or a

project to be fully effective. Furthermore, they must be flexible enough to cover exceptional scenarios, where standard risk management practices won't be effective.

The study also provides a basis for further research in the risk management and in overall ICT project management areas.

5.4. Limitations of the Research

This study, by its nature, has a number of limitations (described in previous chapters) due to the limited amount of time that was dedicated to gather rea-life practices through interviews. Due to the limited number of survey responders and concentration on one singe ICT case programme, the results of this study might not be beneficial for broader organisations. Due to the emphasis on quality of the research data, the survey responses were quite subjective and were based on personal experiences. This also limits the application of the research results in other areas.

5.5. Recommendations for Future Work

The current study proposes further research in risk management area, especially for professionals involved in ICT industry. Further research could be beneficial if it could be based on quantitative analysis with bigger data samples to analyse. This could reveal more patterns in risk management practices toward particular set of risks and propose a set of recommendations to manage those in a separate manner.

Further qualitative analysis could be based on a number of cases to cover more real-life scenarios in different environments.

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Appendices

Appendix 1 – Ethics Application

School of Computer Science & Statistics
Research Ethics Application

CHECKLIST

The following documents are required with each application:

1.	• SCSS Ethical **Application Form**	X
2.	• **Participant's Information Sheet** must include the following: a) Declarations from Part A of the application form; b) Details provided to participants about how they were selected to participate; c) Declaration of all conflicts of interest.	X
3.	• **Participant's Consent Form** must include the following: a) Declarations from Part A of the application form; b) Researchers contact details provided for counter-signature (your participant will keep one copy of the signed consent form and return a copy to you).	X
4.	• **Research Project Proposal** must include the following: a) You must inform the Ethics Committee **who** your intended participants are i.e. are they your work colleagues, class mates etc. b) How will you recruit the participants i.e. **how** do you intend asking people to take part in your research? For example, will you stand on Pearse Street asking passers-by? c) If your participants are under the age of 18, you must seek both parental/guardian AND child consent.	X
5.	• Intended questionnaire/survey/**interview** protocol/screen shots/representative materials (as appropriate)	X
6.	• **URL** to intended on-line survey (as appropriate)	n/a

Notes on Conflict of Interest

1. If your intended participants are work colleagues, you must declare a potential conflict of interest: you are taking advantage of your existing relationships in order to make progress in your research. It is best to acknowledge this in your invitation to participants.
2. If your research is also intended to direct commercial or other exploitation, this must be declared. For example, *"Please be advised that this research is being conducted by an employee of the company that supplies the product or service which form an object of study within the research."*

Notes for questionnaires and interviews

1. If your questionnaire is **paper based**, you must have the following **opt-out** clause on the top of each page of the questionnaire: *"Each question is optional. Feel free to omit a response to any question; however the researcher would be grateful if all questions are responded to."*
2. If you questionnaire is **on-line**, the first page of your questionnaire must repeat the content of the information sheet. This must be followed by the consent form. If the participant does not agree to the consent, they must automatically be exited from the questionnaire.
3. Each question must be **optional**.
4. The participant must have the option to **'not submit, exit without submitting'** at the final submission point on your questionnaire.
5. If you have open-ended questions on your questionnaire you must warn the participant against naming **third parties**: *"Please do not name third parties in any open text field of the questionnaire. Any such replies will be anonymised."*
6. You must inform your participants regarding **illicit activity**: *"In the extremely unlikely event that illicit activity is reported I will be obliged to report it to appropriate authorities."*

UNIVERSITY OF DUBLIN, TRINITY COLLEGE

Faculty of Engineering, Mathematics and Science

School of Computer Science and Statistics

RESEARCH ETHICS PROTOCOL

When is Ethical Approval Needed?
Ethical approval is required before any studies involving human participants can commence. This requirement applies to studies to be undertaken by staff, postgraduate and undergraduate students. In the case of collaborative projects involving researchers from outside the School, ethical approval obtained from an external research ethics body may suffice – evidence of same must be submitted to the SCSS Research Ethics Committee prior to the commencement of the study (see procedures below). In the absence of such external approval, approval must be obtained as per this document. Additional ethical approval may be required if the project involves or is funded by an external body, for example, studies under FP7 automatically require such approval.

For the purpose of this document a "study" may be understood to involve a potentially staged series of different experiments to be conducted over a period of time. If substantive changes are made to a study following receipt of ethical approval, this will constitute a new study for which further ethical approval must be obtained.

Procedure
Completed application forms together with supporting documentation should be submitted electronically to research-ethics@scss.tcd.ie To submit, if the proposal is from an undergraduate or postgraduate students, the **completed** application package must be presented to the academic supervisor who will sign after verifying completeness. These signed originals may be scanned and emailed. Please use TCD e-mail addresses only. When your application has been reviewed and approved by the Ethics committee hardcopies of the application form with original signatures should be submitted to the School of Computer Science & Statistics, Room F37, O'Reilly Institute, Trinity College, Dublin 2.

The Committee will consider each application and normally provide a response within two weeks but not more than one month later. Applications that are considered not to have significant ethical implications may be evaluated by the Committee Chair without reference to the full Committee. Applications will otherwise be considered at a meeting of the SCSS Research Ethics Committee. When approval has been obtained from an external research ethics committee, and School approval is not required, a copy of the external ethical approval must be submitted to the School's Research Unit, prior to commencement of study, for noting by the SCSS Research Ethics Committee.

Please note that in signing the approval form one is making a commitment to review the provisions of the Data Protection Act, like legislation and College Policy on Good Research Practice. Please ensure that your study conforms to the standards of anonymity preservation and data retention set in those documents. Those provisions suggest a default proscription against making digital or photographic recordings of participants. A study which requires such records must include in the research ethics approval application a justification and documentation of the methods by which the statutory provisions and research practise guidelines will be met.

Note: These procedures may be amended from time-to-time following recommendation by the SCSS Research Ethics Committee and with the approval of the SCSS Research Committee.

Before seeking ethical approval researchers should:
- identify actual and potential ethical issues that might arise;
- reflect on how these will be addressed; and
- formulate procedures to deal with all such issues.

During the research project researchers should:
- implement the ethical procedures;
- obtain continuous feedback from participants about ethical issues;
- periodically review the ethical strategy in the light of feedback received; and
- if required, update their ethical procedures;
- retain copies of consent forms signed by the participants.

Composition of the SCSS Research Ethics Committee
The Committee will consist of a Chairperson/Convenor appointed by the Director of Research and two other experts – a member of the School's academic staff and external advisors. The internal and external members will be selected from a panel approved by the Director of Research from time to time. Members will be selected on a case by case basis by the Chairperson subject to their availability. Researchers will be precluded from the Committee considering ethical approval for their study.

School of Computer Science and Statistics
Research Ethical Application Form

Part A

Project Title:	**A study of risk management practices in ICT projects**
Name of Lead Researcher (student in case of project work):	**Aleksandr Djulger**
Name of Supervisor:	**Patrick Joseph Wall**
TCD E-mail:	**djulgera@tcd.ie**
Contact Tel No.:	**+353 (0) 86 087 6436**
Course Name and Code (if applicable):	**Management of Information Systems**
Estimated start date of survey/research:	**May/June 2016**

I confirm that I will (where relevant):

- Familiarize myself with the Data Protection Act and the College Good Research Practice guidelines http://www.tcd.ie/info_compliance/dp/legislation.php;
- Tell participants that any recordings, e.g. audio/video/photographs, will not be identifiable unless prior written permission has been given. I will obtain permission for specific reuse (in papers, talks, etc.)
- Provide participants with an information sheet (or web-page for web-based experiments) that describes the main procedures (a copy of the information sheet must be included with this application)
- Obtain informed consent for participation (a copy of the informed consent form must be included with this application)
- Should the research be observational, ask participants for their consent to be observed
- Tell participants that their participation is voluntary
- Tell participants that they may withdraw at any time and for any reason without penalty
- Give participants the option of omitting questions they do not wish to answer if a questionnaire is used
- Tell participants that their data will be treated with full confidentiality and that, if published, it will not be identified as theirs
- On request, debrief participants at the end of their participation (i.e. give them a brief explanation of the study)
- Verify that participants are 18 years or older and competent to supply consent.
- If the study involves participants viewing video displays then I will verify that they understand that if they or anyone in their family has a history of epilepsy then the participant is proceeding at their own risk
- Declare any potential conflict of interest to participants.
- Inform participants that in the extremely unlikely event that illicit activity is reported to me during the study I will be obliged to report it to appropriate authorities.
- Act in accordance with the information provided (i.e. if I tell participants I will not do something, then I will not do it).

Signed: **Aleksandr Djulger** Date: **15/04/2016**
Lead Researcher/student in case of project work

Part B

Please answer the following questions.	*Yes/No*
Has this research application or any application of a similar nature connected to this research project been refused ethical approval by another review committee of the College (or at the institutions of any collaborators)?	*no*
Will your project involve photographing participants or electronic audio or video recordings?	*yes*
Will your project deliberately involve misleading participants in any way?	*no*
Is there a risk of participants experiencing either physical or psychological distress or discomfort? If yes, give details on a separate sheet and state what you will tell them to do if they should experience any such problems (e.g. who they can contact for help).	*no*

Does your study involve any of the following?	Children (under 18 years of age)	*no*
	People with intellectual or communication difficulties	*no*
	Patients	*no*

School of Computer Science and Statistics
Research Ethical Application Form

Details of the Research Project Proposal must be submitted as a separate document to include the following information:

1. Title of project
2. Purpose of project including academic rationale
3. Brief description of methods and measurements to be used
4. Participants - recruitment methods, number, age, gender, exclusion/inclusion criteria, including statistical justification for numbers of participants
5. Debriefing arrangements
6. A clear concise statement of the ethical considerations raised by the project and how you intend to deal with them
7. Cite any relevant legislation relevant to the project with the method of compliance e.g. Data Protection Act etc.

Part C

I confirm that the materials I have submitted provided a complete and accurate account of the research I propose to conduct in this context, including my assessment of the ethical ramifications.

Signed: **Aleksandr Djulger** Date: **15/04/2016**
Lead Researcher/student in case of project work

There is an obligation on the lead researcher to bring to the attention of the SCSS Research Ethics Committee any issues with ethical implications not clearly covered above.

Part D

If external ethical approval has been received, please complete below.

External ethical approval has been received and no further ethical approval is required from the School's Research Ethical Committee. I have attached a copy of the external ethical approval for the School's Research Unit.

Signed: ..... Date: .....
Lead Researcher/student in case of project work

Part E

If the research is proposed by an undergraduate or postgraduate student, please have the below section completed.

I confirm, as an academic supervisor of this proposed research that the documents at hand are complete (i.e. each item on the submission checklist is accounted for) and are in a form that is adequate for review by the SCSS Research Ethics Committee

Signed: .....PJ Wall..... Date: .....23 April 2016.....
Supervisor

Completed application forms together with supporting documentation should be submitted electronically to research-ethics@scss.tcd.ie Please use TCD e-mail addresses only. When your application has been reviewed and

Appendix 2 – Information Page for Participants

Trinity College Dublin, School of Computer Science and Statistics

Research Title: A study of ICT risk management approaches in formal methodologies and practical application.

Lead Researcher: Aleksandr Djulger

Supervisors: Patrick Joseph Wall, Trinity College Dublin, School of Computer Science and Statistics

Lead Researcher Contact Details: Name: Aleksandr Djulger, djulgera@tcd.ie

Expected Duration.

The expected duration of this research is from March 2016 to August 2016.

This study is conducted in partial fulfilment of Masters Degree, to be awarded by the School of Computer Science and Statistics, Trinity College Dublin, Ireland.

Background to the Research.

Awareness of uncertainty and risk management in many sectors of personal, public and business activities have become one of the main topics. When it comes to Information and Communication Technology (ICT) business sector, risk and uncertainty becomes even more relevant due to its fast evolution and complexity.

Efficient risk management in ICT projects has become one of the key awareness points for businesses involved or employing ICT. There is a significant stream of research on risk management and mitigation, which resulted in a number of frameworks, recommendations and techniques aiming to make an ICT project manager's live easier by following a proposed pattern in responding to a risk. Despite well-established project risk management processes, some ICT project managers perceive their application as ineffective to manage risks.

This research proposes to examine a case to investigate how ICT project managers managed risks, their approaches, behaviours and actions. The focus is on differences between risk mitigation techniques mandated by well-established project management

guides and real actions undertaken by ICT project managers in response to risks in ICT projects.

The procedures relevant to the participant within this particular study.

The lead researcher invites you to participate in this project based on the fact that you are currently, or have been previously, involved with the case ICT project in some capacity. Your participation will involve a semi-structured interview which will last between 60-90 minutes. The topics covered in the interview will include, but are not limited to, a description of your involvement in the case project, a description of the work that you completed, your experiences of the project, what dictated the manner in which you worked, any problems you encountered, what you believe was successful about your participation in the project, and your overall opinions about the project. In some cases, I may ask that you participate in a short follow up interview. This will only occur where there is a need to confirm prior findings and/or identify any changes that may have taken place since the initial interview. For any participants who are to be re-interviewed, the same interview guide and Participant Information Sheet will be used.

Interviews will be electronically recorded. The recordings will be destroyed within three months after the record was taken.

The researcher, being an appointed responsible project manager to the case project, has access to the details of the resources assigned to the project. The case project resource list maintenance has been a responsibility of the lead researcher thus the details of the list are available to him. Personal contact details of the case project prospective participants were obtained from verbal conversations directly with them during the initial introduction to the research. Research participants were selected based on their initial verbal agreement to participate in the research.

Participants will be informed of this prior to the commencement of the interview and will be given the opportunity to withdraw from the interview process if they would prefer not to be interviewed. Participants will also have an opportunity to review all recordings after the completion of the interview process and make any changes and/or corrections they deem necessary. All interview recordings will be encrypted and only the lead researcher and the research supervisor will have access to these recordings. Any recording made will not be replayed in any public forum or presentation of the research. You may stop electronic recording at any time, and you may at any time, even

subsequent to your participation in this research, have such audio and/or video recordings destroyed. At no time will any electronic recording be identifiable unless you give prior written permission.

Declaration of conflicts of interest.

The lead researcher declares that he has no conflicts of interest of any sort in connection with this research. The lead researcher is not aware of any conflicts of interest between any of the research team and this research. The current research contributes to course requirements of the researcher's MSc in Information Systems within Trinity College Dublin.

How Participants have been selected to participate in this Research.

You have been selected for participation in this research because you currently are, or at some time in the past were, involved in some capacity with the case project. This involvement may have been as a business analyst, project manager, systems architect, or senior management project coordinator or any other person who may be reasonably expected to have been involved with the planning, development, implementation, monitoring, evaluation, or operation of the case project.

You have not been selected at random. You have been selected based on the lead researcher’s knowledge of this project, or based on information provided by one or more people who have been involved with this case ICT project.

The voluntary nature of the participation.

Your participation in this research is voluntary, and without prejudice to your legal and ethical rights. You have the right to withdraw at any time without penalty. You have the right to omit any responses to individual questions without penalty.

Anticipated risks/benefits of participation.

There are no anticipated risks to your participation in this research. However, please be aware that if you make illicit activities known, these will be reported to appropriate authorities.

The provisions for debriefing after participation.

If requested, you will be fully de-briefed at the end of your participation in this research. If you so wish, you will also be given a brief explanation of the study.

Dissemination of the Research, and Publications arising from the Research.

Results, data and findings from this research will be published as Masters Thesis Research. Primarily, Trinity College Dublin will be responsible for sharing research findings through their government and academic partnerships both in Ireland and abroad.

By participating in this research, you agree that this data may be used for such scientific purposes, and that you have no objection that the data is published in research and scientific publications in a way that does not reveal your specific identity.

At all times your data will be treated with full confidentiality. There will be preservation of participant and third-party anonymity in analysis, publication and presentation of resulting data and findings. Any results, data and findings will be fully anonymous and no personal details about you will be revealed or identified as yours. If you name any third parties, these will be anonymized.

There will be provision for verifying direct quotations and their contextual appropriateness. If any direct quote from you is to be used, you will be contacted in advance and asked to give permission for the use of the quote. You will also be asked if the use of the quote is contextually appropriate and otherwise accurate. If you decline to give permission, the quote will not be used.

The principle investigator must, at all times, act in accordance with all information provided in this and other documents.

Ethical Approval.

The lead researcher has obtained ethical approval for this research from the School of Computer Science and Statistics, Trinity College Dublin.

Appendix 3 – Survey Questionnaire

- Question 1: How many years of ICT management experience do you have?
- Question 2: What are the industry best-practices you have learned and applied in the past, outside of the current case programme? Could you also describe any additional risk management trainings you had in the past?
- Question 3: What was your role in the case ICT programme?
- Question 4: Please describe the size of the team you were managing within the case ICT programme and your project.
- Question 5: Please describe the level of risk management responsibility you had within the case programme and your project.
- Question 6: Was the project and risk management methodology, you've applied within the case ICT programme, influenced by the organisational standard? If it was, what was the industry best practice the standard was based on?
- Question 7: Please describe the level of risk management that was applied within your project.
- Question 8-12: Please advise if risk management practice you've applied within your project fully followed the organisational, case programme or industry best-practices' recommendations.
- Question 9: What were the internal factors that influenced changes in risk management application within your project?
- Question 10: Were there any external factors that influenced changes in risk management application within your project?
- Question 11: Were you satisfied with level of support in risk management from your project's team?
- Question 12: Are the any other points you would like to add, that could contribute to the current research?