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RISK ASSESSMENT FOR CHANGE MANAGEMENT WITHIN PROJECT MANAGEMENT: A HIERARCHICAL MODEL PROCESS APPROACH

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List of Abbreviations

AHP: Analytic Hierarchy Process

ANSI: American National Standard

AS 8015-2005: Australian Standard for IT Governance

APM: Association of Project Management

APMBOK: Association for Project Management Body of Knowledge

BS: Business Solution

CC: Communications Channels

CEO: Chief Executive Officer

CI: Consistency Index

COBIT: Control Objectives for Information and Related Technology

CCPM: Critical Chain Project Management

CPM: Critical Path Method

CRAM: Change Risk Assessment Model

CR: Consistency Ratio

CFS: Critical Success Factors

DoD: US Department of Defence

EEF: Enterprise Environmental Factors

EM: Environment Model

EMEA: Europe - Middle East - Africa

EMV: Expected Monetary Value

eSCM-SVv2: esourcing Capability Model for Service Providers version 2

eTOM: Enhanced Telecom Operation Map

HR: Human Resources

ISO: International Standards Organisation

ISP: International Service Provider

ITIL: Information Technology Infrastructure Library

ITSP: Internet Telephony Service Provider

MDBE: Model Driven Business Environment

M_o_R: Management of Risk: Guidance for Practitioners

MSP: Managing Successful Programmes

ODM: Original Device Manufacturer

OGC: Office of Government Commerce

OPM3: Organisational Project Management Maturity Level

PESTEL: Political, Economical, Social, Technological, Environmental, Legal

PMBOK: Project Management Book of Knowledge

PMI: Project Management Institute

PSM: Project Specific Model

PRINCE2: Projects in Controlled Environment

RACI: Responsible - Accountable - Consulted - Informed

RI: Random Index

RI: Relative Importance

RnD: Research and Development

RFP: Request for Proposal

RBS: Risk Breakdown Structure

RMS: Risk Management Strategy

SWOT: Strengths, Weaknesses, Opportunities, Threats

VP: Vector Priority

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To my family, and in the memory of Dr Manos Nistazakis

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I, Charalampos Apostolopoulos, author of the thesis entitled **"Risk Assessment for Change Management within Project Management: A Hierarchical Model Process Approach"** grant powers of discretion to the University Librarian to allow the thesis to be copied in whole or in part without further reference to the author. This permission covers only single copies made for study purposes, subject to normal conditions of acknowledgement.

Abstract

The field of modern project management is not new, and what seems to have changed over the past decade is the evolution of techniques applying theory into practice. This had as a consequence for the need to standardise and structure different processes of project management, in a detailed, documented and formal manner.

On the other hand, change management seen as an integrated process within project management is a rational process for exploring decision and behaviour alternatives in an attempt to realign the course of 'derailed' deliverables due to change and ensure project success.

However, models contained in such frameworks often lack formal semantics and clarity; generally fail to address and assess organisational change management risk reasoning, in a rather detailed way as they do for the majority of the project management processes.

Since, uncontrolled changes might have an effect on the projects' success, it is vital to assess the probability of materialisation (risk) of success before the decision is made and whether to proceed with the change or not. For example, if the change dramatically increases the risk of failure then it is logical to assume that avoiding that implementation is the right decision. Ideally, a change or consequence based upon a decision should have a low impact and a fairly high level of predictability.

This research, takes the challenge to propose a novel modelling approach, which will contribute significantly to the missing formality of business models especially in the change risks assessment area.

The introduction of Change Risk Assessment Model (CRAM) allows the identification and definition of speculative relationships, between change risks in the form of hierarchical risk tree analysis. Overall, the method is dynamic and flexible enough that can be tailored to various project requirements, taking into account significant environmental risk factors which influence project deliverables.

Project success is a key objective for today's organisations; professionals can make use of a new methodology for risk assessment, compatible with project management frameworks which currently seems to be missing from literature.

Project management methodologies are not a panacea against project failure; nevertheless, CRAM can be regarded as a comprehensive modelling approach which combines both quantitative and qualitative risk criteria analysis in decision making processes.

Introduction

"Everything is constantly changing….
All is flux, nothing stays still…
Τα πάντα ῥεῖ καὶ οὐδέν μένει"
Heraclitus (540 BC - 480 BC)

The field of modern project management is not new (Cleland, 1994; Chaffey, 1997; Maylor, 2001, Apostolopoulos et. al, 2014) as it started to emerge in 1990s. Actually, what seems to have changed over the past decade is the evolution of techniques applying theory into practice. This has had as a consequence, the need to standardise and structure different project management frameworks in a detailed, documented and formal manner. In this light, change management mostly observed and utilised as an integrated process within project management, is a rational process for exploring decision making and behavioural alternatives in an attempt to address the "derailed" deliverables due to change and ensure project success (Apostolopoulos et. al., 2014b).

On the other hand, high project failure rates (Standish Group, Chaos Reports: 1994, 2003, 2007; Taylor, 2006; Gottesdiener, 2001) has given the incentive to institutions, agencies and even individuals to develop and establish standards for project management methodologies, such as: PMBOK[1], PRINCE2[2], APMBOK, SCRUM, ISO 21500 and others. These are not simply good practice guidelines, but also

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1 PMI® and PMBOK® are registered trademarks and PMP® is a registered certification mark of the Project Management Institute, Inc., registered in the United States and other nations.
2 PRINCE2® , M_o_R® , ITIL® are registered trademarks of AXELOS Limited.

mandatory requirements in complex project environments. The US and UK governments request that organisations bidding for public services projects have human resources certified in PMBOK and PRINCE2 respectively.

The main strength of such frameworks lies in their comprehensive formality, narrative of collective experience and accuracy in describing specific processes for specific purposes such as indicatively: plan scope management, control schedule, perform quality assurance, control costs and perform qualitative risk analysis.

Nevertheless, there can be found many reasons a project can fail, like for example: lack of user input and clarifications, change in requirements and specifications, unrealistic budgeting, lack of risk estimation policies and poor requirements definition (Chaos Reports: 1994, 2003, 2007; Faulconbridge and Ryan, 2002; Apostolopoulos and Karamitsos, 2009; Apostolopoulos and Simpson, 2009).

In this context, Bourne and Walker (2005) categorised project failure as technical, data, user and organisational. In addition, the culture of the stakeholders is also accounted as one of the organisational reasons for project failure. In this extent, culture may refer to underlying beliefs, values or even principles that can serve as a foundation for an organisation's management system (Denison, 1990) exerting strong influence on its members, who are involved with project management and undertake projects.

Based on an independent study 'The changing face of project management', examining the project panorama in UK conducted by Loudhouse Research (2007) some interesting results were revealed:
"

- 30% budget over-runs (1 in 6 projects surpass this limit)
- 50% over budget (10 out of 29 projects on the go at any one time will come in over budget).
- Inaccuracy concerning scope and forecasting (50% cause for budget over-run).
- Only 35% of the companies check whether initiatives are aligned with objectives
- 74% struggle to access critical skills. "

Effectively, a standardised approach is necessary to enhance success and deliver projects within time, budget, quality and scope taking also into account, other environmental factors such as anticipated change(s) and risk(s).

In this light, professionals consider structured project management methodologies as a possible solution to the aforementioned issues.

For reasons of effective comparison and alignment to the scope of this thesis, the two most highly regarded and widely established global project management frameworks, PMBOK[3] (US standard) and PRINCE2 (UK standard) will be thoroughly examined and discussed.

PMBOK a project management framework and PRINCE2 a process-driven methodology are both highly detailed and structured; PMBOK (5th edition, 2013) consists of 47 processes mapped in 5 distinct process groups split into 10 knowledge areas, is recognised by the American National Standards Institute (ANSI) as an American National Standard (ANSI/PMI 99-001-2008). On the other hand, PRINCE2 (2009) consists of 7 processes which are organized into 7 themes and various activities. Both frameworks, eventually introduce a degree of complexity and lack of an effective mechanism for accommodating change in relation to risk assessment (More details can be seen in Appendix 3).

Nonetheless, the processes of change management and risk assessment are usually regarded as separate business domains and ones which should be generally implemented during the entire life cycle of a project. Besides the generic need for change, implementing change is often perceived as an unsurpassable challenge due to several cultural or even behavioural reasons, relating to human resources who express considerable resistance to change and often hinders the success of the overall process (Apostolopoulos et.al, 2014a).

However, as long as business environments are subject to constant change and cultural diversity, frameworks require processes such as change management to

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3 PMBOK is the most dominant project management standard as it is used in more than 75% of the projects worldwide (Zandu and Lano, 2014).

maintain an up-to-date set of specifications for business requirements which can be applied to model depictions (Apostolopoulos and Maroukian, 2011).

Therefore, when the 'as-is' organisational architecture is visualised through models as well as the 'to-be' architecture which indicates the aftermath of a change, the purpose for change can be more effectively communicated to stakeholders.

However, what today seems to be a mission critical necessity for an organisation is to adapt to specific customer requirements and concepts such as: strategic business planning, customer satisfaction, market and customer profile adaptation, flexibility, and subsequently efficient and effective business change management (Dunford, et. al, 2013; Apostolopoulos and Simpson, 2009; Balogun and Hope Hailey, 2008).

PRINCE2 (2009) argues that organisations in order to succeed they have to balance two parallel competitive imperatives. The first one is related to current business operations maintenance (for example: profitability, service quality, productivity, customer relationships) and the second one business operation transformation. Especially for business transformation, this is linked with decisions on how de-risking business change can be pursued. On the other hand, PMBOK (2013), measures project success in terms of product and project quality, timeliness, budget compliance and degree to customer satisfaction.

The aforementioned structured project management approaches, could address to a higher degree the change management aspects associated to organisational risk management as they do in their current form for certain aspects of other project management processes.

However, project management can have strategic value, when the level of effectiveness and the efficiency with which a project is accomplished are interlinked and when the project's outcomes (product or services), can provide overall business value. Cabanis (1998) argued for the connection between project management and strategy, by indicating the involvement of the project manager at the start of the project, whereas Cicmil (1997) explained that strategic organisational change can be facilitated and managed through the use of project management disciplines.

Change management, is also a strategic (Balogun and Hope Hailey, 2008; Burke, 2008; Beitler, 2003) and structured approach to transitioning individuals, teams and organisations from a current state to a desired future state.

It is an organisational process aiming to empower employees to accept and embrace changes in their current business environment. Change and adaptation focusing on project requirements concerns mainly the organisation's general approach in doing business or the relationship between managers and employees or more general company-clients business relationships. Nonetheless, the implementation of project management also requires changes, e.g. in the processes, tools, and methods used to fulfil organisational goals (Martinsuo et. al., 1991).

As it will be shown later, managing changes can well lead projects to be on time, within budget adhering to defined quality. For PMBOK (2013, p.9) project management is not only a critical strategic discipline but also a means to utilise projects directly or indirectly to achieve objectives. Such objectives might be seen as strategic opportunity, in terms of business demand, customer requests and market demand.

Actually, contemporary project management methodologies can be seen as an integrated tool for managing change irrespective of organisation type. Such changes may involve for example new organisational strategies (Pelligrinelli & Bowman, 1994; Turner, 1999); or even new business development (Cleland, 1994). Hence, in order for business value to be generated, most organisations turn into contemporary structured project management methodologies so as to gain competitive advantages and increase the probabilities of project's success.

In literature, there exist many different models and views for managing change, such as Lewin's, (1951) three stage model (Unfreezing, Confusion, Refreezing); Bullock and Batten's (1985) planned change phases (Exploration, Planning, Action, Integration); Bridges (1991) managing the transitional phases (Ending, Neutral, New Beginning). Overall, this is mainly a narrative complex, time consuming; above all descriptive multi-stage process which excludes any risk-assessment process (Apostolopoulos et. al., 2014a).

1.1   Project Management Frameworks Overview

There are certain predominant global project management frameworks which have a significant impact and contribution to global teams performing according to a set of project goals, with specific deliverables e.g. a report, a project or quality plan, a product or even a service.

More specifically, the Project Management Body of Knowledge (PMBOK) has been developed by the Project Management Institute (PMI), based in the US, whereas the PRojects IN Controlled Environments (PRINCE2) was developed by the Office of Government Commerce (OGC), in the United Kingdom. The term 'Body of Knowledge' signifies the complete set of concepts, terms and activities that make up a professional domain.

A 'professional domain' can be characterised as customer, company, contact, location, airport, gas station (Eremin, 2008). Most organisations work in only a few domains. They repeatedly build similar systems within a given domain with variations to meet different customer needs. Rather than building solutions from scratch, significant savings can be achieved by reusing portions of previous systems in the domain to build new ones.

Effectively, a 'Professional Domain Engineering' (Apostolopoulos et. al., 2014) could mean, the process of systematic reuse of domain knowledge such as 'business documentation' e.g. solution proposals to RFPs, project plan, communication plan, risk management plan, change management plan, etc. in projects of any nature and specialised industry e.g. pharmaceutical, aerospace, petroleum, retail, telecommunications, etc., in order to attain financial and productivity gains by avoiding to repeat tasks of building the solution from scratch.

The globally established project management frameworks, such as PMBOK, provide baseline information on what needs to be in place for an organisation or a project team to have the setup, that will facilitate the project to its successful accomplishment in terms of scope, cost and time and quality.

Other modern process-driven project management methodologies such as PRINCE2 provide a thorough insight concerning how to conduct effective project management, following a specific set of step-by-step rules. More details about PMBOK and PRINCE2 processes can be seen in Appendix 3.

1.2   Project Change Management Overview

Market needs are constantly changing and the new status quo requires market adaptation, strategic business planning, flexibility, speed, and sometimes even cultural changes. However, the transitional period of change is not only time consuming but also a risky process. Quite often, due to cultural or even organisational reasons, the whole process can fail (Apostolopoulos et. al., 2011). In this context, risk can be regarded as an integral part for both, businesses and management (Hagigi and Sivakumar, 2009).

Project teams are the specific stakeholders who are firstly influenced by changes. In most cases a project management team is formed by members who may have significant differences, for example in terms of experience, cultural norms, business handling behaviour, etc. It is not rare in large and complex projects, to involve a considerable number of teams from vendors and/or clients of different ethnicity, which have to collaborate and work together.

In view of this, Kanungo (2006) argued that "people in different cultures respond in different ways and have different value systems which make the differences in business practices" and in effect understanding and adapting to changes. In the same sense, project team members within different departments have to interact and work together but at the same time have different professional backgrounds (Pieterse et. al., 2012).

In particular, 'change' for project management can be seen as an integrated process which is related to controlling the project's requirements in an effort to change them, so as to eventually place activities in order and conform to customers requirements.

Not all changes have the same implications (risk impact) for projects as some might be accepted and some others might not. Similarly for risks, changes have analogous

impact. The more changes are accepted during the projects' execution phase (Baca, 2005) the more chances for project delays. (See Figure 2.6: Impact of Variables based on Project Time).

The main goal of organisational changes is improvement and sustainability; change over change is a state that most managers are reluctant to accept. In effect, changes in regard to project management are related to conforming to projects requirements such as: on time delivery, within budget and to acceptable quality (Figure 1.1), where client or end user requirements are actually fulfilled (scope).
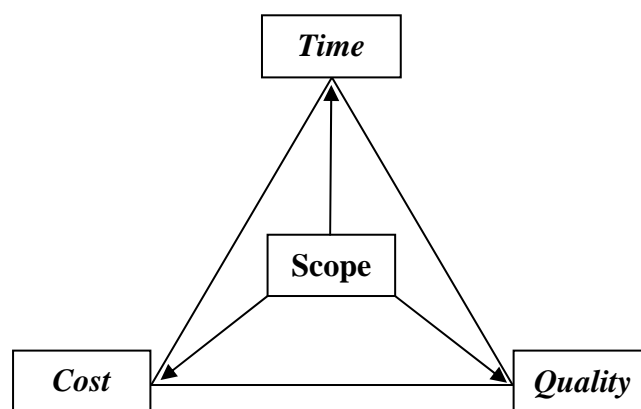
Figure 1.1: Project Management Triangle: Time, Cost and Quality Constraints; Source: Association of Project (APM)

Nevertheless, on per case basis, change plans need to be reviewed and conform to the current organisational or market needs. Since, overall changes might have an effect on the project's success, it is vital to assess the probability of success materialisation before the decision is made to proceed with the change or not; or even have an indication of the risk level. For example, if project change dramatically increases the risk of failure then it is logical to avoid a decision leading to its ratification (Apostolopoulos et. al., 2014a).

Project success can be described in a hexagon constraints diagram (Figure 1.2) where, realisation of strategic objectives, satisfaction of end users, and satisfaction of stakeholders is added (Shenhar et. al., 1997; Baccarini, 1999).
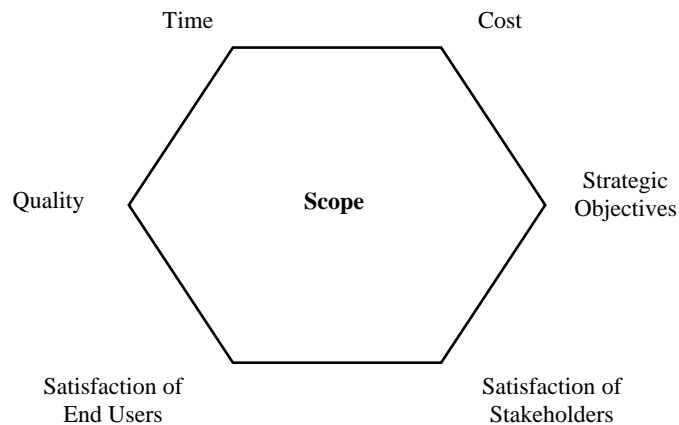
Figure 1.2: Project Management Hexagon

PRINCE2 (2009) actually moves a step forward by naming the constraints into variables which are involved in every project and have to be managed for the successful performance of the project:

- Costs
- Timescales
- Quality
- Scope
- Risk
- Benefits

In effect, except the four major constraints, risk and benefits are added. It is clear, that any changes in the project constraints can influence the success or failure of the end result of a project or its deliverables. However, it is within the scopes of this research to examine different attributes far beyond the constraints which are extensively referenced in PMBOK and PRINCE2, showing that the four major ones: time, cost and quality are just the peak of the iceberg. What lies beneath are factors related for example to: leadership, communication, culture, project management team characteristics and others (Apostolopoulos et. al., 2014).

Similarly, PMBOK (2013, p.3) defines the competing project constraints which have to be balanced:

- Scope

- Quality
- Schedule
- Budget
- Resources
- Risks

The relationship among the above factors is direct. If any one factor changes, at least one other factor is likely to be affected. Changing the project requirements or objectives may create in turn additional risks. However, project success in terms of measurement criteria (subjective or objective) is different to different people (Freeman and Beale, 1992). More details about contemporary project management frameworks and change can been in Appendix 3, paragraph A3.3.

In general, measurement of project success is difficult to be assessed due to changes during the projects' life cycle or because stakeholders may apply different criteria to the overall project success evaluation process. One of the objectives of this research is to propose that change as a knowledge area is highly related to project management and to attempt to assess the risk associated with, it in terms of modelling (Apostolopoulos et. al., 2014a).

1.3 Project Risk Management Overview

Risk can be defined as "any potential problem that threatens the success of a project" (Taylor, 2006). Focus on project risk management has moved from quantitative methods to structured risk management processes with a view to understand and embedd risk management throughout the projects' life cycle (Arrto, 1997). Table1.1 shows the definition of risk as defined in PRINCE and PMBOK respectively:

OGC PRINCE (2009)	PMI PMBOK (2013)
An uncertain event or set of events that, should it occur, will have an effect on the achievement of objectives. A risk is measured by a combination of the probability of a perceived treat or opportunity occurring and the magnitude of its impact on objectives (p.311).	An uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives (p.558).

Table 1.1: Risk Definition

From a quick look the two definitions share similarities in the sense of event uncertainty which impacts projects in terms of objectives achievement.

More specifically, project risk management is one of the main subjects of project management (Raz and Michael, 2001) together with other knowledge areas such as: planning, organisational control & monitoring, risk identification, estimation and control. In this context, risk estimation involves priorities and probabilities, rather complex in the real world that can be managed with intelligence, creativity and prior planning (Saaty, 1987). Even though, contemporary project management frameworks discuss topics related to risk management, yet they do not explicitly treat change risk assessment in terms of modelling adequately. In fact, PMBOK and PRINCE2 lack emphasis on a 'change management risk' knowledge area. However, Office of Government Commerce (OGC) publishes PRINCE2, and alongside with the project management methodology also publishes as a supplement guide, M_o_R (Management of Risk: Guidance for Practitioners) as an effective framework for taking decisions about risks that affect business performance objectives, fully integrated and aligned with PRINCE2 principles.

Briefly, the principles described in (M_o_R, 2007; p.9) are as follows:

1. *Organisational context* (identification of threats, opportunities, other uncertainties);
2. *Stakeholder involvement* (who is engaged in the risk process);
3. *Organisational objectives* (achieved in a satisfactory, responsible way);
4. *M_o_R approach* (describes, what, when, where, who, how and why);
5. *Reporting* (review and act accordingly);
6. *Roles and responsibilities* (who does what and how);
7. *Support Structure* (ensure that the processes are followed, led and directed);
8. *Early warning indicators* (proactive to anticipate potential problems);
9. *Review cycle* (internal control, monitoring);
10. *Overcoming barriers* (put things back on track, take corrective actions);
11. *Supportive culture* (establish right culture to support management of risk);
12. *Continual improvement* (development of strategies to improve risk maturity).

Since M_o_R is principles-based, it is able to describe a framework for risk management that can be applied to any organisation regardless of its size, complexity, location, or the sector within which it operates.

In contrast, PMI has its own relative publication named 'Practice Standard for Project Risk Management' in an attempt to provide a standard for project management practitioners and other stakeholders in a rather descriptive way. The underlying principles are as follows (Project Risk Management, 2009; p.3):

- *Plan Risk Management* (Develop overall risk management strategy);
- *Identify Risks* (identify known risks to project objectives);
- *Perform Qualitative Risk Analysis* ("assesses and evaluates characteristics of individually identified project risks and prioritises risks based on agreed-upon-characteristics", PMI; Risk Management, p.31);
- *Perform Quantitative Risk Analysis* (numerical estimation of the overall effect of risk on the project's objectives);
- *Plan Risk Responses* ("determines effective response actions that are appropriate to the priority of the individual risks and to the overall project risk", PMI; Risk Management, p.43);
- *Monitor and Control Risks* (related to correct plan executions, review and regular updates).

Overall, risks that are worth to be investigated can be highlighted through analysis to their high probability of occurrence or their high impact (Ahmed et. al., 2005). One of the main purposes of project risk management is to identify, estimate and control project risks which effectively are related to project success or failure.

Further to the brief introduction of contemporary project management frameworks, the next paragraphs describe in brief the research's aim, questions and significance. More details about the proposed model, integrated with AHP are provided in chapter 3 (Methodology) and chapter 4 (Change Risk Assessment Model: An AHP approach) of this thesis.

1.4   Research Aim

This research's aim is to propose an integration of change management within contemporary project management frameworks; alongside with a risk assessment mechanism, in the form of a hierarchical model. The proposed model, CRAM (**C**hange **R**isk **A**ssessment **M**odel) is a novel modelling approach for assessing business change management risk. It can be easily integrated with contemporary project management frameworks as the factors (and related attributes) are widely applicable in the broader landscape of business environments. For the assessment of change risks in terms of mathematical formulae and results reliability, AHP will be deployed.

This novel approach, (theoretically and practically) will eventually add the notion of risk assessment for change management within project management methodologies, which currently seem to be missing from literature. The main research question which arises is:

How is it possible to assess the risk of Change Management within Project Management? Additionally, how can this process be formalised in terms of modelling to a higher degree in order to output reliable and measurable results?

More specifically, in order to address these questions in terms of operational research; AHP, a multicriteria decision technique that can combine qualitative and quantitative factors for prioritising, ranking and evaluating alternatives will be used to model the notion of change risk management within contemporary project management processes.

Effectively, the use of models will contribute to the accuracy of calculating change risk(s) which in turn can be integrated to existing project management methodologies. The evaluation of the approach will be carried out in real business environments, through the facilitation of business case studies (Apostolopoulos et. al., 2014).

Figure 1.3: Research Challenge: Integration of Change Management, Project Management and Risk Management.

The main reason why AHP approach is proposed, is because business environments are complex in way that the more changes happen the more complicated project management is. This can be justified by the fact that there is a lot of interaction among multiple decision factors and attributes affecting complex decisions concerning change. In effect, it is important to determine the degree (impact) that each attribute entails, address complex situations, identify criteria and measure overall change management risk in a hierarchically based on priorities and overall risk tolerance model (Apostolopoulos et.al., 2015).

AHP sets priorities being a systematic method for comparing a list of objectives leading to a decision. The same stands true to risk taking; there should be made a decision concerning which risks are 'affordable' to take on. Risks which cannot be estimated or even controlled may a have a severe impact on change and in effect in the successful outcome of a project (Apostolopoulos et.al., 2015).

Based on Saaty (2001, p.12) " the most significant test of a scientific theory is its success in predicting outcomes correctly, and in how general is the class of the problems with which deals".

Similarly, change risks in project management have to be predicted accurately so as to avoid confusion among stakeholders and in the worst case scenario project failure. In addition a hierarchical 'tree like' graphical model representation can be easily interpreted being capable of representing probabilistic relationships among a set of variables and associated attributes, by the determination of the pairwise relationships among them.

Even though CRAM may carry a degree of complexity, one of its scope deliverables is to be used universally and irrespective of specific structured project management framework's approach. Overall, the aim is to fit to project business scenarios as a repeatable process. For this reason, upon completion of the model, the whole process can be simplified and automated (Apostolopoulos et. al., 2014).

1.4.1 Research Questions and Objectives

Further to the main aim of this research (risk assessment, modelling), there are some key research questions to be addressed as objectives which will contribute to the research as follows:

R1) Which are the key risk factors (identification) and their related attributes that influence successful project management change(s)?

The factors will be modelled and described with the aid of CRAM and will originate mainly from related literature review and interviews with executives from different industries, and contemporary project management frameworks knowledge. Author's personal reflection and experience in strategic project management will contribute accordingly.

R2) How much effect (impact) does a key risk factor (estimation) has on successful project management change?

The weight of each risk factor will be specified with the use of qualitative analysis and more specifically with the use of a questionnaire. Participants will be given the chance to weight each one of the identified risks based on Saaty's linear scale.

R3) How is it possible to asses change risks in terms of modelling?

Change management risk will be modelled with the introduction of CRAM in terms of a hierarchical tree model approach. The model's output will be an actual and measurable result; risks prioritisation.

1.4.2 Reseach Significance and Challenge

The integration of change management, project management and risk management is a challenging and highly novel objective. This research will consist mainly on both qualitative (questionnaire) and quantitative risk assessment approach with the deployment of AHP (hierarchical model approach).

Apostolopoulos et. al., (2015), argued that among other advantages, AHP can be overall assistive in estimating the changed probability of attributes in relation to other attributes, which facilitates the measurement of the risk probability change through the risk control of overall project risk management.

Having a risk estimate of a given change, provides essential information in reaching a decision of whether to accept the change or not, and also what are the risks and implications that this change will introduce.

As far as the academic community is concerned, this research, aims to bridge the gap between theoretical and applied work in the integrated research field of change management, project management and risk management.

In terms of the AHP research community, the final work will attempt to develop a novel systematic methodology (model) for assigning probabilities in attributes' pairwise comparisons; specifically, modelling the organisational / project change risks.

For the project management community, CRAM will provide a new novel representation integrating contemporary project management frameworks into

change management and risk management, adding new ideas and techniques to the area.

This is a challenging task, since core ideas of structured project management methodologies are based on processes and emphasise more accurately on the different ways of undertaking tasks. Project managers, implement and monitor change with a view to success, even though, the majority of actions are governed by time, cost and quality constraints. Consequently, they describe in a very detailed manner the processes to be followed, so as the outcome to be project success, nevertheless, there is a gap when analysing the risk of changes.

The proposed research, attempts to substitute currently prevailing descriptive risk analysis methodologies by a hybrid qualitative / quantitative change management risk modelling approach based on real input and measurements.

Upon completion of the research, it is expected that the final model can be applied to many industries (practical approach), including (but not limited) to those listed below:

- Product and Strategy Management;
- Software / Technology Solutions;
- Telecom /IT;
- Banking;
- Consulting;
- Engineering;
- Insurance;
- Government;
- Retail;
- Utility Sector;
- Defense;

and others.

1.4.3 Research Contribution References

This thesis results and related contribution have been published in the following peer- reviewed journals and proceedings:

[1] Apostolopoulos, C., Halikias, G., Maroukian, K., Tsaramirsis, G. (2015). *Facilitating Organisational Decision Making: A Change Risk Assessment Model Case Study,* Emerald, Journal of Modelling in Management; accepted

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1.5 The CRAM Appoach: An Overview

As it will be explained thoroughly in chapter 4, Change Risk Assessment Model (CRAM) is composed of three interrelated processes which are continually recorded and monitored (Figure 1.4). CRAM's processes accomplish specific risk objectives (identification, assessment, monitor and control) which are applied to projects or at a greater extend to business environments with a view to facilitate and control change risks.
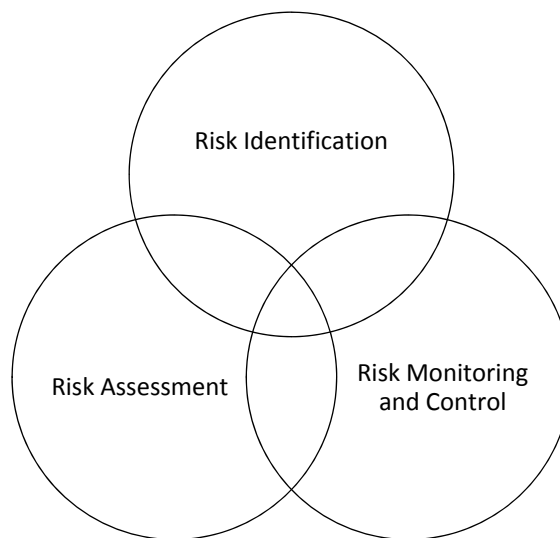
Figure 1.4: CRAM Processes

Nonetheless, up to now there is no specific context for risk estimation in relation to project changes but, rather project management is directly related to the specific context of the organisation.

Depending on the scope and deliverables of a project, CRAM's nodes and related risk attribute's hierarchy per level can change so as to accommodate more of fewer criteria.

1.5.1 Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP[4]) in short utilises attribute's pairwise comparison in order to make decisions. As Saaty (2001) argued "by making paired comparisons of the elements in a level in terms of the elements of the next higher level, it is possible to decide on an appropriate choice of that level. This provides an overall flexibility because hierarchies are flexible as they can be altered and accommodate more criteria". Basically, it is "a well defined mathematical structure of consistent matrices and their associated eigenvectors ability to generate true or approximate weights" (Forman and Gass, 2001).

For Saaty (1987, p.166) a hierarchy "is a simple structure used to represent the simplest type of functional dependence of one level or component of a system, in a sequential manner; a convenient way to decompose a complex problem in search of cause-effect explanations which form a linear chain".

Since decisions, in general involve tangible tradeoffs, they have to be measured with tangible ones, which in turn have to evaluated on how well they accomplish the objectives of the decision maker (Saaty, 2008). Priorities are created for alternatives with respect to criteria or sub-criteria in terms of which they need to be evaluated.

Briefly, the steps using Analytic Hierarchy Process as been described by Saaty (2008) are as follows:

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[4] Thomas L. Saaty (Chair of University Professor at the University of Pittsburgh) is the father of AHP, a method initially discussed in 1971. His work is mainly associated to decision making, planning, conflict resolution and neural synthesis.

1. *Definition of the problem and determination of the kind of knowledge sough.*

2. *Decision structure hierarchy (top; decision goal), followed by the objectives from a broad perspective, through intermediate levels (criteria on which subsequent elements depend) to lowest level (usually a set of alternatives).*

3. *Construction of a set of pairwise comparison matrices. An element in an upper level is used to compare the elements in the level immediately below with respect to it.*

4. *Use the priorities obtained from the comparisons to weight the priorities in the level immediately below. This process is repeated for every matrix element. Finally, each element in the level below and its weighed values obtain its overall or global priority.*

Concluding, AHP in relation to CRAM, as a methodology can be considered as an established approach to define the internal dynamics of change management within project management eliciting also risk cause-and-effect relationships.

1.6 Thesis Organisation

1.6.1 Introduction

The introductory chapter describes the main ideas of the research (aim, objectives, significance). Relevant arguments about project management, change management and risk management are discussed as an overview, to help the reader gain a more concrete idea about the directions of the proposed research. Focus is also given on a brief introduction of CRAM and AHP.

1.6.2 Literature Review

The literature review chapter provides details establishing what is known and what is open; more specifically, topics that will be discussed include the two most well established project management methodologies (PRINCE2 and PMBOK) and the approaches followed to estimate risk.

Literature review findings will link effectively change management, risk assessment and contemporary project management methodologies. Moreover, literature arguments will give an insight to the critical factors that influence project management success but targeted to change management under risks influence.

1.6.3 Methodology

The methodology chapter discusses the proposed research approach that will be used for assessing change risk. More specifically, it will describe in details, the reasoning behind the proposition to develop a questionnaire, in combination to the application of AHP. Emphasis will be given on how these approaches will be used in agreement with CRAM in order to answer the research question (change risks assessment). Moreover, the mathematical formulae used, will be shown so that CRAM's risk assessment processes are explained in more detail.

1.6.4 Change Risk Assesemnt Model (CRAM)

This chapter aims to provide more details about the design and factors of the 'Change Risk Assessment Model'. Overall, the proposed model will be thoroughly analysed and explained, in accordance to the attributes weighting as this is related to the analysis of the questionnaire.

1.6.5 Discussion and Analysis

Detailed analysis of CRAM's results will be thoroughly presented. Results will be discussed in combination to earlier literature arguments and comments by the author. Moreover, the first commercial case study modelled under CRAM, "RingTokk Systems" will be analysed and discussed.

1.6.6 Conclusions

In the final chapter, further to the conclusions drawn from this research; the challenges of future work be discussed.

Following next, the literature review chapter, aims to put on track various aspects like for example change management and project management integration. In addition, various risk factors from literature will be analysed. Also, the different ways that risk can be accommodated in terms of contemporary project management frameworks will be thoroughly discussed.

Literature Review

"I do not believe you can do today's job with
yesterday's methods and be in business tomorrow"
Nelson Jackson

There can be found several reasons that reflect endeavours of modern organisations to respond to environmental changes by deploying contemporary project management frameworks. As projects become a common organisation tool in everyday working habits, it is hard to distinguish the boundaries between projects and the overall process of work (Jugdev and Müller, 2005). Shein (1996) argued that the majority of change programs fail due to the different and multiple cultures that may exist in an organisation and the lack of alignment among them when implementing change or the adoption of new work methods occurs. Moreover, the successful adoption of new management frameworks or better, new business processes is highly dependent on organisations' members.

In the industry (except PMBOK and PRINCE2), there exist several frameworks for managing projects; these include AS 8015-2005, Australian standard for IT Governance; eSCM-SP v2, eSourcing Capability Model for Service Providers, Version 2; Cobit, Control Objectives for Information and related Technology; MSP - Managing Successful Programmes, OPM3, Organisational Project Management Maturity Model; eTOM, Enhanced Telecom Operations Map; ITIL (Information Technology Infrastructure Library, framework for the governance of IT).

Nevertheless, there can be found few dedicated literature findings which relate project management and change risks management in terms of modelling assessment. This comes as natural, taking into account that still in PMBOK, there is no dedicated change management knowledge area[1], but PRINCE2 and ITIL have introduced change as a relative process integrated in their overall structured framework in the change theme. Baca (2005) pointed out, that if someone checks over the glossary guide of PMBOK (2004) the term change management will not be found; the same holds true for even for the 5th and latest edition, published in 2013. On the other hand, one of the aims of this research is to close this gap which exists in literature, following an overall more practical, modelling approach.

2.1 Project Management in terms of Contemporary Frameworks

Project success, even if it remains vague and ambiguous depending on a plethora of factors, with the aid of project management frameworks the whole process towards success is formalised and documented.

Based on PRINCE2 (2009, p.4) definition: "project management is the planning, delegating, monitoring and control of all aspects of the project, and the motivation of those involved, to achieve the project objectives within the expected performance targets for time, cost, quality, scope, benefits and risks". Whereas for PMBOK (2013, p.5) "Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements".

Back in 1986, Slevin and Pinto proposed the scientific basis of project success missing the significance of change(s) and overall management. This scientific basis was consisted on ten key factors: project mission, project plan, top management support, technical tasks, client consultation, client acceptance, monitoring, troubleshooting, feedback and communication.

Later on, Pinto and Slevin (1998) expanded the initial, ten factors by the addition of another four taking into account the project implementation process. These four factors are: project team leader characteristics, power and politics, environmental

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[1] A 'knowledge area' represents a complete set of concepts, terms and activities that make up a professional field, project management field, or area of specialisation (PMBOK, 2013; p.59).

events and urgency. Nowadays, project management is so significant, that, not only individuals can be certified but also it is considered a profession.

2.1.1 Change Management and Project Management Integration

Change in structured project management frameworks is an embedded process within project management methodology. In this context, every project is subject to changes and actually, one of the aims of structured project management methodologies is to adapt to changes and in effect minimise risk and finally ensure project success. However, project changes incur risks affecting the output of the project (Baca, 2005).

Pitagorsky (2011) argued that project managers are indeed change managers and moreover, managing change is by itself a project. Based on his exact words, "Project managers, to be effective must be competent change managers. Often projects introduce new or changed products or processes or to put on an event are planned without appropriately considering the change that the project result will cause in its environment". Especially for project managers, he suggests looking at projects realistically, advise business leadership, ensure that change is managed appropriately and finally ensure the project deliverables have been justified at the beginning of the project.

Homes (2001) argued, that for project managers to become competent change managers it is necessary to establish a solid foundation for change. Today's role of the project manager focuses more on the project and the team. Effective projects are those which achieve a business change within a managed organisational context (Gooch, 1997).

Cicmil (1997) argued that project managers need to reposition project management in order to support organisational strategic change. Creasey (2007) sharing the same views, argued that it is not enough to merely describe 'the change' and expect it to happen. Furthermore, there is a definite link between project management and change management since both support moving an organisation from a current state to a desired future state, i.e. a transitional process (Carnal, 2003).

Overall, project management focuses on tasks or activities (PMBOK, 2013) whereas change management focuses on people impacted by change. According to Collyer (2000), 75% of all transformation projects fail due to lack of internal communication and failure to project management team to understand the impact of project change on the overall business.

Figure 2.1 shows that both change management and project management, evolved in a way that provided not only tools but also processes. Effectively, project management and change management practically, are integrated.
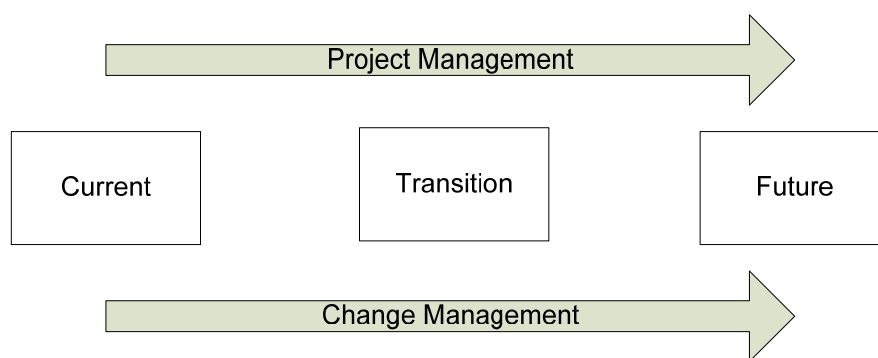
Figure 2.1: Project Management and Change Management; Parallel and Transitional Processes (Creasy, 2007)

Project leaders are typically not in favour of change, since change can prove to be hard for everyone (Englund, 2011). Moving forward, and remaining unchanged at the same time is impossible. People have a tendency to resist change for several reasons, like for example: tradition, personal losses, affection, and fear for the unknown.

Sharing his experience Englund (2011) argued that many professionals managed projects without following any specific project management methodology framework. Nonetheless, as organisations become bigger and more complex, the need for a structured project management methodology arises.

As far as the two widely established and globally applied project management frameworks are concerned, and more specifically PMBOK (2013); there is extensive referencing for change, in monitoring & controlling project work and perform integrated change control processes, whereas PRINCE2(2009) devotes a whole theme.

To the best and current author's knowledge, research in literature review did not indicate the existence of a solid model which examines the risk of change(s) under contemporary project management frameworks but rather the examination of the roots and factors of project failure or success. However, project success in terms of measurement criteria, subjective or objective, differs from individual to individual (Freeman and Beale, 1992).

Actually, most project managers focus on accomplishing the agreed project deliverables. Shenhar and Wideman (2000) argued that actually, there is not any "agreed-upon understanding" success concept in project management literature. As long as the organisational systems become more open, and complex, there exists a proportional level of uncertainty which affects the unstable project environment (Thompson and Richardson, 1996). This instability may force change efforts to fail and in effect render future change initiatives harder to achieve (Heracleous, 2000).

2.2 Project Success Factors and Related Models

Taking into account that project management and change management are integrated processes, an analogy can be found between project and change influence factors. Often, project success is assessed at the end of the project, which is not a valid point for success measurement (Munns and Bjeirni, 1996). Heldman (2005) argued that critical success factors (CSFs) are requirements or deliverables that must have a satisfactory completion rate for the successful outcome of the project. Nevertheless, it is not necessarily related to risk, but is critical to the success of the project as the impact can vary significantly.

Events, leading to project failure may occur during the whole life cycle of the project and not only upon its closure. Bryde (2003) undertook a research with sixty subjects (Project Managers) which indicated that 43.33% of the sample's respondents agreed that among other factors 'responsiveness to change' is a project success criterion. In another research, in pharmaceutical industry Cooke-Davies and Arzymanow (2003) indicated that project culture is a significant element of project management.

PMBOK (2004, p.421) defines culture as a richer attribute at behavioural level, including those behaviours and expectations that occur independently of geography,

ethnic heritage or common and disparate languages. In PMBOK (2013, pp.18-21) it is mentioned that "an organisation's culture, style, and structure influence how its projects are performed". Moreover, culture may have strong influence on a project's ability to meet its objective being an enterprise environmental factor.

Provided that project success or failure irrespective of reasoning can be estimated, Andersen et. al., (1983) identified specific project pitfalls, which managers do or don't. These pitfalls are identified in different stages of the project life cycle such as in planning, organising or control stage. In light of this, Morris (1998) identified both failure and success factors at project stages which are successive. For Pinto and Slevin (1998) the success factors are concluded as seen in Table: 2.1:

Success Factor	Description
1. Project Mission	Clearly defined goals and direction
2. Top Management Support	Resources, authority and power implementation
3. Schedule Plans	Detailed specification of implementation
4. Client Consultation	Communication with consultation of all stakeholders
5. Personnel	Recruitment, selection and training of competent personnel
6. Technical Tasks	Ability of the required technology and expertise
7. Client Acceptance	Selling of the final product to the end users
8. Monitoring and Feedback	Timely and comprehensive control
9. Communication	Provision of timely data to key players
10. Troubleshooting	Ability to handle unexpected problems

Table 2.1: Project Success Factors; Pinto and Slevin (1998)

Also, Morris (1998) used a strategy based model, which in turn was developed further by Turner (1999) and consisted of five success factors (internal to the organisation, external to the organisation, project drivers, pressures and resistance) in seven different areas (Definition, Systems, People, Attitudes, Sponsorship, Organisation, Context), which he named 'The seven forces model for project success' as seen in Figure 2.2.
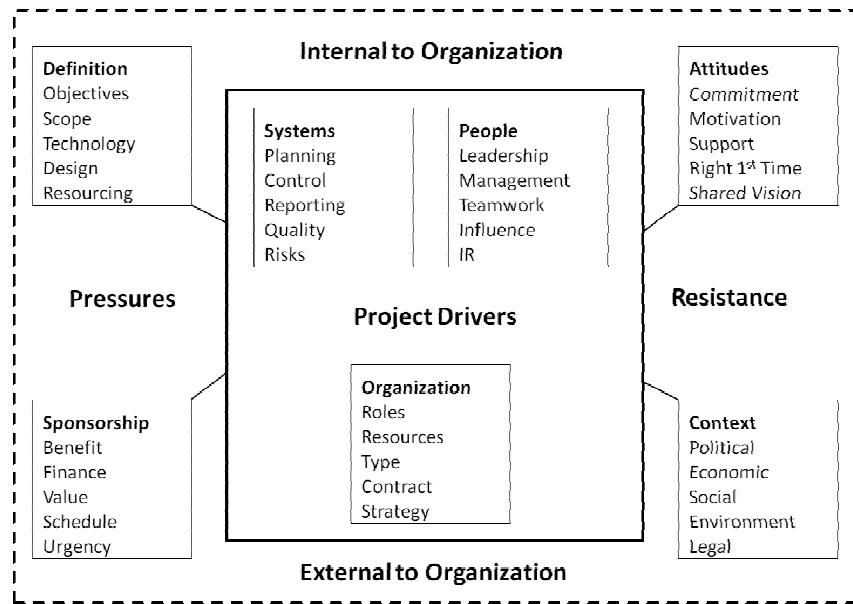
Figure 2.2: The Seven Forces Model for Project Success (Turner, 1999)

In addition, Cicmil (1997) described that project failure can be a result of many reasons, like, poor understanding of stakeholders' requirements, inadequate project specifications, organisational behaviour factors (structure, functions, performance), lack of the appreciation of dynamics and change and poor monitoring/controlling.

Morris and Hough (1987) developed their own framework for project success which included different attributes such as: project definition, external factors, financial terms, communication and control and human resources.

Other criteria, which Freeeman and Beale (1992) used for measuring success, were: technical performance, customer satisfaction and business performance. For Pinto and Prescott (1990) projects' success is seen rather multidimensional in three distinct factors:

1) Budget and schedule
2) Value (positive impact, organisational effectiveness) and
3) Client satisfaction.

Shore (2008) in another model as seen in Figure 3, suggests that the outcome of a project can be related to various factors like for example: leadership (executive and

project), culture (organisational, project, national) and other behavioural factors named as systematic biases. Systematic biases can be for example, available data, conservatism, escalation of commitment, groupthink, illusion of control, overconfidence, selective perception and sunk cost.
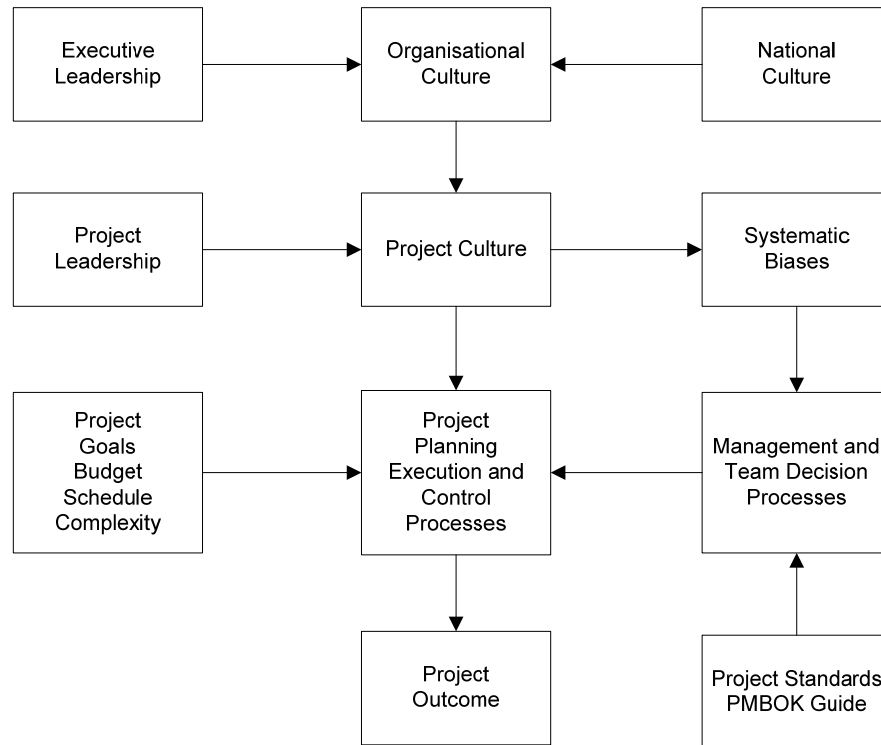
Fig 2.3: Influence of Cultural, Leadership, Project Management, and Behavioural Factors on Project Outcome; Shore (2008)

In an effort to measure culture in relation to PMBOK processes, Livari and Huisman (2007) used a model which they named the 'competing values model'. Their model, as included four dimensions which were: internal focus, external focus, stability and change.

Kendra and Taplin (2004) presented another modelling approach which actually venerated a model of success factors, grouped into four (4) categories: micro-social, micro-technical, macro technical and micro-technical. Actually, they developed their model so as to address the questions which were raised by Standish Group Chaos's report (2000). In this study, it was reported that the primary reason behind declining project success rates (during 1997 - 2000; overall fail rate of 72%) was insufficiently

collaborative working relationships. In their modelling approach, factors were split into several levels:

- *Micro-social:* project manager skills, leadership, motivation, team building and communication.

- *Macro-social:* organisational structure at the project level: cross-functional team participants, collaborative work environment.

- *Micro-technical:* performance measurement systems, business objectives, and team performance.

- *Macro-technical:* supporting management practices, grouping of structured business processes of frameworks.

Each of the four dimensions, not only is independent to each other but also, if one element is changed then this change does not affect the other ones. The main contribution of the modellers was the integration and link between success factors and project culture. The respective model diagram can be seen in Figure 2.4.
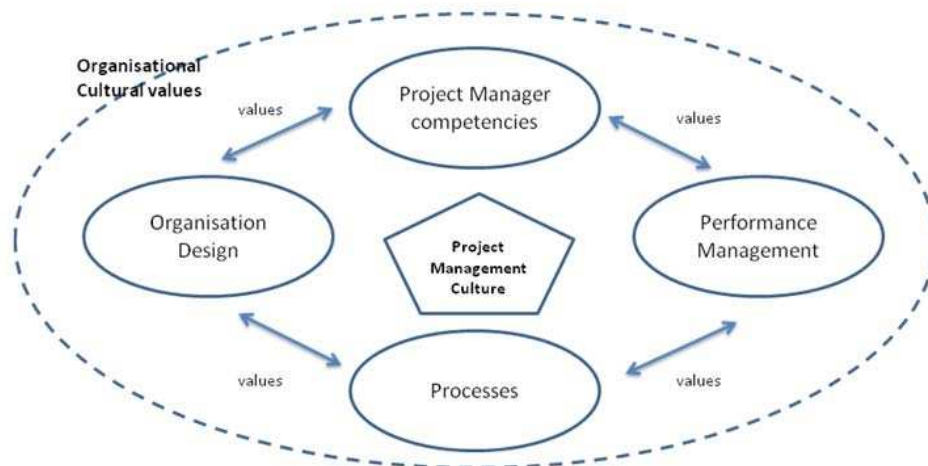
Fig. 2.4: Cultural Model for Project Success (Kendra and Taplin, 2000, p.35)

Based on the research of Kendra and Taplin, Procca (2008) developed a project management model for a government research and development organisation. Actually, the research method that Procca used, was based on a rather extensive cultural survey. Some of the questions were related to the importance of

communication, efficiency of risk analysis on projects results, project management and scientific leadership role integration. What he concluded, is that the implementation of project management requires sustainable efforts to change both to the organisation's structure but also its culture.

Hyväri (2006) in her own research, attempted to address different success factors in different organisational conditions by categorising them based on the project in four main categories:

a) Factors related to the project
b) Factors related to the project manager/leadership
c) Factors related to the project team members
d) Factors related to the organisation

Specifically, management of changes is considered a factor related to the project manager's role as a leadership skill. Moreover, based on her research, a comparison among related literature concerning the project implementation profile is seen in Table 2.2.

Factors	Hyväri (2006)	Finch (2003)	Delisle and Thomas (2002)	Pinto and Prescott (1998)	Pinto and Slevin (1987)
Project Mission	6	7	1	1	1
Top Management Support	4	6	9	7	2
Project Schedule/Plans	5	5	5	9	3
Client Consultation	2	1	2	2	4
Personnel	9	10	10	10	5
Technical Task	7	9	4	3	6
Client Acceptance	3	4	6	4	7
Monitoring and Feedback	10	3	3	5	8
Communication	1	2	8	6	9
Trouble-shooting	7	8	7	8	10

Table 2.2: Project Implementation Profile; Hyväri (2006), p.38; [ranking is related to the frequency of responses]

In a similar view, PMBOK (2013, p.29) discusses about 'Enterprise Environmental Factors' as conditions that influence the constraints of the project and may have a positive or negative influence on the outcome (include but not limited to):
"

- organisational culture, structure and governance
- geographic distribution of facilities and resources
- government or industry standards (e.g. regulatory agency regulations, codes of conduct, product standards, and workmanship standards).
- infrastructure (e.g. facilities and capital equipment)
- existing human resources (e.g. skills, disciplines, and knowledge, such as design, development, legal, contracting, and purchasing).
- personnel administration (e.g., staffing and retention guidelines, employee performance reviews and training records, reward and overtime policy, and time tracking).
- company work authorisation systems
- marketplace conditions
- stakeholder risk tolerances
- political climate
- organisation's established communications channels
- commercial databases (e.g. standardised cost estimating data, industry risk study information and risk databases).
- project management information system (e.g. an automated tool, such as a scheduling software tool, a configuration management system, an information collection and distribution system, or web interfaces to other online automated systems)"

However, the success of the project should be measured in terms of project completion taking into consideration the constraints as defined within the framework (scope, time, cost, quality, resources, and risk) and as approved between the project and senior management PMBOK (2013, p.34).

2.2.1 Organisational Change Success Factors

Successful change can be influenced by a variety of factors which can be individual or cross-correlated. These factors can have a severe influence on the result of change and effectively in the projects' processes implementation. Regarding project management, the optimal goal is project success; consequently conformance to contractual obligations and fulfilment of project objectives.

Since, change cannot be avoided as it is one of the most certain processes in life, it is better to move forward, adapt and turn change into an advantage as a whole. Recent success factors (Adedayo, 2010; Townsend, 2011; Kaizen Consulting Group, 2011; Scheid, 2011) found in literature are seen in Table 2.3:

Adedayo (2010)	Townsend (2011)	Kaizen Consulting Group (2011)	Scheid (2011)
Active and committed leadership	Active, committed leadership	Strong Leadership	Change Team
A clear and compelling business case for the change	A clear, compelling, business case for change	A Shared Vision	Change Control Plan
Full and active stakeholder's participation	Embedded change, not programmatic change	Continuous catalytic activity at the CEO level	Change Communication
Focus on long-term benefits	Employee participation	Trustworthy Communications Top Down/Bottom Up	Change Meetings
Effective and robust communication		The Right Attitude	Change Monitoring
Monitoring and Evaluation		A Comprehensive and Systematic Approach	Change Review
Organisation culture and values		High Employee Involvement	
Sensitivity to corporate and diversity issues			
Supportiveness			
Preparedness			

Table 2.3: Recent Literature Success Factors

As seen so far from literature, there is evident relation between project management and change management. Later on, findings will relate change and project management to risk in terms of success factors.

2.3   RiskManagement Frameworks, Methodologies and Techniques

Further to modelling project/change influential success factors, this section discusses the integration of risk management and contemporary project management frameworks. Projects are exposed to risks since the business environment is uncertain. Actually PRINCE2 (2009) argues that projects entail more risk than stable operational activity.

However, risks can be managed with the aid of project risk management (Dey, 2002). There is no project without risk, as risks are inevitable; nevertheless, with the aid of project risk management some of them are predictable and manageable. Mulcahy (2013) argued that there is an impressive 90% problems reduction in projects after risk management procedures have been engaged.

Risks that are worth investigating can be highlighted through analysis to their high chance of occurrence (Ahmed. et. al., 2005) or the high impact (the significance of the consequences of the risk event) they can have. One of the main purposes of project risk management is to identify, estimate and control project risks which effectively are related to project success or failure.

Notwithstanding, measurement of project success is a dynamic process. Stakeholders, based on the level which influence the project, have various and different success evaluation criteria.

A simplistic definition of risk in terms of probability of occurrence and its related impact can be given by the formula (Heldman, 2005; Kendrick, 2009, Kerzner, 2000):

$$f \text{ (uncertainty, damage)} \hspace{4cm} \text{(Eq. 2.1)}$$

or better:

$$\text{Risk} = \text{Probability x Impact} \hspace{3cm} \text{(Eq. 2.2)}$$

According to various views (Taylor, 2006; Dey, 2002) risk management is one of the project management knowledge areas which is highlighted throughout the entire project life cycle. Heldman (2005) agued specifically that risk management is an integral part of project management being one of the "most often skipped project management knowledge areas on small to medium sized projects".

As depicted in Figure 2.5, the propensity of risk is directly associated to the project's life cycle. Taking into account PMI's five process groups, it can be observed during the *Initiation Phase* risk is higher than any other phase. This can be justified by the

fact that the project at early stages carries a lot of uncertainty. As the project evolves towards the *Closing Phase*, the risks are minimised since, most of the related work is accomplished.

However, risks which can have severe impact can occur during the whole lift cycle of the project and influence the respective rate of success or even failure of the project. Ackermann et. al., (2007) expressed the view that one risk may occur at the same time as other risks which can form a risk portfolio. In such a case, the impact of the whole can be greater than the sum of the parts.
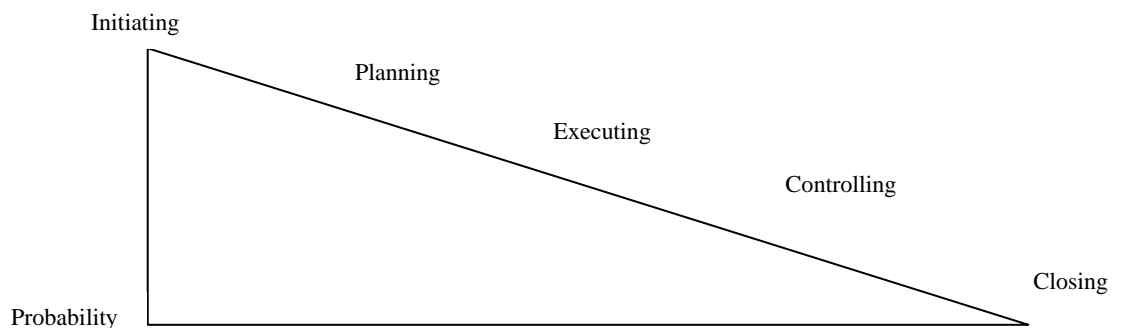
Figure 2.5: PMI's Project Phases and Probability of Risks Occurrence, Source: Heldman (2005), p.10

Risk and uncertainty are high during the start of the project as seen in Figure 2.6. In effect, the 'cost' of changes is also high because the result, successful of not, cannot be determined yet. The variables as the time progresses have lower impact as decisions are reached and during the project's closure phase, project deliverables are accepted among stakeholders.
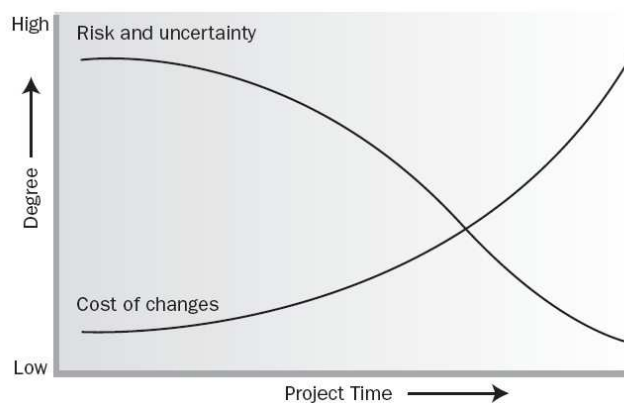
Figure 2.6: Impact of Variables based on Project Time, Source: PMBOK (2013), p.39

Risk management processes include risk identification, risk response planning (project planning phase) and risk monitoring (continues throughout the project implementation). In his study, Taylor (2006) attempted to correlate risk management and problem resolution strategies after interviewing twenty-five (25) Hong Kong project managers. Table 2.4 shows a summary of the risk factors that were identified:

Theme	Source of Risk		
	Vendor	**Third Party**	**Client**
Project Management	- Staffing resources - *Change Management* - Schedule and budget - Documentation	- Staffing resources - Deliverable control	- Staffing resources - Sing-off control - Readiness - **Project Management**

Relationships	- Team morale
	- Internal negotiations
	- Top management
	  support
		- Cooperation	- Expectation
			- Trust
			- Top management
			  support
			- Users
			- IT department
			- Bad news

Solution Ambiguity	- Customisation
	- Newness
	- Complexity
	- Development choice
	- Requirements
	  understanding
		- Integration and
		  compatibility
		- Deliverables
			- Data conversion
			- Technical
			  Environment
			- Requirements
			  understanding
			- Functionality

Environment		- Non- local third party - Multiple third parties	- Multiple sites / countries - *Organisation culture* - Multiple departments - *Business changes*

Table 2.4: Summarised Risk Factors, Taylor (2006, p.53)

According to Taylor's analysis change management, can be evidenced not only in the control but also in the negotiations strategy. This can be justified by the fact that respondents' considerations regard that it is important to exercise change control closely.

Nevertheless, project requirement changes are inevitable, and often discussed with the customer or in a broader frame with the stakeholders. In effect, risks that are related to change are addressed both with strong control and negotiation strategies. However, change control and relationship-building strategies; have as common objective clients' expectations. In conclusion, the study described risk management and problem-resolution strategies that can be summarised in four categories:

- *Control*
- *Negotiation*
- *Research*
- *Monitoring*

However, irrespective of structured project management methodologies and processes of risk management, Patterson and Neailey (2002) argued that the process should follow steps like:

- Risk identification
- Risk assessment
- Risk analysis
- Risk reduction/mitigation and
- Risk monitoring

In contrast, Cooper et. al., (2005) discussed problems in establishing the context of risk identification, analysis of risk, evaluation and finally treatment of risk.

2.4 Project Risk Management Analysis

Risk estimation is actually an attempt to address the question of 'what can go wrong?, in other words, what is the likelihood of an event being triggered and materialising as an unexpected result in a plan.

As Charette (1989) suggests, especially during risk estimation, four items have to be accomplished. The first step requires that variable values are determined. Usually, this

step is accomplished by selecting an appropriate scale, which actually measures the variables.

The second step regards the identification of the various consequences of an event and the third concerns the magnitude of risk to be determined. In other words, the magnitude is related to the severity of the consequences. The final and fourth objective is to eliminate any unexpected or unplanned events from occurring (surprises).

Heldman (2005) tried to categorise and quote risks for further reference. Some of the risks quoted, are in direct relation to the scopes of this research are as follows:

- Changes in key stakeholders;
- Changes in the company's ownership;
- Resistance to change (as a result of project implementation);
- Cultural barriers (diversity, corporate culture and international projects).

For instance, a high level classification of risks can be the following:

- Technical, quality and performance;
- Project Management;
- Organisational;
- External (outside the project organisation).

Nevertheless, since projects differ in terms of scope, approved budget, delivery timeframes, quality and other factors it is natural that risk classification will also differ.

In chapter four and more specifically in table 4.4 aligned with the scope of this thesis Apostolopoulos et. al., (2014a) presented various project risk categories based on CRAM analysis.

2.4.1 Project Management Frameworks and Risk Management Facilitation

Contemporary project management methodologies like PRINCE2 and PMBOK attempt to address issues related to risk analysis and management but not explicitly risk analysis of change management. The main purpose is to apply risk management tools, knowledge, stakeholders skills and experiences to projects in order to reduce risks or the threats which come out from risks to an acceptable level; even controllable so as to maximise projects' success.

Based on PRINCE2 (2004, p.251), risk is defined as uncertainty of outcome. "The task of risk management is to manage a project's exposure to risk (i.e. the probability of specific risks occurring and the potential impact if they do occur). The aim is to manage exposure by counteraction to maintain it at an acceptable level in a cost-effective way."

In PRINCE (2009, p. 79) besides the above perspective, the purpose of risk theme is to "identify, assess and control uncertainty and, as a result improve the ability of the project to succeed". For example, a question which arises, is what is the potential impact of anticipated changes?

Concerning uncertainty, Saaty (1987) explained that there exist two types: a) uncertainty about the occurrence of events, and b) uncertainty about the range of judgements used to express references. Especially, for CRAM, the second one suits better, since it is experienced by the decision maker, making pairwise comparisons.

Furthermore, PRINCE2 (2009) explains that projects bring about change and consequently change incurs risk; more specifically risk taking in projects is inevitable. Since change and risks cannot be avoided the project board and project manager have to take into account the levels of risk that can be tolerated. This is one of the reasons the project manager is responsible for the identification of risks, recording and regular reviewing. The project manger is also responsible for all necessary actions to reduce the impacts of risks.

As shown in Figure 2.7, risks have a tendency to grow exponentially with time is left unmanaged.
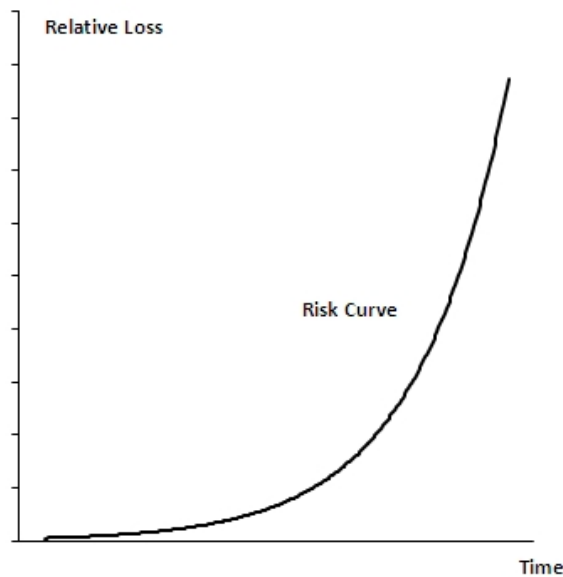
Figure 2.7: The Risk Curve
Source: ITIL v3: Service and Transition volume

Initially, in unmanaged change there are high expectations, this is because there is no actual mechanism to prevent change or to know exactly when and what will happen. Because changes are complex, they require efforts and patience from all stakeholders when unmanaged, then overwhelming stage may occur. What comes as a result is that managing change increases the acceptance and shortens the payback cycle. Actually this is the major goal of contemporary project management methodologies; the provision of safe walkthrough and manage the project boundaries which will lead to project success.

As has been argued earlier, every project is subject to change, simply because the business environment changes. Every project has significant differences, in terms of several factors, including factors that are the well-established, such as cost, time scope and quality. For PRINCE2 (2005) there exists a risk management cycle as seen in Figure 2.8:
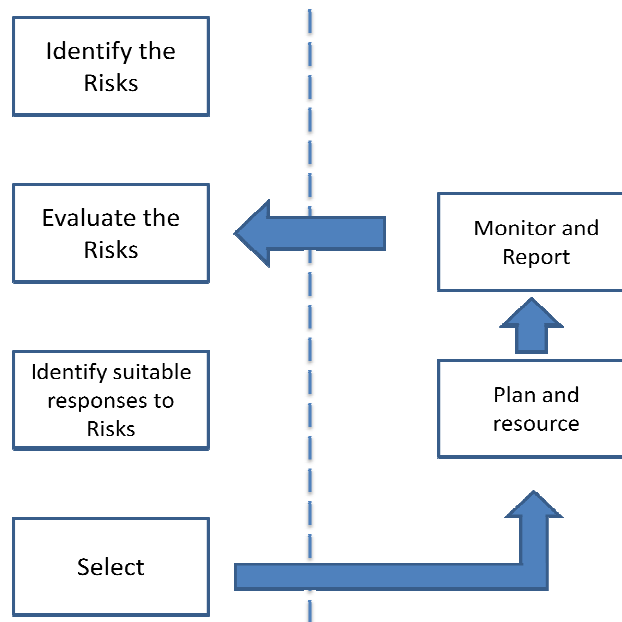
Figure 2.8: The Risk Management Cycle; Source: OGC, PRINCE2 Guide, 2005, p.254

The *identification of risks*, identifies the potential risks or opportunities; once identified they are recorded in the Risk Log or Risk Register, whereas *evaluation of risks* assesses the probability and the impact of risks. PRINCE2 (2005, p.255) identifies impacts based on the following elements:

- Time
- Cost
- Quality
- Scope
- Benefit
- People/Resources

According to PRINCE2 guide (2009), *planning* consists of various activities, like for example, identification and quantification of the type of recourses required to carry a set actions, developing a detailed plan, confirming the desirability and obtaining management approval.

Resourcing defines and assigns the resources necessary to conduct the work. Briefly, the assignments are shown in the project and stage plans. If for example, budgeting of

the resources is required this will come up from the project's total budget, whereas, contingency actions will be funded from a contingency budget. As far as monitoring and reporting is concerned, it is related to mechanisms for monitoring and reporting selected actions for addressing risks.

2.4.2 Project Risk Management Procedures and Strategies

In PRINCE2 (2009, p. 79) the recommendation for risk management procedure is based on five steps:

- Identify
- Assess
- Plan
- Implement
- Communicate

As it can be seen in Figure 2.9, *communication* runs in parallel with the rest four (4) sequential steps, as any related findings have to be communicated prior to process completion.
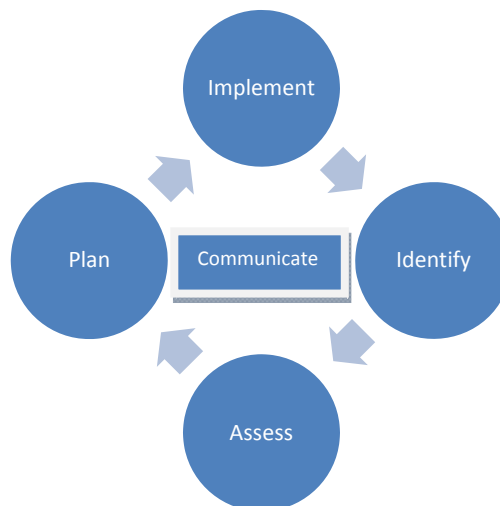
Figure 2.9: The Risk Management Procedure; Source: OGC, PRINCE2 Guide, 2009, p. 80

The main goal of the *Identify* context is to gather information concerning the project, gain an understanding of the specific objectives and form the RMS (Risk Management Strategy). *Assessment*, as seen in Figure 2.10, has two parts, *estimation* and *evaluation*.
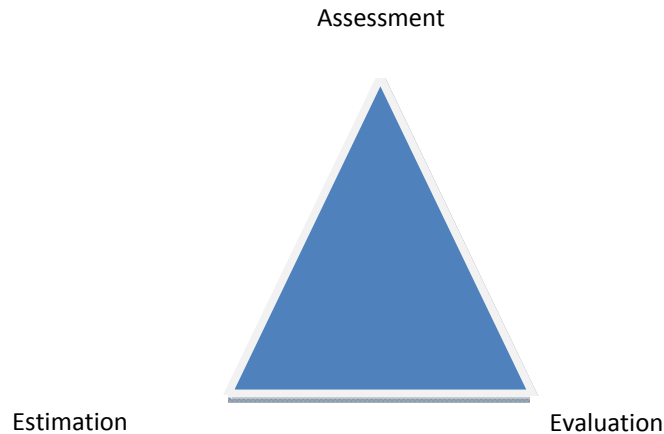
Figure 2.10: Assess Step based on PRINCE2 (2009) Recommendation

PRINCE (2008, p.81) explains that the primary goal of *Identify Risks* is to recognise the threats and opportunities that may affect the project's objectives in the following actions:

"

- Capture identified threats and opportunities in the Risk Register;
- Prepare early warning indicators to monitor critical aspects of the project and provide information on the potential sources of risk;
- Understand the stakeholder's view of the specific risks captured."

More specifically, 'Risks' are identified as: Causes (source of the risk), Events (area of uncertainty (threat/opportunity) and Effects impact(s).

Estimation facilitates threats and opportunities to the project in terms of the probability and the impact they have. A risk cause may result in a risk event, which may affect a project objective. Accuracy is not guaranteed in 'Estimation' and estimates will inevitably change as more is discovered about the project. This case stands true, because, more processes are engaged, stakeholders have a better understanding of the deliverables and risks are assessed based on the framework's directives.

Overall, risk management has to take the form of a systematic process and as PRINCE2 explains, it should not be based on chance. It is rather related to proactive

actions of identification, assessment and control of risks that might affect the delivery or the project's objectives. The more risks are not assessed and controlled, the higher the possibility of project failure during the project's life cycle. *Estimation* assesses threats and opportunities in terms of their probability and impact (*Risk = Probability x Impact*).

Evaluation, assess the aggregate effect of all identified threats and opportunities. Concerning risks, an assessment is made to determine whether the level of risk(s) is within the tolerance of the project which regards the following:

a) The probability of threats and opportunities in terms of likelihood of occurrence;

b) The impact of each threat and opportunity in terms of the project's objectives;

c) The proximity of these threats and opportunities regarding to when they might materialise; and

d) How the impact of the threats and opportunities may change over the project's lifecycle (PRINCE2, 2009, p. 83).

Planning relates to the preparation of specific management responses to the threat and opportunities identified previously. Optimum goal is to remove/reduce threats and maximise opportunities.

Furthermore, the implementation goal is to make sure that the planned risk responses are implemented, their effectiveness is monitored and corrective action is taken, irrespective of the fact, whether responses match expectations (PRINCE2, 2009, p. 85).

Finally, the continuous step of communication ensures that relative information to the project concerning threats and opportunities is communicated both within the project and externally to stakeholders (PRINCE2, 2009, p. 87).

Some kinds of risks, like for example financial risks, can be evaluated in numerical terms. However, in order to identify suitable responses to risk PRINCE2 (2009) breaks into following types:

- Avoid (threat)
- Reduce (threat)
- Fallback (threat)
- Transfer (threat)
- Accept (threat)
- Share (threat or opportunity)
- Exploit (opportunity)
- Enhance (opportunity)
- Reject (opportunity)

Management of risk is based on a number of risk management principles, of which the following are appropriate within a project context (PRINCE2, 2009; p.78):

- Understand the project's context
- Involve stakeholders
- Establish clear project objectives
- Develop the project management approach
- Report on risks regularly
- Define clear roles and responsibilities
- Establish a support structure and a supportive culture for risk management
- Monitor for early warning indicators
- Establish a review cycle and look for continual improvement

Finally, PRINCE2 uses a relatively simple table to summarise the risk profile (Figure 2.11). Any risk, shown above and to the right of the "risk tolerance line" is deemed to be a considerable risk. The person who is responsible to update the table is the project manager.

		Probability				
		Very Low	Low	Medium	High	Very High
Impact	**Very High**	H	H	VH	VH	VH
	High	M	H	H	VH	VH
	Medium	L	M	H	VH	VH
	Low	L	L	M	H	VH
	Very Low	VL	L	M	H	H

Figure 2.11: Risk Profile Summary; Source: OGC, PRINCE2 Guide, 2005, p.259

In contrast PMBOK (2013 pp.344-345) defines the following strategies as responses to risk (s)[2]:

Strategies for Negative Risks or threats:

- Avoid
- Transfer
- Mitigate
- Accept

Strategies for Positive Risks or opportunities:

- Exploit
- Enhance
- Share
- Accept

The responses of risk do not necessarily remove the inherent risk, which might have as an effect to leave residual risk. This residual risk may be significant if the risk response is partially successful. On per case basis, more than one risk response can be selected to facilitate the risk cause. Table 2.5 shows a comparison between the proposed risk strategy as described by PMBOK and PRINCE2.

OGC PRINCE2 (2009)	PMI PMBOK (2013)	
Avoid	Avoid	Negative Risks (Threats)
Reduce	Transfer	
Fallback	Mitigate	
Transfer	Accept	
Accept (threat / opportunity)	Exploit	Positive Risks (Opportunities)
Share		
Exploit	Enhance	
Enhance	Share	
Reject	Accept	

Table 2.5: Risk Strategies Comparison

As a result, any given risk is likely to lead to appropriate actions in any or some of the above categories. Selection of risk is related to balancing the risk.

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[2] Positive and negative risks are referred to as opportunities and threats respectively.

PMBOK explains that both organisations and stakeholders can accept risk dependimg on the respective attributes. Risk attitudes can be influenced by a variety of factors, which are classified in the following themes (p.308):

- Risk appetite (degree of uncertainty an entity is willing to take on in anticipation of a reward);
- Risk tolerance (degree, amount or volume of risk that an organisation or individual will withstand);
- Risk threshold (measures along the level of uncertainty or the level of impact at which a stakeholder may have a specific interest).

It is rather obvious that, PMBOK (2013)[3] shares some similarities (bold characters) with PRINCE2 (2009). The main steps are summarised below:

- **Plan Risk Management**
- **Identify Risks**
- Perform Qualitative Risk Analysis
- Perform Quantitative Risk Analysis
- **Plan** Risk Responses
- Monitor and **Control** Risks

The definition given based on PMI's Practice Standard for Project Risk Management (2009, p.4) is the following:

"Project Risk Management aims to identify and prioritise risks in advance of their occurrence, and provide action-oriented information to project managers. This orientation requires consideration of events that may or may not occur and are therefore described in terms of likelihood or probability of occurrence in addition to other dimensions such as their impact on objectives."

Moreover, the key objectives regards increase of the likelihood and impact of positive events and, on the other hand decrease the likelihood and impact of negative events in the project (PMBOK, 2013, p. 308). PMI defines the detailed steps as far as project

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[3] The differences between 4th ed. (2008) and 5th ed. (2013) version of PMBOK concerning Risk knowledge area can be considered as insignificant.

risk management process is concerned (Practice Standards for Project Risk Management, 2013, p.308). These are:

Plan Risk Management: Defines the scope and objectives, ensuring that the risk process is fully integrated into wider project management. In addition, the purpose and objectives of the plan risk management process is to develop the overall risk management strategy and decide how this will be executed. The level of project risk acceptance depends on the risk attitudes of the relevant stakeholders. The higher the control on the risk factor, the higher the probability of project success (Practice Standard for Project Risk Management, 2009, p.22).

Identify Risks: Lists the risks and identifies the risk owners. In order for risks to be managed they have to be identified first. As Practice Standard for Project Risk Management, (2009, p.25) indicates, "the level of risk exposure changes as a result of the decisions and actions taken previously (internal change) and of externally imposed change". The earlier the risk identification the better, as this will allow for example project managers to pursue actions which can realign the course of project activities the soonest possible.

Perform Qualitative Risk Analysis: Evaluates key characteristics of individual risks enabling for prioritisation and further actions. For this stage, qualitative risk analysis evaluates the probability of risk occurrence and the effect of each individual risk on the project's objective.

In effect, there is an analogy between the risk importance and the level of impact. Since risks do not have similar levels of impact on projects, they are often categorised based on the severity they possess as low, medium and high. Provided that it is almost impossible to know beforehand all the risks that may occur in a project, the identification and qualitative analysis process should be repeated periodically for each risk (PMI Risk, p.33).

The preferred process used to perform qualitative risk analysis can be seen in the following Figure 2.12:

Figure 2.12: Qualitative Risk Analysis Process; Source: Practice Standard for Project Risk Management, 2009, p.33

Qualitative risk analysis provides a means to distinguish important risks that require further analysis. The impact of risks is related to causes; for example: one of the most severe can be non conformance to project's requirements which may lead to project failure.

Finally, it is more than useful for future reference purposes to document and record all the above processes as risks are identified with priorities. Those which have high priority are separated for further analysis. Therefore, it is highly beneficial for project managers and especially for individuals who are engaged with risk analysis, to have a recorded track (documentation) concerning risk's probability of occurring and its potential impact.

Perform Quantitative Risk Analysis: Evaluates numerically the combined effect of risks on the overall project outcome. The outcome from quantitative analysis can be useful to evaluate the probability of success (conformance to project's requirements).

Actually, when risks are quantitatively analysed, the process may be used for the assignment of a numerical priority rating the risks individually (PMBOK, 2013; p. 334).

Results of the quantitative analysis can give answers to indicative important questions like:

- What is the probability of meeting the project's deliverables / objectives?
- Which are the individual risks which contribute the most overall project risk?

Plan Risk Responses: Determines appropriate response strategies and actions for each individual risk and for overall project risk. In order for risks to be addresses they have first to be identified, analysed and prioritised. Since potential risks cannot be eliminated, there is a limit to select which opportunities can be managed in a proactive manner.

PMBOK as a global standard specifies the critical success factors (CSFs) for planning the risk responses process. Briefly, these are as follows:

- Communication;
- Definition of risk related roles and responsibilities;
- Specification of timing in terms of risk responses;
- Provision or resources;
- Budget and proper scheduling;
- Addressing the interaction of risk responses;
- Ensuring appropriate timely-effective and agreed-upon responses;
- Addressing both threats and opportunities;
- Developing risk response strategies.

Monitor and Control Risks: Implements agreed-upon actions, reviews changes in project risk exposure, identifies additional risk management actions as required, and assesses the effectiveness of the Project Risk Management process. The main objective of *risk monitoring and control* is to identify the potential risks, monitor,

identify new risks and provide improvements to the management of the project. The monitoring process is a continuous one as it requires regular reporting for the occurrence and risks' handling.

2.5 Risk Accommodation Project Management Techniques

Depending on the different stage of risk accommodation, both PRINCE2 and PMBOK propose several relevant techniques. However, currently none of them introduces Analytic Hierarchy Process as a technique for risk assessment as far as change management is concerned.

2.5.1 Techniques for Context Identification

Regarding context (organisational activities perception, overall background) identification, PRINCE2 proposes as techniques the process map (workflow diagrams to describe the business processes), PEST prompts, SWOT prompts, RACI diagrams (for stakeholder analysis) and Stakeholder matrix.

On the other hand, PMI specifically for the risk planning process proposes techniques like: planning meetings and analysis which involves core team members (expert judgement), using specific templates (for example strategic risk scoring sheets). As far as the prioritisation of risks is concerned these must first be linked with objectives. Overall, the risk management plan will define the relative importance to be assigned respectively (Practice Standard for Project Risk Management, 2009, p.69; M_o_R, 2007, p.91; PMBOK, 2013, p. 315).

2.5.2 Techniques for Risk Identification

For the identification of risk related to identification of threats and opportunities PRINCE2 proposes: the risk potential assessment (available from http://www.cabinetoffice.gov.uk/, which scales the project against criteria), the risk check list, PESTLE analysis, lessons learned, business risk breakdown structures (RBS; a hierarchical decomposition of the business processes to illustrate potential sources of risk), risk taxonomy (organises known enterprise risks into general classes subdivided into elements and attributes), risk identification workshops, fish-bone

diagrams, brainstorming, Delphi technique, risk questionnaire, risk database, gap analysis. M_o_R (2007, p.93).

Especially for the scope of this research, a change risk questionnaire will be used so as to weight the respective risks of CRAM. On the other hand, some of the techniques that PMI signifies for the identification of risks are: assumptions and constraint analysis, brainstorming, cause and effect (Ishikawa) diagrams, check lists, Delphi technique, document review, fault tree analysis, interviews, questionnaires, SWOT analysis and others. Practice Standard for Project Risk Management (2009, p.72).

2.5.3 Techniques for Risk Estimation

As it has been noted earlier, in PRINCE2 (2009) the wording 'assessment' is used to include both risk estimation and risk evaluation. The risk estimation step is related to assessing the probability of threat or opportunity in accordance to their respective impact. For this stage, PRINCE2 proposes: Pareto analysis, probability impact matrix (qualitatively rank previously identified risks), risk maps, risk profile summary, Probability Trees, Expected Value (Practice Standard for Project Risk Management, 2009, pp.69; M_o_R, 2007, pp.97; PRINCE, 2009, p.82-83).

2.5.4 Techniques for Risk Evaluation

The most common technique for risk evaluation is the model which represents a real business situation and involves the transformation process in terms of outcomes, being generated by a range of inputs. Other techniques that OGC proposes for risk evaluation are: Simulation, Monte Carlo Analysis, CPM (Critical path method), Sensitivity analysis, Cash flow analysis, Portfolio analysis and Cost Benefit Analysis (M_oR, 2007; p.102).

2.5.5 Quantitative and Qualitative Risk Analysis

On the other hand, for the evaluation and estimation of risk, PMI uses the wording: *Qualitative* and *Quantitative* analysis. More specifically, the proposed qualitative techniques can be for example: estimating techniques related to probability, post project reviews, probability - impact matrix.

The respective techniques, for quantitative risks analysis, proposed are: Decision Tree Analysis, EMV (Expected Monetary Value), Fault Tree Analysis, Monte Carlo simulation, post project reviews (lessons learned) and systems dynamics. M_oR (2007, pp.86, 91).

More specifically, as far as PMBOK framework is concerned, both qualitative and quantitative techniques can be used to estimate risk. Qualitative techniques are used to gain a better understanding of individual risks, considering a range of characteristics such as probability of occurrence, degree of impact on project objectives, manageability, timing of possible impacts, relationships with other risks, common causes or effects, etc.

Understanding and prioritising risks is an essential prerequisite to managing them, so qualitative techniques are used on most projects. The outputs from qualitative assessments should be documented and communicated to the key project stakeholders and form a basis for determining appropriate responses.

Aligned with the scope of this research thesis, Garcia and Gluesing (2013) explained qualitative research in the field of organisational change can be applied in a variety of research areas like for example, development theory, testing, validation construct and also to uncover new emerging phenomena.

Pieterse et. al., (2012) used extensively qualitative research method to research on the description of communication and resistance impacts among professionals during change processes.

Quantitative techniques provide insights into the combined effect of identified risks on the project outcome. These techniques, take into account probabilistic or project-wide effects, such as correlation between risks, interdependency, and feedback loops, thereby indicating the degree of overall risk faced by the project. The results of quantitative analysis should be used to focus the development of appropriate responses, particularly the calculation of required contingency reserve levels, and must not be required for all projects to ensure effective management of risk (PMI, Practice Standard for Project Risk Management; p.15).

Overall, based on PMBOK (2013) qualitative risk analysis prioritises risks in order to be analysed further, mainly by assessing and combining their probability of occurrence and impact (as seen in figure 2.11) whereas, quantitative risk analysis numerically analyses (use of statistics) the effects of identified risks on overall project activities.

2.5.6 Techniques for Risk Planning and Implementation

Risk planning is concerned with turning risk assessment and evaluation into actions. PRINCE2 propositions for this step are risk indicators (show the level of acceptable risk, usually expressed as cost) and finally, reporting as a technique for risk implementation which can be accomplished by risk maps, scatter diagrams, radar charts, histograms. Corrective actions, may be followed where necessary (M_oR, 2007; pp.105).

On the contrary, some of the related techniques that PMI proposes for Plan Risk Responses are: Brainstorming, CCPM (Critical Chain Project Management), Decision Tree Analysis, Multi-criterion selection techniques, root cause analysis. Practice Standard for Project Risk Management (2009, pp.96).

Further to the various techniques proposed per different risk management stage, Table 2.6 illustrates a comparison between PRINCE2 and PMBOK risk accommodation techniques:

OGC PRINCE2 (2009)		PMI PMBOK (2013)	
Identify (context and risks)		Plan Risk Management	Select Risk Characteristics
Assess (Estimation and Evaluation)	**Communicate**	Qualitative Risk Analysis Quantitative Risk Analysis	Collect and Analyse Data Prioritise Risks
Plan		Plan Risk Response	Categorise Risk Causes
Implement		Monitor and Control Risks	Document Results

Table 2.6: PRINCE2 and PMBOK Risk Accommodation Comparison

2.6 CRAM Risks Facilitation Approach

CRAM can be regarded as a comprehensive modelling structure which combines both quantitative and qualitative risk criteria analysis in a decision-making process. Risks are usually presented in one of the following forms: narrative, qualitative or quantitative.

Qualitative Analysis in terms of an estimation approach, uses ordinal rating system. Risks which fall in this category are distinguished from each other as high, medium, low, etc. However, for many people high and medium risk might mean different things, due to the fact that the categorisation is to some extent subjective. As it will be explained in detail in Chapter 3, for the Qualitative Analysis, CRAM will use a related 'risk' survey for appointing the criteria weights based on Saaty's scale (Table 3.1).

On the other hand, *Quantitative Measurements* use cardinal or ratio scales involving mathematical formulae, and risk is expressed using a fraction representing probability of occurrence. In comparison to qualitative risk analysis, quantitative pursues unambiguity and conciseness. The probability of something occurring is more or less belief; it may happen but it also may not. Specifically, for the numerical prioritisation of risk attributes (probability of occurrence), AHP eigenvalues and eigenvectors method will be used (See chapter 3, par 3.3 and par. 3.3.1).

The narrative approach seems to be the easiest approach and least costly than the other two approaches, but the least reliable. Irrespective of the method used, all three of them have a degree of uncertainly, the extent of which is related to the magnitude of the risk in terms of estimation. One of the problems when qualitative analysis is deployed, is that the words used to describe risk are often imprecise and more or less subjective. Charrete (1989) describes some of these words used, like for example: high, probable, not certain, likely, maybe, unlikely, doubtful, possible, etc.

The narrative approach has an advantage of providing contextual information but on the other hand, it does not allow the level (magnitude) of the risk to be measured. Qualitative and quantitative scales do indicate levels or rating but lack the information content. Table 2.7 shows an indicative comparison of the approaches described:

Narrative Risk Analysis	Quantitative/Qualitative Risk Analysis
- Descriptive form of potential risks	- Ordinal rating system (high, medium, low)
- Nominal or ordinal scale used	
- Lack of mathematical formulae	- Cardinal ratio scales
- Easier approach (time consumption, information gathering)	- Risk is expressed as a fraction, representing probability of occurrence
- Less costly	- Relatively difficult, requires skills
- Less reliable	- Time consuming
- Disregard of actual measurement of risk	- Overall result can be reliable, less biased

Table 2.7: Comparison of Quantitative/Qualitative and Narrative Approaches

Moreover, a high level comparison of quantitative and qualitative risk analysis process based on Practice Standard for Project Risk Management (2009, p.38) is shown in Table 2.8:

Qualitative Risk Analysis	Quantitative Risk Analysis
- Addresses individual risks descriptively - Assesses the discrete probability of occurrence and impact on objectives if it does occur - Prioritises individual risks for subsequent treatment - Adds to risk register - Leads to quantitative risk analysis	- Predicts likely project outcomes based on combined effects of risks - Uses probability distributions to characterise the risk's probability and impact - Uses project model (e.g schedule, cost estimate - Uses a quantitative method requires specialised tools - Estimates likelihood of meeting targets and contingency needed to achieve desired level of comfort - Identifies risks with greatest effect on overall project risk

Table 2.8: High Level Comparison of Qualitative and Quantitative Approaches; Source: Practice Standard for Project Risk Management, 2009, p.38

2.7 Summary

Literature review indicated strong coherence between project management and change management; being both transitional activities but also integrated ones. Moreover, for the success of a project, accommodating changes is as much important as accommodating risks.

For this reason, the two most established project management frameworks (PMBOK and PRICNE2) stress the importance of various risk management processes. Even though they describe several techniques for managing risks, they do not actually show any strong preference to any specific technique. The most appropriate technique to be selected is subject to a decision taken by the project manager based on the nature and scope of the project.

The next chapter explains in detail the methodology deployed to asses change risks. As it has been mentioned earlier, a risk questionnaire will be used to weight the risk attributes which in turn will be assessed and prioritised numerically based on AHP.

3

Methodology

T he two most common approaches for operational research are quantitative and qualitative research analysis. The basic difference between the two arises from the fact that quantitative analysis is based mostly on scientific method. Quantitative analysis is based on measurable data and statistics in order for objectiveness to be preserved. Conclusions are mostly drawn from empirical data and via the mathematical use of formulae and statistical data measurements. On the other hand, qualitative analysis is often based on subjective data, which cannot be measured easily or measured at all. As an example, opinions or behavioural aspects fall in the category of subjectiveness rather than to measurable facts.

For this research's aim, in order to analyse the coherence of the identified risks and associated attributes, a qualitative approach integrated with quantitative prioritisation was deployed to establish theoretical and practical interrelations on Change Management Risks within Project Management. More specifically a 'risk' survey was used as a primary source of data collection from which useful information, facts, figures and professional views can be recorded. The survey is available for download at web page link: http://www.changemodel.net, released in December 2012. Respondents, can download the questionnaire in excel format and upon completion return to info@changemodel.net.

By downloading the questionnaire in excel format, someone can read the instructions for completion and all risk attributes are thoroughly defined and explained in a terms

of glossary. More details about CRAM's 'Questionnaire' and 'Glossary' can be found in Appendix 1 and Appendix 2 respectively.

Except descriptive explanations, the survey can be further numerically analysed with the use of Analytic Hierarchy Process, which will be explained in detail in the coming sections.

The main reason why, a questionnaire is selected as the primary qualitative research method for this thesis, is to provide the weights of the CRAM model. The sample of project management professionals that were invited to answer the survey are individuals with experience in managing projects (various organisational levels and years of experience), from various industries, such as organisations' consultants, analysts and managers.

Moreover, except the survey (web-based or hard copy), interviews in the form of brainstorm sessions were also employed for the final glossary definitions. Eventhough, both types can be applicable, Witmer et. al., (1999) pointed out, internet-mediated questioners and more specifically those that are administered in conjunction to e-mail, often seem to provide a greater control overall.

Except hard copy questionnaire, similar survey information can be collected by mail-out or web-based surveys. Rea and Parker (2005) explained the advantages of the above types. Both are convenient since the respondents can complete them at ease of time. Notwithstanding, since there is no personal and direct contact, anonymity can be preserved. Questions have a more complex structure in terms of size (no. of questions) and moreover easier to be followed up.

Finally, research is as a multistage process. However, the exact number of stages varies, which for example may include: formulation, clarification of the topic, literature review, methodology approach, analysis and collection of data, derived conclusions and finally the write up.

3.1 Establishing the Survey Characteristics

The survey is designed in such a way that will follow specific principles (Johnson and Christensen, 2008; Saunders et. al., 2007; Rea and Parker, 2005). Belton (2005, pp. 56-57), summarised some of those principles:

"Principles:

- respondents must be able to understand the questions
- they must be able to provide the information requested
- they must be willing to provide the information requested

Questions should:

- be phrased in simple language
- be economically worded
- avoid jargon
- avoid phrases or words which have different meanings to different groups
- be well defined
- avoid ambiguity"

One major characteristic of the risk survey is the rating scale. Actually, in many cases, surveys use rating scale. This research's survey uses AHP rating scale, as risk attributes were weighted by integer numbers (1, 3, 5, 7 and 9) depending on the respondents' preference. However, the rating questions most frequently use Likert style rating scale, as respondents are asked how strongly they agree or disagree with a statement or series of statements (Saunders et. al., 2007).

Johnson and Christensen (2008) explained that by using rating scales researchers can obtain data by providing to respondents statements and corresponding rating scales. Usually, instructions are used to help respondents make judgements. More specifically, the numerical rating scale consists of set of numbers and anchored (written description for a point on a rating scale) end points. A fully anchored rating scale provides descriptions for all end points (Saaty's AHP rating scale).

The rating scale, for this research was selected due to the advantages of easiness to complete, in terms of time consumption and question comprehension on behalf of the survey's participants. Moreover, it is a prerequisite for CRAM methodology deployment. In addition, this method ensures a thorough analysis and presentation of findings since the scale is uniform for the questions. Based on Dillman (2000), if there is an intention to use a series of statements it is advised to keep the same order of response categories, which in effect help respondents to avoid confusion.

Further to the rating scale, the phrasing of the questions is important. It must reflect the proper relationship between the elements in one level with the property in the next higher level (Saaty, 2008; p.72).

In the same light, professionals are more appreciative when providing short and concise answers to a set of questions. Nevertheless, in order to make comparisons, a scale of numbers is needed so as to indicate how many times more important or dominant one element is over another element with respect to the criterion of property with respect to which they are compared (Saaty, 2008).

When using AHP, special care should be taken on the formation of the questions since by asking the wrong question, nonsensial results may be obtained. Saaty (1987) provided some hints when asking the questions which compare the attributes. In general, the questions should be phrased in a manner asking which is more 'important', meaning a greater processor of the attribute.

The survey's questions took the form of how important is element 1 compared to element 2 with respect to a specific element in the immediately higher level. Forman and Gass (2001) expressed the view that AHP must use ratio scale priorities for elements above the lowest level of the hierarchy. More specifically he argued that, "this is necessary because the priorities (or weights) of the elements at any level of the hierarchy are determined by multiplying the priorities of the elements in that level by the priorities of the parent element".

For example, as shown in Figure 3.1:

Q) For *communication* attribute which is more important being trustful or having common vocabulary?

Figure 3.1: Weighting and Selection of Attributes Importance

The respondent (based on her/his opinion) has to choose either trustful (A) or common vocabulary (B) and rate (pairwise comparison; 1,3,5,7 and 9) the relative importance as far as communication is concerned (higher level risk attribute).

In order to be able to quantify the respondents' replies, a relative weights mapping scale is used as seen in Table 3.1:

Intensity	Definition	Explanation
1	Equal Importance	The two activities contribute equally
3	Moderate Importance	Slightly favours one over another
5	Essential or Strong Importance	Strongly favours one over another
7	Demonstrated Importance	Dominance of the demonstrated importance in practice
9	Extreme Importance	Evidence favouring one over another of highest possible order of affirmation

Table 3.1 Saaty's Scale[1]

---

[1] Even intensity (2,4,6,8) numbers are considered as intermediate values which may be used when compromise is needed. For the scope of this research they are omitted since "1" is used for equal importance.

The Saaty's scale is linear:

c = a . X, a>0, x= {1, 2, 3 ... 9}   (Eq. 3.1)

Effectively, the resultant measure or scale is represented by a 'Relative Weights Scale' by combining the scores for each one of the rating questions. If the problem concerns simple ranking and the degree to which elements being ranked reflect the criterion (or attribute) it is then obvious, that one can simply assign numbers. Numbers must be selected with care, which use to express the strength with which each element possesses or contributes to the property in question (Saaty, 2008; p.74).

In some cases except intermediate values, reciprocals of table 3.1 (i.e. 1, 1/3, 1/5, 1/7, 1/9) can be used, which result to a reasonable assumption provided that activity i has one of the non-zero numbers (1, 3, 5, 7, 9) assigned to it when compared with activity j. Then j has the reciprocal value when compared with i. "In other extreme cases, because it may be difficult to assign the best value but when compared with other contrasting activities the size of the small numbers would not be too noticeable, yet can still indicate the relative importance of the activities. In such cases 1.1 - 1.9 can be used" Saaty (2008, p.86).

However, in an example of Waltham, Massachusetts Police Department, and as referenced by Forman and Gass (2001) the evaluation of the criteria was made based on 1 to 5 scale, abandoning the traditional scale as seen in Table 3.1. This gives the power to AHP modellers to use relative attributes weighting scales different than those that Saaty has initially proposed. Nevertheless in most cases studies what is being used is the original proposals of Saaty. Initially, Saaty had proposed verbal judgements (Equal, Weak, Strong, Very Strong and Absolute). After more careful examination, 'Weak' and 'Absolute' were changed to 'Moderate' and 'Extreme' respectively.

Nevertheless, other researchers have proposed various other scale types apart from the linear one, like for example geometric, logarithmic, asymmetrical and others as seen in Table 3.2.

Scale type	Definition	Parameters
Linear (T. Saaty, 1977)	$c = a \cdot x$	$a > 0$; x = {1, 2, ..., 9}
Power (Harker & Vargas, 1987)	$c = x^a$	a > 1 ; x = {1, 2, ..., 9}
Geometric (Lootsma, 1989)	$c = a^{x-1}$	a > 1 ; x = {1, 2, ..., 9} or x = {1, 1.5, ..., 4} or other step
Logarithmic (Ishizaka, Balkenborg, & Kaplan, 2010)	$c = \log_a(x + (a-1))$	a > 1 ; x = {1, 2, ..., 9}
Root square (Harker & Vargas, 1987)	$c = \sqrt[a]{x}$	a > 1 ; x = {1, 2, ..., 9}
Asymptotical (Dodd & Donegan, 1995)	$c = \tanh^{-1}\left(\frac{\sqrt{3}(x-1)}{14}\right)$	x = {1, 2, ..., 9}
Inverse linear (Ma & Zheng, 1991)	$c = 9/(10-x)$	x = {1, 2, ..., 9}
Balanced (Salo & Hamalainen, 1997)	$c = w/(1-w)$	w = {0.5, 0.55, 0.6,., 0.9}

Table 3.2 Various Comparison Scales for Attributes, Ishizaka A., Labid A. (2011)

The number (No) of questions required per AHP matrix is given by the formula below:

No of questions = ((No of elements x No of elements) − No of elements) /2 (Eq. 3.2)

For example, the child factor, 'Monitoring' which is composed of four risk attributes (*reporting, learn from failure, corporate policy alignment and systematic*):

Child Risk Factors Monitoring	Reporting Risk	Learn from Failure Risk	Corporate Policy Alignment Risk	Systematic Risk
Reporting Risk	**1**	7	3	3
Learn from Failure Risk	1/7	**1**	5	7
Corporate Policy Alignment Risk	1/3	1/5	**1**	5
Systematic Risk	1/3	1/7	1/5	**1**

Table 3.3 Child Risk Factor (Monitoring); Random Weights

In matrix format: $A_{monitoring} = \begin{bmatrix} 1 & 7 & 3 & 3 \\ 1/7 & 1 & 5 & 7 \\ 1/3 & 1/5 & 1 & 5 \\ 1/3 & 1/7 & 1/5 & 1 \end{bmatrix}$

No of questions$_{Monitoring}$ = ((4 x 4) – 4) /2 , then

No of questions$_{Monitoring}$ = 6

More precisely, the element that appears in the left-hand column is always compared with the element appearing in the top row, and the value is given to the element in the column as it is compared with the element in the row. The reciprocal value is entered in the position where the second element (transpose), when it appears in the column, is compared with the first element when it appears in the row (Saaty, 2001; p.75).

If

$A_{ij} = k$

then

$A_{ji} = 1/k$ (Eq. 3.3)

Saaty (2008, p.94) argued that the pairwise comparison has far broader uses for making decisions. For example, people may use the well known SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis. Having switched the order of weaknesses and opportunities then we can deal with a decision referred to BOCR (Benefits, Opportunities, Costs and Risks).

3.2 Survey's Research Contribution

Once weights are calculated, risks can be assessed with the use of related mathematical formulae and more precisely AHP's eigenvectors.

Who should be asked?

Within the scope of survey design, respondents fall in different specialist categories but not limited to the following:

- CXO level;
- Board of Directors;
- Outsourcing managers;
- Senior managers;
- Corporate legal and advisory staff;
- Consultants;
- Project Managers;
- Project Team Members;
- Services directors.

In general, any stakeholder who is related to the project.

What type of survey should be used?

Sample Size	Depending on Case Study
Scale	Saaty AHP scale (linear)
Type	On-line via dedicated web page; Hard Copy (where applicable)
Notification to respondents:	Mainly via e-mail
On – line survey gathering responses time	~ 6 months to reach a valid result
Scope	Opinions concerning business change risks within contemporary project management frameworks.
Avg. Allocated time per survey completion	Approx. 10 – 15 min

Table 3.4 Generic Survey Characteristics

How will the results of the survey be assessed?

The main points discussed will be compared to literature, and any significant differences will be noted and highlighted, within the research's scope. Differences, will also be analysed by taking into account the respondents' background, specialisation, workplace and size of organisation. Moreover, the final model (CRAM) will be tested in real business scenarios (case study).

CRAM can produce results, even if only one respondent is asked, for example the project manager or in other cases even the CEO of an organisation. Usually, the number of project team members depends on the scale of the project. Taking into account the author's experience, a range of 5 to 10 people is commonly seen. CRAM has also the advantage that more respondents can be added and evaluated, even if initial results are produced.

3.2.1 Case Studies

In order to evaluate the survey's results and in effect CRAM's applicability, the model was deployed commercially at "Ringtokk Systems" results of which are being presented and analysed in chapter five of this thesis.

Briefly, RingTokk is a start-up, registered in UAE that was facing serious organisational problems, mainly in the operations and planning sectors. Frequent changes in the daily business operations were causing side risks. With the aid of CRAM, risk causes were prioritised and analysed with a view to minimise and control them. In short, the organisational results after deploying CRAM's recommendations were: increased productivity, higher revenues and overall greater brand image.

Moreover, two other companies have expressed interest to test the applicability of the model in their business environment:

a) Athens International Airport (http://www.aia.gr)
b) Printec Group of companies (http://www.printec.gr)

3.3. AHP for Change Risk Analysis

Analytic Hierarchy Process (AHP) is an established and structured multi-criteria hierarchical technique for making complex decisions that helps users sort out the "best" decision for their challenge, situation, and variables instead of the finding the "correct" decision. It was first conceived in the 1970s by Thomas L. Saaty. Actually, it mainly deals with decision making problems by determining the relative importance or criteria weight though criteria pairwise comparisons. A matrix is constructed which shows the relative importance of each criterion relative to the others.

PRINCE2 (2009) defines Risk Breakdown Structures as a hierarchical decomposition of projects' environment in an attempt to illustrate potential sources of risk. However, even if RBS is hierarchical as AHP, it does not include any mathematics or quantitative analysis.

Saaty (2001) argued that AHP breaks down a complex and unstructured situation or problem into smaller parts (components) but in a hierarchical way. Numerical values are assigned to subjective judgments on the relative importance of each variable.

Basesd on Saaty (2008) the Analytic Hierarchy Process has three explicit logical steps:

- *Hierarchy representation and decomposition:* Breaking down the problem into separate elements.
- *Priority discrimination and synthesis:* Ranking the elements by relative importance.
- *Logical consistency:* Ensuring that elements are grouped logically and ranked consistently according to a logical criterion.

The pairwise comparison as described in AHP seems to be ideal to analyse the relative criteria against others. Initially, a functional hierarchy is constructed so as to decompose the complex system in smaller criteria or attributes in a logical and

simpler way. The elements in the hierarchy compose clusters of system's objectives, the decision criteria, the attributes of the criteria and the alternative solutions.

The highest level of the hierarchy is the decision objective (consists only of one element). Other sub-levels may have several elements so as to compare one level to another against a criterion in the next higher level (Satay, 2001). Figure 3.2, shows the AHP functional hierarchy:
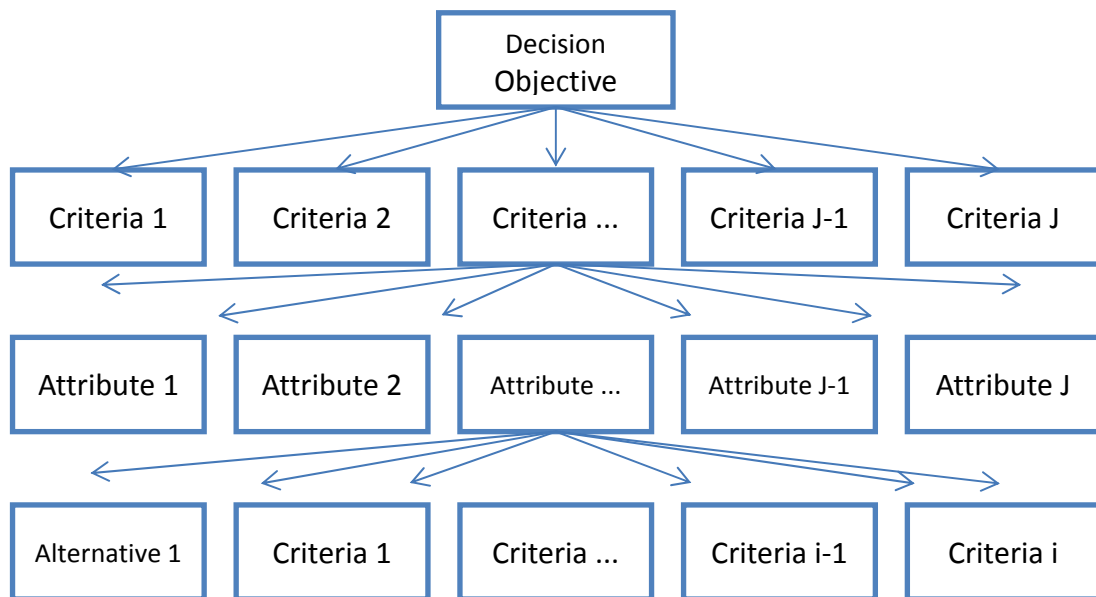
Figure: 3.2: The AHP functional hierarchy

Based on Saaty (2008, p.38) hierarchies should be constructed after the inclusion of enough relevant details to depict the problem as thoroughly as possible. Actually, this serves two purposes:

a) Provision of an overall view of the complex relationships inherent in the situation.

b) Permits the decision maker to assess whether issues of the same order of magnitude in weight or impact on the solution are being compared.

What follows next, is the elements' priority analysis which is made with pair-wise comparison, i.e, comparing the elements in pairs against a criterion in a matrix

format. In order to populate the pair wise comparison matrix, the RI (relative importance) process is introduced.

As Saaty (2008, p.38) proposed, the elements should be clustered into homogeneous groups of five to nine so they can be meaningfully compared to the elements in the next higher level. In case the elements per level were more than nine then clustering solution could have been followed.

The only restriction on the hierarchic arrangement of elements is that any element in one level must be capable of being related to some elements in the next higher level, which serves as a criterion for assessing the relative impact of elements in the level below.

A typical pair wise comparison matrix is seen below, Table 3.5 (diagonal is always completed by 1's):

Objective	Criteria 1	Criteria 2	Criteria 3	Criteria i-1	Criteria i
Criteria 1	**1**	RI_{12}	RI_{13}	RI_{1i-1}	RI_{1i}
Criteria 2	$1/RI_{12}$	**1**	RI_{23}	RI_{2i-1}	RI_{2i}
Criteria 3	$1/RI_{13}$	$1/RI_{13}$	**1**	RI_{3i-1}	RI_{3i}
Criteria i-1	$1/RI_{1i-1}$	$1/RI_{2i-1}$	$1/RI_{3i-1}$	**1**	RI_{i-1i}
Criteria i	$1/RI_{1i}$	$1/RI_{2i}$	$1/RI_{3i}$	$1/RI_{i-1i}$	**1**

Table: 3.5: Typical Pairwise Comparison Matrix

When comparing the elements together, the smaller one to be compared "is considered to be the unit and the larger one is assessed to be so many times more than that it, using the intensity of feeling and translating it to the numerical value" Saaty (1987, p.161).

Or better, in a matrix formation:

$$A = \begin{matrix} 1 & RI_{12} & RI_{13} & RI_{1i-1} & RI_{1i} \\ 1/RI_{12} & 1 & RI_{23} & RI_{2i-1} & RI_{2i} \\ 1/RI_{13} & 1/RI_{13} & 1 & RI_{3i-1} & RI_{3i} \\ 1/RI_{1i-1} & 1/RI_{2i-1} & 1/RI_{3i-1} & 1 & RI_{i-1i} \\ 1/RI_{1i} & 1/RI_{2i} & 1/RI_{3i} & 1/RI_{i-1i} & 1 \end{matrix}$$

The matrix is a simple tool that offers a framework for testing consistency, obtaining additional information through making all possible comparisons, and analysing the sensitivity of overall priorities to changes in judgement. (Saaty, 2008, p.72). The next step after forming the matrices is to derive the relative weights for the various elements.

The integration process involves the evaluation of the so called, vector priorities (VP or eigenvectors) that designate the relative ranking of the dependent decision attributes for the objective in scope.

A brief example of the above procedure is shown in table 3.6 below:

According to the judgment assigned to each criterion, a pairwise comparison matrix A and a weights vector w can be computed in the following steps as seen below:

1. Let Aij equal the intensity of relative importance between criterion i and criterion j as defined in table 3.1 with $A_{ji} = \dfrac{1}{A_{ij}}$;

2. Compute $A_j = \sum\limits_{i=1}^{n} A_{ij}$, the sum of each column of A ;   (Eq. 3.4)

3. Normalize A by dividing each element Aij in the comparison matrix A by Aj ;

(Eq. 3.5)

4. Compute $w_i = \dfrac{1}{n}\sum\limits_{j=1}^{n} A_{ij}$, the weight of criterion i ;   (Eq. 3.6)

where n is the total number of criterion (i.e. the dimension of A).

Actually, normalisation permits meaningful comparison among elements and the final step is to yield the percentage of overall relative priorities or preferences.

	Criterion 1	Criterion 2	Criterion 3	Criterion 4	**Weights**
Criterion 1	1	2	3	5	47.09%
Criterion 2	½	1	2	3	26.72%
Criterion 3	1/3	½	1	4	18.80%
Criterion 4	1/5	1/3	1/4	1	7.39%

Table: 3.6: An Example of Pairwise Comparison Matrix and Weights

The numbers in the table represent the relative importance between the criteria. For example: the relative importance of criterion 1 versus criterion 3 is 3 and between criterion 3 and criterion 1 it is 1/3. This indicates that criterion 1 is *moderate* important compared with criterion 3. The numbers in the weights column show the relative weights of the corresponding criteria. More detailed calculation examples can be seen in Appendix 4.

3.3.1 AHP Results Credibility

To evaluate the credibility of the estimated weights, Saaty (1980, 1983) proposed an eigenvector which is considered a theoretically and practically proven method for evaluating the credibility of the weights (Golden et. al., 1989). The eigenvector is actually the calculation of a list of related weights of the chosen initial factors which are in turn relevant to the problem in questions.

The method can be described as follows:

1. Calculate the maximum eigenvalue λ_{max} of the pair-wise comparison matrix A;

After computing the nth root of the products of the values in each row, λ_{max} can be found as follows. The priority vector is the nth root divided by the sum of the nth root values.

$$\lambda_{max} = \text{Sum of Priority Row} \qquad\qquad (Eq. 3.7)$$

Priority Row = (sum of the row value) x Priority vector

2. Compute the consistency index (C.I.) defined by Saaty as:

$$C.I = \frac{\lambda_{max} - n}{n - 1}$$ (Eq. 3.8)

If a matrix [A] which represents the pairwise comparisons elements is absolutely consistent, then it should be equal to the the matrix which denotes the ratios of the weights matrix [W].

In effect if A = W , then λ_{max} = n

The weights ($w_{1...n}$) which can be obtained by using the eigenvectors, should be positive and normalised, in effect satisfy the reciprocity property.

Now, provided that there is no absolute consistency then, $\lambda_{max} > n$, in effect this level of inconsistency has to be measured. For this reason Saaty, defined the consistency ratio (CR).

3. Calculate the consistency ratio (CR)

$$C R = \frac{CI}{RI}$$ (Eq. 3.9)

where the random index (RI) for different n can be obtained from Golden et al. (1989).

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Random Index (RI)	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Tab: 3.7: Random CI table

Random Index (RI) is the average of (CI) for random matrices using the Saaty scale. More precisely, the above table represents a composite of two different experiments performed by Saaty and his colleagues at the Oak Ridge National Laboratory and at the Wharton School of the University of Pennsylvania. 500 random reciprocal n x n matrices were generated for n = 3 to n = 15 using the 1 to 9 scale. CR is normalised as a value is divided by the arithmetic mean of random consistency indexes (RI).

In literature, there a lot of various views concerning the random RI calculations, as they depend on the simulation methods used. Table 3.8, shows the differences found after various simulations performed.

	Oak Ridge	Wharton	Golden Wang	Lane, Verdini	Forman	Noble	Tumala, Wan	Aguaron et. al.	Alonso, Lamata
	100	**500**	1000	2500	17672-77478	500	46000-470000	100000	100000
3	**0.382**	**0.58**	0.5799	0.52	0.5233	0.49	0.500	0.525	0.5245
4	**0.946**	**0.90**	0.8921	0.87	0.8860	0.82	0.834	0.882	0.8815
5	**1.220**	**1.12**	1.1159	1.10	1.1098	1.03	1.046	1.115	1.1086
6	**1.032**	**1.24**	1.2358	1.25	1.2539	1.16	1.178	1.252	1.2479
7	**1.468**	**1.32**	1.3322	1.34	1.3451	1.25	1.267	1.341	1.3417
8	**1.402**	**1.41**	1.3952	1.40		1.31	1.326	1.404	1.4056
9	**1.350**	**1.45**	1.4537	1.45		1.36	1.369	1.452	1.4499
10	**1.464**	**1.49**	1.4882	1.49		1.39	1.406	1.484	1.4854
11	**1.576**	**1.51**	1.5117			1.42	1.433	1.513	1.5141
12	**1.476**		1.5356	1.54		1.44	1.456	1.535	1.5365
13	**1.564**		1.5571			1.46	1.474	1.555	1.5551
14	**1.568**		1.5714	1.57		1.48	1.491	1.570	1.5713
15	**1.586**		1.5831			1.49	1.501	1.583	1.5838

Tab: 3.8: RI (n) values, Alonso & Lamata (2006), p.5[2]

As indicated by Alonso and Lamata (2006) results show changes of values depending on different experiments on the size and number of matrices. The experimental values of Golden & Wang (1990), Lane & Verdini (1989), and Forman (1990) are closer. On the other hand, the respective values indicated by Saaty (1980) are higher; Noble (1990), Tumala and Wan (1994) produced lower RI values.

In more recent approaches, researchers such as Aguaron & Moreno-Jimenez (2003), Ozdemir (2005), Alonso and Lamata (2004) obtained different RI values but they are closer; as seen in table 3.9. Also, Alonso and Lamata (2006), proposed an estimation of RI but now, used 100,000 and 500,000 matrices on different dimensioning (n). Results indicated no serious differences can be seen in the following Table 3.9.

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[2] Oak Ridge and Wharton refer to Saaty's simulation experiments

	100000 matrices		500000 matrices	
n	RI	std (σ)	RI	std(σ)
3	0.5245	0.6970	0.5247	0.6973
4	0.8815	0.6277	0.8816	0.6277
5	1.1086	0.5087	1.1086	0.5087
6	1.2479	0.4071	1.2479	0.4071
7	1.3417	0.3312	1.3417	0.3310
8	1.4056	0.2779	1.4057	0.2777
9	1.4499	0.2383	1.4499	0.2381
10	1.4854	0.2076	1.4854	0.2074
11	1.5141	0.1847	1.5140	0.1844
12	1.5365	0.1670	1.5365	0.1667
13	1.5551	0.1516	1.5551	0.1514
14	1.5713	0.1383	1.5713	0.1380
15	1.5838	0.1279	1.5838	0.1276

Tab: 3.9: RI (n) values, Alonso & Lamata (2006); 100,000 and 500,000 matrices

After a lot of experiments Alonso & Lamata (2006) concluded to the following calculation of consistency ratio (CR) as better results can be obtained.

$$CR = \frac{\lambda_{max} - n}{2.7699n - 4.3513 - n} \qquad \text{(Eq. 3.10)}$$

The maximum eigenvalue, based on Saaty, can be determined by raising each random matrix to increasing powers and normalising the result until the process converged. The consistency index was then computed on each matrix for n = 1 through n = 15. As a rule of thumb, a value of C.R. ≤ 0.1 is typically considered acceptable.

In other words, inconsistency is permitted in AHP as long as it does not exceed the ratio of 0.1. If CR equals 0 then that means that the judgments are perfectly consistent.

Larger values require the decision maker to reduce inconsistencies by revising judgments (Harker & Vargas, 1987). The eigenvector approach can be used for determining whether the pairwise comparison matrix is acceptable or not.

Usually, because the number of respondents is >1, results will be consolidated. In effect for the consolidation of inputs, the geometric mean of replies is used (Eq 3.11), due to higher accuracy in result than the respective arithmetic mean. Overall, consulting several experts avoid bias and provide a more concrete result.

$$b_{ij} = (a_{1_{ij}} \cdot a_{2_{ij}} \cdots a_{k_{ij}})^{\frac{1}{k}}$$

(Eq. 3.11)

3. 4 Research Limitations

The most obvious limitation of this research is related to identifying risk factors. It is well understood that complete risk factors cannot be indexed and named, as many of those can be classified as unknown which can be discovered after the initiation phase of the project. Each project is different in a variety of factors (for example the four constraints), in effect each project has a lot of different risks which can be associated to business environments. CRAM has identified initially major change risks which can suit to a lot of cases. At the same time, it provides enough flexibility to add or delete risk attributes based on exact projects' requirements facilitation.

One of the basic limitation of the questionnaire, is that might lead to bias since the respondents might have differences in terms of business sector, mix of experience, etc. This is one of the reasons why, all risk attributes were defined in terms of a glossary. In such a way, all respondents will have at minimum a common understanding of what is requested to be assessed (understandability).

Concerning other AHP limitations, the elements per level can range between 4 -9. In rare cases that elements are more than nine, these can be grouped in clusters so the comparison is made per clusters and not per level (Saaty, 1987; Mustafa and Al-Bahar, 1991).

To this frame, Forman and Gass (2001) discussed about three axioms that AHP is based on which have to be followed for someone who wishes to select AHP as methodology.

The first one is the reciprocal *axiom*. If A is five (5) times larger or more important than B, then it goes without saying that B is one fifth (1/5) as large or important as A. The second one is the *homogeneity axiom*. The elements which are compared together per level shouldn't be too much different or else large errors in judgement may occur. This is one of the reasons why the consistency ratio (C.R) should be equal or less than 0.1. The third and last axiom states that "*judgments about or the priorities of the elements in a hierarchy do not depend on lower level elements*".

Finally, another limitation for this research is the lack of specific knowledge area related to change management in contemporary project management frameworks. It should be noted, that up to now the literature in this area of study is limited creating a rather challenging motivation for further research.

3.5 Summary

This chapter presented the methodology and processes that will be used to carry out this research's results; being a combination of qualitative and AHP numerical prioritisation; the CRAM approach. A survey will be used, deploying the AHP scale, as an opinion gathering tool which will provide the weights of relative risks and attributes. The actual mathematical risk assessment will be evaluated after the use of AHP formulae in terms of a hierarchical tree model.

Overall, upon completion, the whole research will provide new insights to the project management community luxuriating in the knowledge area of change management and risk assessment. The next chapter will describe the formation of CRAM's risk tree (hierarchy) parent and child nodes. Also, more information will be provided concerning the related attributes of each node.

4

Change Risk Assessment Model

"It is not the strongest of the species that survives, nor the most intelligent; it is the one that is most adaptable to change."

Darwin, C (1809 – 1882)

C hange seems to have become the rule within organisations in an attempt for rapid and effective business environment adaptation. Specifically for contemporary project management methodologies, project success is related to conformance to projects' requirements; hence change might be necessary to put things back on track and make related adjustments. Moreover, project risk management is essential for successful project management since project changes have an impact on projects' outcome (Apostolopoulos et.al., 2014).

PRINCE2 (2009, p.2) clearly mentions that "as the pace of change (technology, business, social, regulatory etc.) accelerates, and the penalties of failing to adapt to change become more evident, the focus of management attention is inevitably moving to achieve a balance between business as usual and business change". Nevertheless, changes especially in the business environment are associated with risks.

Taking into account the generic term risk, by estimating it, the question which is being addressed is "what can go wrong? In other words, what is the likelihood of an event deviating from its expected and planned course or occurrence? As Charette (1989) suggests, especially during risk estimation, four items have to be determined; variable values determination, is the first.

Usually this is done by selecting an appropriate scale, which actually measures the variables. The second one is the identification of the various consequences of an event and the third is for the magnitude of the risk to be determined. The final and fourth objective is to eliminate any surprises.

Organisations have precise missions and objectives that take the challenge to accomplish, taking the least possible risks. Similar to project management processes, objectives reflect accepting all the planned activities of each organisation that have to be specified upon achievement (Apostolopoulos and Tamvakidis, 2011).

In order for project management processes to be integrated into an organisation context, the current organisational status and barriers need to change. Nevertheless, they have to be firstly identified. This will allow in turn for the development of an end state. This end state has to do with: centralisation of project management control, the improvement of organisational project management infrastructure and finally the decentralisation of project management control (Firth & Krut, 1991). Additionally, Ives (2005) concluded that changes to the organisational context of a project, increases the risk of project failure itself. Actually, small changes can have large impact and specifically the changes which happen suddenly are the ones which are the most difficult to accept (Gladwell, 2005).

It is not rare the fact that, projects managers may be confused by the information which is provided by stakeholders needing assistance in identifying differences of opinions and seeking positions where compromise might be reached. To this frame, change management integrated within project management may be proven a powerful coalition to judge whether the outcome (project changes leading to successful result) is sensitive to slight or drastic changes in opinion and judgements either in individual or organisational level.

4.1 CRAM High Level Desing and AHP

AHP applications have had a long established history, nevertheless their initial development started in the late 1970s by the modelling need of top-down and bottom-up diagrams (Apostolopoulos et. al., 2015). The use of an AHP approach for

the assessment of change management risks within contemporary project management methodologies will allow the utilisation of a novel model (CRAM) for solving problems semi-qualitatively and semi- quantitatively. The model is designed to be user friendly and flexible enough, to allow users decide upon their own risk attributes (if required) and test the sensitivity of the solution or result to changes in information; for example change(s) of the respective nodes or attributes.

Based on Saaty (2001, p.7), people in the public or private sectors tend to cooperate in defining and structuring their problems broadly and richly so as to include as many ideas as possible. On the other hand, when asked to explain which are the specific factors that pose the greatest impact on the outcome of the decision, not even experts with the clearest logic can explain adequately.

Saaty (2008) argued that people not only have different feelings about the same situation but also their feelings change and can be changed. This is because they can be influenced by a variety of unpredicted and unstable factors. Consequently, when managing projects, in most of the cases the more managing roles are engaged in decision making the more diverse the result might be. However, it is within the duties of the project manager, and related stakeholders to make the best decisions taking into account project's constraints.

To give an example, a useful outcome of the model will be: the project manager or the model user to comprehend the relationships among the different factors of the model and be able to judge, evaluate and assess risks. Figure 4.1 shows a high level diagram of the research approach:
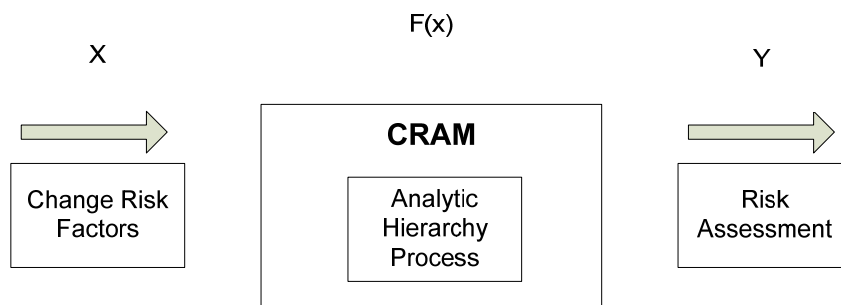
Figure 4.1: CRAM High Level Diagram

The main inputs of the model are represented by risk factors which are related to project change requests and in a greater context with change management. The respondents will be able to appoint proportional weights (qualitative analysis) after completing a respective questionnaire with several questions using a linear rating scale (AHP) as explained thoroughly in chapter three.

Nodes' (root/parent/child) attributes' relationships will be illustrated with the use of a hierarchical risk tree. A risk tree is a hierarchical structure that breaks down the decision into progressively greater detail until a level is reached at which it is easier to make pairwise comparisons between factors. Concerning the mathematical approach, with the use of AHP attributes will be prioritised quantitatively and assessed accordingly.

4.1.1 CRAM Nodes and Attributes Relatioships

Further to the proposed CRAM approach, in order for the tree to be developed Figure 4.2 shows the level relationships:
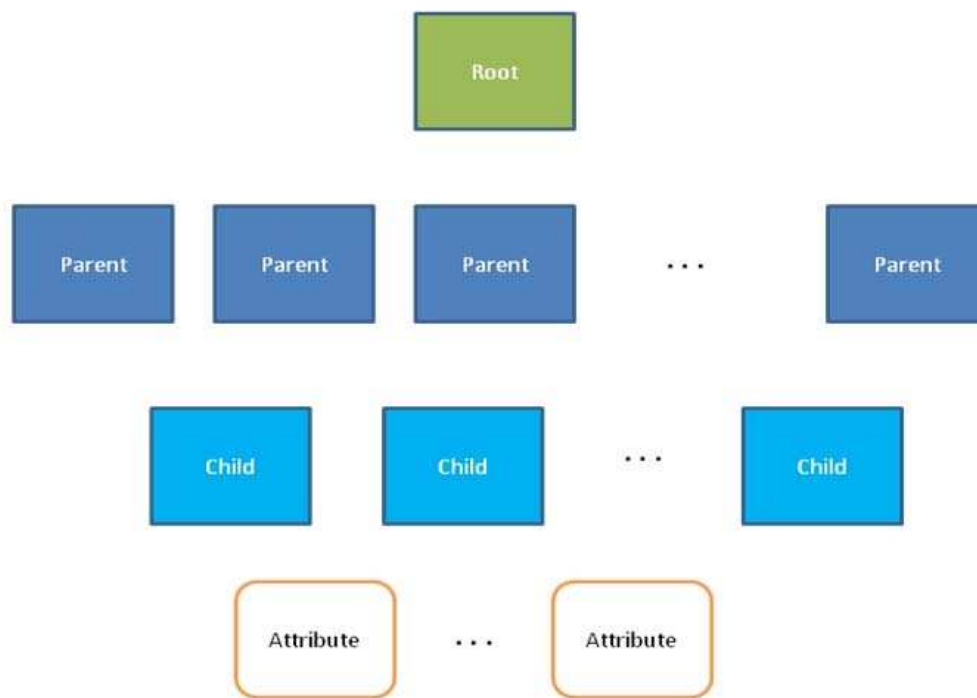
Figure 4.2: Risk Tree Hierarchical Layer Relationships

An overall, schematic representation of the proposed tree is illustrated in Figure 4.2, which consists of one (1) core (root) node, eight (8) parent nodes, five (5) child nodes and its respective sixty-one (61) attributes.

A tree model structure can be defined as a collection of tree elements (the nodes), where each node can be assigned a relative value together with a list of references to nodes named the "children". A parent node, being the converse notion of a child, is positioned at a higher level.

Nodes are composed of criteria so as to refer in a general sense to factors relevant to the decision. In turn, an attribute is a characteristic of the options being evaluated which is measurable against some objectives.

As depicted in Figure 4.3, the project management team is the only parent node possessing child attributes indicating a third level of analysis due to the overall significance in the process of project management frameworks.

Prior to project initiation, the project management methodologies define clearly the members and the responsibilities of the stakeholders, emphasised in the project management team.
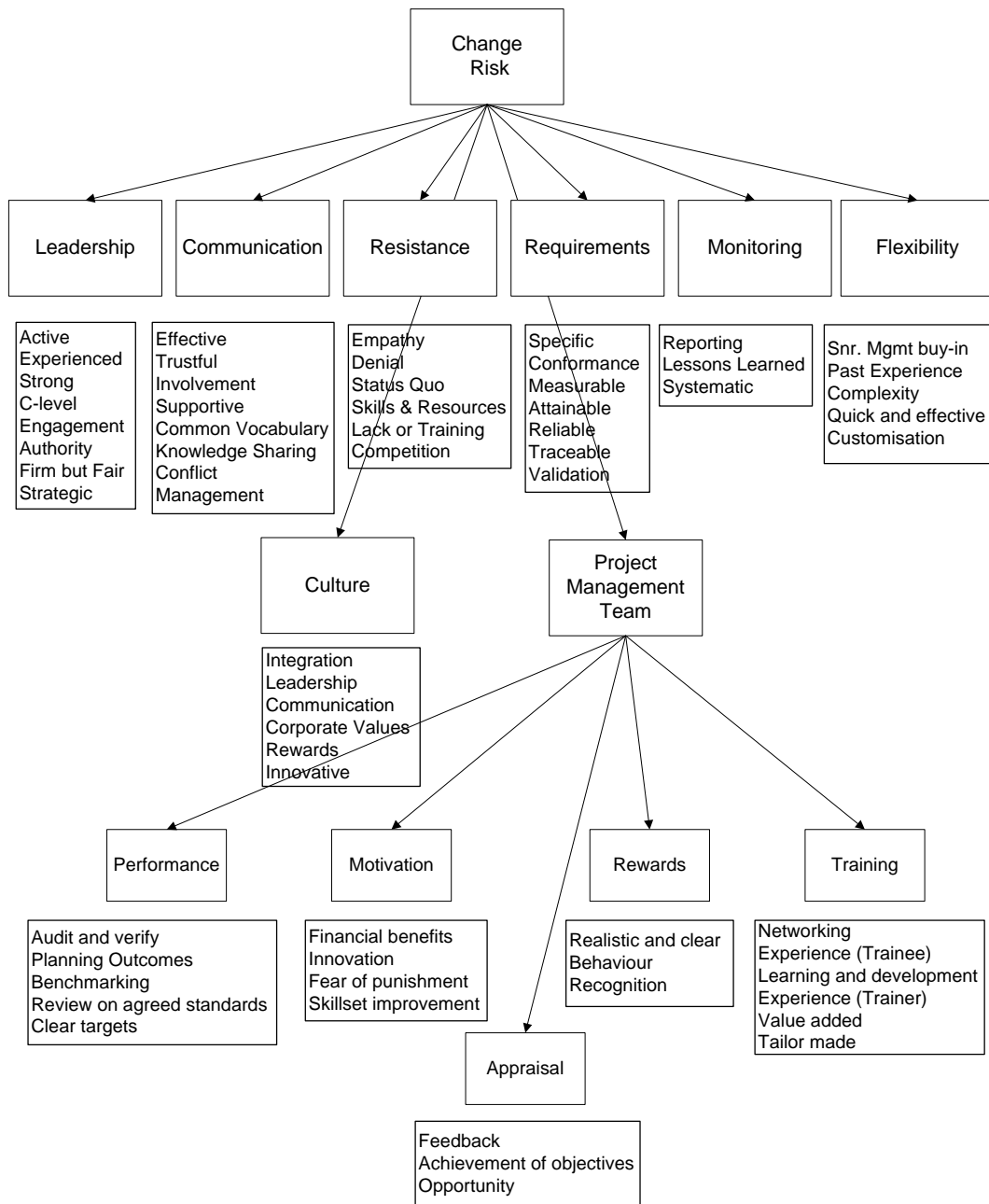
Figure 4.3: Change Risk Hierarchy Tree (Apostolopoulos et.al., 2014a)

The lines connecting the elements are called "branches". The root is the starting node (highest node in the hierarchy). A node's "parent" is a node one step higher in the hierarchy (i.e. closer to the root node) and lying on the same branch. A node has at most one parent and finally an attribute is a characteristic of the options being evaluated. Saaty (1987, p.166) argued that a hierarchy "is a simple structure used to represent the simplest type of functional dependence of one level or component of a system, in a sequential manner; a convenient way to decompose a complex problem

in search of cause-effect explanations which form a linear chain". CRAM's node hierarchy is indicated in Table 4.1, which consists of one core (root) node, eight parent nodes, and five child nodes.

On per case basis and depending on the scope and deliverables of a project, CRAM's nodes and related risk attribute's hierarchy per level can change so as to accommodate more of fewer criteria.

The only restriction on the hierarchic arrangement of elements is that any element in one level must be capable of being related to some elements in the next higher level, which serves as a criterion for assessing the relative impact of elements in the level below.

The hierarchy of CRAM per levels can be seen in Table 4.1:

Level 1(Root Node)	Level 2 (Parent Nodes)	Level 3 (Child Nodes)
Change Risk	Leadership	Performance
	Communication	Motivation
	Culture	Appraisal
	Resistance	Rewards
	Requirements	Training
	Monitoring	
	Flexibility	
	Project Management Team	

Table 4.1: CRAM Nodes Hierarchy

The various root/parent/child nodes have been selected after extensive literature review and further to several brainstorming sessions with high level executives from the EMEA market which have extensive knowledge in project management.

The whole modelling process consisted of eight beta version diagrams with a view to create a rich risk semantics tree; ensuring that the risks wording is kept accurate and simplistic, but at the same time avoiding jargon and misunderstandings. The initial identified project risk categories are seen in Table 4.2:

Project Risk Categories	
Technical	Project
Quality	Legal
Performance	Environmental
Change	Scope
Organisational	Quality
External / Internal	Schedule
Business	Process
Cultural	Requirements

Table 4.2: Project Risk Categories (Apostolopoulos et. al., 2014a)

CRAM has the capacity to define the internal dynamics of change management within project management eliciting also risk cause-and-effect relationships. Effectively, stakeholders are allowed to describe a problem as they see it, refine the complexity and structure a hierarchy of attributes.

The methodology in terms of scientific research used so as to develop the nodes and attributes of the prototype model, combined in depth literature review analysis and semi-structured personal interviews in correlation with group meetings (Delphi technique).

The intension of the semi-structured interviews approach that was followed, was not an attempt to establish consensus (large sample and time consuming analysis); instead the author's goal was to record the widest possible range of perspectives (risks). In such a way, respondents provided analytical answers to questions, in as much detail as they wished, in an open-ended discussion.

Taking into account that focused group discussions (Delphi Technique) was engaged as a further verification tool of the interviews results, it was more than obvious, that a group environment is beneficial for the respondents in gaining a deeper understating of the research questions.

Professionals were able to discuss further their common opinions or disagreements; contribute more effectively either by listening to new ideas or even discussing in more depth with fellow participants.

The change risk categories that were identified are summarised in Table 4.3.

Change Categories	
Individual	Rules / Regulations
Organisational	Evolutionary
Cost cutting	Revolutionary
Process	Strategic
Cultural	Transformational
Technical	Proactive /Reactive
Planned / Unplanned	Technological

Table 4.3: Change Categories (Apostolopoulos et. al., 2014a)

The key idea of categorisation was to construct the prototype model in a sense that can be used repeatedly in various industries, minimising any bias as possible.

4.2 CRAM′s Processes Approach

As it has been mentioned in chapter 1, Change Risk Assessment Model is consisted of three interrelated processes which are continually recorded and monitored. Even if project managers, change managers or other stakeholders discuss about change and the effects that change risks can have; still, there is a lot of room for research improvement in this area.

Literature shows increasing rates of project failures (Kotter, 1995; Gottesdiener, 2001; Taylor, 2006), but also an increasing use of project management frameworks for facilitating change. Similarly, change programs have also considerable low success rates (Meaney and Pung, 2008; Ford et. al., 2008; Szabla, 2007; Burnes, 2004; Beer and Nohria, 2000).

Within research scope, models are defined as the representation of a view of an interpreter about an entity or concept from the real world (Seidewitz, 2003). However, it is not uncommon to do business or perform business related activities without the use of models.

In this aspect, CRAM attempts to take into account several business environmental factors which may be proven risky enough for the success of the project's objectives. Nevertheless, business models which can be combined and configured with project business seem to be an exploited research area (Wikström et. al., 2010). Under a

systematic and user friendly approach change risks can be accommodated effectively and in most of the cases controlled. The three interrelated CRAM's processes are explained below:

4.2.1 Risk Identification

Risks can be practically identified in numerous environments and in fact, the difficult part in not only to identify (hidden risks are more difficult to be found) but also to control them. The primary goal of *Risk Identification* is to recognise the threats and opportunities which may affect the project's objectives and consequently deliverables. According to Rescher (1983), a risk can be categorised as follows:

Known Risks: these kinds of risks refer to an in-depth project analysis which has a considerably high probability of occurrence. In most cases, it can be identified from sources of information which are analogous to previous well-known similar cases.

Predictable Risks: are those risks that past experience dictates one may face with high probability. For example reviews, subcontractor problems, labour problems, cultural issues, etc.

Unpredictable Risks: are the risks that could happen, but the probability of occurrence in terms, for example, of timing cannot be estimated accurately. The success of many projects is related to the level that this risk will be estimated. In many cases, it can be regarded as the result of poor management and political redirection. This type of risk can result in project failure if immediate actions are not taken.

In any case and irrespective of risk categorisation, the proposed tools and techniques suggested by CRAM, so as to, identify change risks include the following:

- SWOT analysis
- Change/risk surveys
- Delphi technique
- RACI diagrams
- PERT diagrams

- PESTEL analysis

- Risk Breakdown Structure (RBS)

- Interviews

- Brainstorming sessions

Of course, potential risks and required changes can be identified and decided during the entire lifecycle of the project. Nevertheless, they have to be assessed and monitored accordingly the soonest the possible. The more risks are identified before initiation of the project the better outcome can be expected (see Figure 2.5 and Figure 2.6).

Potential risks and required changes can be found and decided during the whole lifecycle of the project; nevertheless they have to assessed and monitored accordingly.

One of CRAM's advantages is that risks which are introduced and identified initially, can in turn be linked to actual scope and objectives of the project. Table 4.4, shows some indicative project risk categories after respondents' revision of Table 4.2:

Project Risk Categories	
Technical	Marketing
Quality	Legal
Performance	Environmental
Change	Scope
Organisational	Quality
External / Internal	Schedule
Business	Process
Weather	Management
Cultural	Requirements
Project Management	Security

Table 4.4: Revised Project Risk Categories (Apostolopoulos et. al., 2014a)

Depending on the projects' aim and scope and in relation to the deliverables the more risks are identified and controlled (the earlier the possible) the higher the probability for project success. Changes and associated risks can occur during the whole life cycle of a project. CRAM has the capacity to define the internal dynamics of change management within project management eliciting also risk cause-and-effect relationships. In other words, allows stakeholders to describe a problem as

they see it, refine the complexity and structure of a hierarchy of attributes (Apostolopoulos et. al., 2014a).

4.2.2 Risk Assessemt

The basic aim of this research among different objectives as has been described in previous sections is *Risk Assessment*. More specifically, risk estimation and evaluation of change risks. Change, if uncontrolled can be associated with activities of uncertain outcomes which would be deemed unwanted deliverables from the viewpoint of project stakeholders. However, when change management and risk management are coupled together, risk consequences and impacts can be reduced. This is because risk is estimated at the planning stage of a project and consequently, there is time to develop a risk mitigation plan and take all necessary preventive actions (Apostolopoulos et. al., 2015).

The majority of quantitative methodologies based on probabilities carry less ambiguity and imprecision, meaning that they have increased accuracy as far as the assessment of gathered information on identified risks is concerned. Quantitative methods interpret results more formally compared to narrative descriptions or qualitative measurements.

Estimation can facilitate project risks in terms of the probability of occurrence and impact. On the other hand, *Evaluation* assesses the overall effect of all identified risks aggregated together. Some kinds of risks, like for example financial risks, can be evaluated in numerical terms.

 Overall, *risk assessment* can be accomplished with the aid of a variety of methods and techniques, such as for example:

- Simulations
- Monte Carlo analysis
- CPM (Critical Path Method)
- AHP (Analytic Hierarchy Process)
- Risk maps
- Bayesian probability and statistics

- Probability trees

As for the *Evaluation* activities and results, these can be recorded by a change controller by means of benchmark questions, such as:

- Were all implemented non-standard changes assessed?
- Did the approved changes meet the intended goal?
- Concerning result, does it satisfy stakeholders and more specifically conform to customer's requirements?
- Were there any unplanned changes found, and what are the associated risks?
- Concerning the implementation phase, did it exceed the project's constraints?
- Are the results documented for example in the change risk log?

CRAM uses the survey approach extensively, in an attempt to document and weight the impact of risks. Since there is no risk free project, at the same time there can be no model that can accommodate the needs of all cases. However, the first step is to develop a conceptual model of risk/change management (tree diagram) and then with the use of quantitative/qualitative analysis, assess the respective risks. CRAM incorporates respondents' judgments from various sectors in a rational and structured way (Apostolopoulos et. al., 2014a).

4.2.3 Risk Monitoring and Control

The *Risk Monitoring and Control* process mainly intends to identify, analyse, plan and track new risks, constant and periodic review of initially identified risks, monitor and control existing or residual risks. Moreover, the process is concerned with the review of proper execution of risk responses while evaluating their overall effectiveness.

Risk monitoring and Control can be accomplished with the aid of a variety of methods and techniques, for example:

- Risk Reassessment
- Meetings
- Variance Analysis
- Trend Analysis

- Risk Auditing

Alongside with the above described CRAM's processes an 'Experts' Judgment' may be proven overall constructive. An expert might be for example an individual (project manager, change manager) of a group of people (Project Steering Committee, Change Advisory Board) which can influence and advice further to CRAM's results.

CRAM does not actually favour for any specific tool or technique for risks assessment selection; rather it is regarded as a structured approach for facilitating change risk effectively.

Even if for example, no project management framework is followed, CRAM has exactly the same capabilities concerning change risk identification, assessment and monitor and control processes. Hence, expert's judgment is an 'advice guide' that authorised stakeholders may use or propose to use for managing changes and consequently the success of the project (Apostolopoulos et. al., 2014a).

Besides expert's judgment on testing and reviewing purposes, the use of case studies can help to extend experience, and compare what is known through earlier research. A database of case studies can be created to assist to the overall contextual analysis. Contextual analysis, can enable stakeholders to achieve the desired outcome; for example, completion of activity within budget and on time. Moreover, goal clarity and performance measurement in relation to resources coordination can minimise uncertainty and in effect risks (Apostolopoulos et. al., 2014a).

4.3 CRAM's Change Risks Approach

Taking into account that project changes incur risks, which have to be managed; contemporary project management frameworks paid attention to risk and the different ways that can be managed. For most people's beliefs, risk is synonymous to uncertainty and fear for the unknown, meaning that it is mainly related to future actions or events.

Specifically, contemporary project management methodologies attempt to address issues related to risk analysis and management but not to actual risk estimation modelling and more precisely change risk management. The most common approach is to discuss risk which incurs after changing the three constraints and the scope of the project.

Of course in a real world, since there is no risk free (perfect project) at the same time the constraints cannot be fully balanced. Previous sections earlier show that, CRAM goes far beyond examining constraints that contemporary project management methodologies introduce. New risk factors are introduced. like: leadership, communication, resistance, culture, requirements, monitoring, flexibility and project management team. Nevertheless, the tricky part is the level (impact) of the associated change.

4.4 General Sample's Data

In order for the model to be tested commercially with the least problems possible, a dedicated web page http://www.changemodel.net was uploaded with all the key information regarding the CRAM approach (Appendices 1 and 2).

Initially, for the development and testing of the prototype model, twenty-three high level executives from various industries were interviewed (phase one) in a three-month period. The scope of the interviews was to identify and record risks forming a baseline. Moreover, final recorded risk attributes were defined in terms of a *Glossary* and finally, executives which participated in the interview sessions were requested to complete the relative *Change Risk Assessment Model Questionnaire*[1].

The interviews also focused on extended open discussion analysis (details about respondents' background, special interests in change and risk management, related case studies in terms of professional experience) in an effort to grasp key information and end up with a complete possible model. Interviews were proven more than assistive in coupling together not only professional experience but also the personal reflection of the participants (Apostolopoulos et. al., 2015).

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[1] CRAM's Glossary and Survey are available at: http://www.changemodel.net/

Concerning the respondents' background it was the author's intention that executives who participated in this research outcome to have at least intermediate or extensive knowledge of contemporary project management frameworks and processes. Moreover, in order to minimise bias, participants will be from various industries and with several years of experience. Figures 4.4 and 4.5 show some participants' key information:
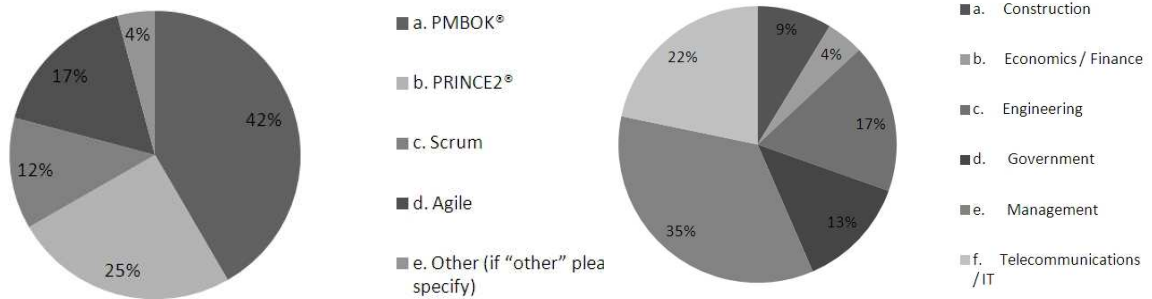
Figure 4.4: Respondents' Frameworks Use   Figure 4.5: Respondents' Background

The majority of executives use in their business environment PMBOK (42%), however they are familiar with PRINCE2 (25%) and Agile (17%) techniques. All executives which participated in this research have strong managerial background; 35% are related to Senior Managers, Director and C-level roles; 22% are affiliated to Telecoms/IT duties and 17% with Engineering.

Taking into account that focused group discussions (Delphi Technique) were engaged as a further verification tool of the interviews results (phase 2), it was more than obvious, that a group discussion environment is beneficial for the respondents in gaining a deeper understating of the research questions. Moreover, professionals were able to discuss further their common opinions or disagreements; contribute more effectively either by listening to new ideas or even discussing in more depth with fellow participants.

Table 4.5, shows the consolidated results of the executives who participated. For the consolidation of the results the weighted geometric mean of replies was used. From quick view of the consolidated results, the consistency ratio is less than ten per cent which indicated that the results are of low bias and within the limits of AHP acceptance.

	Leadership	Com/cation	Culture	Resistance	Req/ments	Mon/ring	Flex/lity	PMT	%Likelihood
Leadership	**1**	1	1	7	5	5	3	3	23.39
Com/cation	1	**1**	3	5	3	5	7	3	27.36
Culture	1	1/3	**1**	5	3	5	3	1/3	14.54
Resistance	1/7	1/5	1/5	**1**	½	1/3	1	1/3	3.49
Req/ments	1/5	1/3	1/3	2	**1**	1	1	1/3	5.36
Mon/ring	1/5	1/5	1/5	3	1	**1**	1/3	1/3	4.67
Flex/lity	1/3	1/7	1/3	1	1	3	**1**	1/3	5.79
Project Management Team	1/3	1/3	3	3	3	3	3	**1**	15.39
								$\lambda = 8.696$	CR = 7.1%

Table 4.5: Respondents' Consolidated Results obtained from chanemodel.net

The above data are dynamic and can change as more respondents participate in the research.

Even though the model might seem complicated, one of the scopes is to be used universally and irrespective of specific structured project management frameworks approach. Overall the aim is to fit to project business scenarios as a repeatable process.

4.5 Summary

Change management is not a simple or easy process; it is a time consuming and overall risky process. Project management frameworks, even though they discuss about change there is no specific model to address change and associated risks. In order for the process to be successful, managers must first realise the need for change on time. Quite often transitional processes fail unless well prepared and planned.

On the other hand, for contemporary project management frameworks the notion of change is concerned with conforming to project's objectives and stakeholders expectations. Since no change model can fit all cases; no project management framework can guarantee for the successful changes accommodation.

Clearly, there can be no right way to affect project changes and moreover to adapt to change risks, because what works on business level might not work for project level. Overall, it is not easy to make the correct decisions that are both desirable and survivable.

Further to the detailed risk attributes analysis, the main aim of CRAM is to assist organisations establish an effective framework for reaching informed decisions about change management risks; which effectively affects objective's performance and projects' outcome.

CRAM in relation to the proposed risk tree entails three levels of interaction with several nodes and respective attributes. After analysing the survey's results and with the aid of eigenvectors and eigenvalue formulae a numerical representation or the respective change risk can be assessed (prioritisation).

Following next, chapter five is devoted to an insight of analysis of CRAM results (Ringtokk Case Study) together with a thorough discussion and analysis.

5

Discussion and Analysis

M odern business processes often demand the utilisation of a variety of business frameworks and methodologies in order to offer a concrete business solution. Many times, the use of such frameworks is imposed by clients such as governments or large organisations. However, models contained in such frameworks often lack formal semantics and clarity. Moreover, even if they describe the processes very analytical, there is a risk of failing to take into account environmental factors like for example business culture. This may lead to inconsistencies between solutions, improper model selection or even modelling confusion. The maintainability, reusability and agility of such models tend to require manual work and it is vulnerable to human errors. CRAM as a novel modelling approach facilitates several environmental factors related to change risks in projects (Apostolopoulos et.al., 2014).

5.1 Modelling Issues

The current industrial landscape predisposes business solutions with a number of defects in terms of lack of understanding and implementing frameworks, methodologies and best practices. As a consequence, informal models or even non-modelled business solutions offer limited value to the business.

Based on Apostolopoulos and Maroukian (2011) such informalities, may lead to a number of limitations such as, the requirement for model specific training, difficulty in capturing changing business requirements, the use of inconsistent models which are not often updated. Effectively, changes that will not be included in all corresponding models will create inconsistencies since the models will no more reflect the actual business concepts and environment.

As Saaty (2008, p.47) described, by prioritising the factors in one level with respect to each factor in the preceding level and finding the overall priorities; the relative influence, feasibility, importance or contribution can be found. The priority of each attribute is therefore a relative measure of how this specific attribute impacts risk factors of the higher level and overall change management project risk. Forman and Gass (2001) pointed out, ratio scales are the cornerstone of AHP because of the information they convey; overall it is a simple way to measure objective and subjective factors by pairwise comparisons.

Moreover, systems theorists point out that complex relationships can always be analysed by taking pairs of elements and relating them through their attributes. The objective is to find among many things those that have a necessary connection. This causal approach to understanding complexity is complemented by the systems approach, whose object is to find subsystems or dimensions in which the parts are connected. CRAM has the capacity to deal with both approaches at the same time.

From a quick view analysis (Tables: 5.1, 5.2, 5.3), and as it can be seen from the results, CR is less than 0.1 (acceptance level). On the other hand, if CR would have been much higher than the accepted level, the judgments could have been considered as untrustworthy and of low preciseness.

This can be justified by the fact that, judgements would be too close to comfort to randomness. In a trial and error approach, it may seem easy to make again a minimum number of judgments or in worst case scenario judge the criteria where necessary.

5.2 AHP Case Studies

On the past, AHP has been used extensively in various sectors[1] and complex decisions, like for example: frequently used by DoD (Department of Defence) in US so as to allocate appropriate resources to diverse activities; British Airways in 1998, to choose the entertainment system vendor for its entire fleet of airplanes, Xerox corporation, to allocate $1B for research projects, Ford Motor company to establish criteria which would improve customer satisfaction; IBM in 1991 for the design process of AS 400 computer; several military and political applications worldwide (Saaty, 2008).

Concerning project management and associated risks assessment several cases studies have been reported in literature, Mustafa and Al-Bahar (1991), Dey (2002), Al-Khalil (2002), Shiau et. al., (2002) Capaldo et. al., (2008), Palcic and Lalic (2009), Pakseresht and Asgari (2012).

5.3 RingTokk Case Study Overview

The following case study, serves as a commercial application of CRAM, results of which will be thoroughly discussed and analysed in the coming sections of chapter five. "RingTokk" Systems is where leading Telecommunication carriers, Cable companies, ISP's, ITSP's, Original Equipment Manufacturers(OEM's), Original Device Manufacturer's (ODM's) and Enterprises join innovations to provide the widest choice of independent soft-phone solutions. "RingTokk" Systems integrates Voice, Data, Video into the most compelling, innovative and leading edge technologies to offer creative soft phone solutions available on the market today. More information can be seen at: http://www.ringtokk.com.

As a start-up registered in UAE in 2012, RingTokk had severe problems entering the market and beating competition. Overall the company's mission and vision messages were not communicated clear enough, and the company was facing problems mainly in the operations and planning business domains. It was mutually agreed with Ringtokk's CEO, that the utilisation of CRAM's respective results analysis recommendations will be considered and handled as a project. Moreover, it was

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[1] AHP is related in over 1000 articles and almost 100 doctoral thesis (Forman and Gass, 2001).

decided and agreed that CRAM will be utilised for "RingTokk" case study without any changes in the prototype's attributes, as it was not necessary to identify new attributes or replace part of the existing ones (as depicted in Chapter 4; Figure 4.3).

Prior to using CRAM, and after the kick-off discussions with the executives' board, it was obvious that communication in a multicultural business environment together with the increasing rate or technical unsolved requirements were the two highest identified risks. Something had to change drastically, as it is vital for every start up, to enter the market with the minimum problems possible. However, at the same time stakeholders have to keep risk exposure also at minimum, control risks the earlier the possible and be able to find the problem's root cause. As far as changes are concerned, frequent and uncontrolled changes for example in plans, company policies, technical requirements and procedures affect severely the key operations of an organisation.

"RingTokk Systems" designs, develops and integrates VoIP communications products & solutions that make a viable and competitive difference for various business solutions with a view to improve the way people communicate around the globe. As it has been explained earlier, such kind of business processes requires the establishment of extensive communication channels. The RnD department of the company is based in India but the marketing, legal and Strategy (Operations & Planning) departments are based in UAE. Leadership, authority, conflicts and deliverables' delays were issues that the board had to take actions on.

Effectively, in order to find the root-cause of the problems "RingTokk" was facing, a lot of issues had to be changed and decided upon, drastically. CRAM was deployed, so as to elicit and provide business recommendations concerning organisational change risks. The results of CRAM (RingTokk case study) are discussed in the following sections.

More specifically, for "RingTokk" case study, the respondents were twelve executives from the Director's board, Marketing, Legal, Technical, Strategy, Procurement and Human Resources departments. For the analysis of the

consolidated results, the weighted geometric mean of replies is used, due to higher accuracy in results than the respective arithmetic mean.

Actually, the consolidated, results decision matrix [c] can combine all k participants' inputs to get the aggregated group result. The weighted geometric mean of the decision matrices elements $a_{ij(k)}$ using the individual decision maker's weight w_k is described by Equation 5.1:

$$c_{ij} = \exp \frac{\sum_{k=1}^{N} w_k \ln a_{ij(k)}}{\sum_{k=1}^{N} w_k} \qquad \text{Eq. 5.1}$$

Table 5.1, shows the consolidated matrix results (rounded):

	Leadership	Com/cation	Culture	Resistance	Req/ments	Mon/ring	Flex/lity	PMT	%Likelihood
Leadership	**1**	3	1	7	5	5	3	3	27.99
Com/cation	1/3	**1**	3	5	3	5	7	3	24.28
Culture	1	1/3	**1**	5	3	5	3	1/3	14.32
Resistance	1/7	1/5	1/5	**1**	½	1/3	1	1/3	3.35
Req/ments	1/5	1/3	1/3	2	**1**	1	1	1/3	5.12
Mon/ring	1/5	1/5	1/5	3	1	**1**	1/3	1/3	4.49
Flex/lity	1/3	1/7	1/3	1	1	3	**1**	1/3	5.66
Project Management Team	1/3	1/3	3	3	3	3	3	**1**	14.79
								λ = 8.861	CR = 8.8%

Table 5.1: Consolidated Results; CRAM Matrix for RingTokk, (Apostolopoulos et. al., 2015)

In greater details, Table 5.2 and Table 5.3 show the rounded-up results obtained for RingTokk (detailed AHP attributes' comparison tables can be seen in Appendix 5):

Factors	Likelihood	Attributes	Likelihood
Leadership λ = 7.737 CR = 9.2%	0.28	Active	0.235
		Experienced	0.081
		Strong	0.034
		C-level engagement	0.092
		Authority	0.277
		Firm but Fair	0.036
		Strategic	0.245
Communication λ = 7.695 CR = 8.7%	0.243	Effective	0.115
		Trustful	0.104
		Involvement	0.21
		Supportive	0.123

		Common Vocabulary	0.04
		Knowledge sharing	0.24
		Conflict Management	0.167
Culture	0.143	Integration	0.17
		Leadership	0.379
$\lambda = 5.338$		Communication	0.317
CR = 7.5%		Corporate values	0.086
		Rewards Innovative	0.048
Resistance	0.034	Empathy	0.034
		Denial	0.096
$\lambda = 6.629$		Status Quo	0.191
CR = 10%		Considerations of Skills and Resources	0.055
		Lack of Training	0.421
		Competition	0.203
Requirements	0.051	Specific	0.123
$\lambda = 7.649$		Conform to customers expectations	0.12
CR = 8.1%		Measurable	0.036
		Attainable	0.107
		Reliable	0.07
		Traceable	0.338
		Validation	0.206
Monitoring	0.045	Reporting	0.238
$\lambda = 3.018$		Improve from lessons learned	0.136
CR = 1.9%		Systematic	0.625
Flexibility	0.057	Snr. Management Buy-in	0.28
$\lambda = 5.263$		Past Experience	0.325
CR = 5.8%		Complexity	0.089
		Quick and effective	0.059
		Customisation	0.246
Project Management Team	0.148	Performance	0.072
		Motivation	0.369
$\lambda = 5.387$		Appraisal	0.275
CR = 8.6%		Rewards	0.164
		Training	0.121

Table 5.2: Change Risk Likelihood (Parent Nodes); (Apostolopoulos et. al., 2015)

Factors	Likelihood	Attributes	Likelihood	Attributes	Likelihood
Project Management Team λ = 5.387 CR = 8.6%	0.148	Performance λ = 5.329 CR = 7.3%	0.072	Audit and Verify	0.16
				Planning Outcomes	0.30
				Benchmarking	0.077
				Review on agreed standards	0.05
				Clear Targets	0.413
		Motivation λ = 4.198 CR = 7.3%	0.369	Financial Benefits	0.508
				Innovation	0.151
				Fear of punishment	0.075
				Skillset Improvement	0.265
		Appraisal λ = 3.065 CR = 6.8%	0.275	Feedback	0.081
				Achievement of objectives	0.731
				Opportunity	0.188
		Rewards λ = 3.025 CR = 2.6%	0.164	Realistic and clear	0.333
				Behaviour	0.57
				Recognition	0.097
		Training λ = 6.614 CR = 9.8%	0.121	Networking	0.287
				Experience (Trainee)	0.271
				Learning and development	0.061
				Experience (Trainer)	0.038
				Value added	0.25
				Tailor made	0.093

Table 5.3: Project Management Team (Child Nodes); (Apostolopoulos et. al., 2015)

Due to the fact that the research's results are more than extensive, it is the author's intention to comment on the majority of the parent nodes (risk factors; Figure 5.1). However, recommendations were reported and discussed extensively with the RingTokk's CEO. The respondents' results regarding the top four influential change risk factors based on CRAM ranking are as follows:

1. Leadership (27.99%)
2. Communication (24.28%)
3. Project Management Team (14.79%)
4. Culture (14.32%)

From a quick view on the top influential factors, 'Culture' and 'Project Management Team' have very small difference (0.47%), a result which shows that project management team and culture are two factors which seem to complement each other.
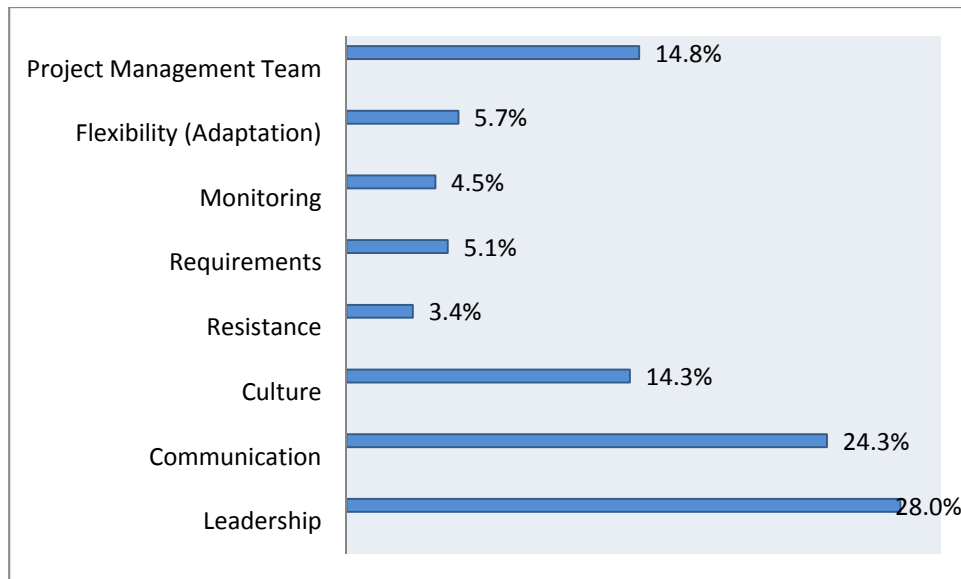
Figure 5.1: Parent Nodes Results

The risk analysis presented in the following paragraphs goes a step forward from the conventional approach of project management in terms of time, budget, scope and quality constraints. Though, in order for a project to be successful the triplet leadership, culture and communication are the most important change risk factors which stakeholders should focus on.

The success parameters for projects vary, however, when changing key parameters of the project with a view to success potential risks arise. A thorough analysis based on the results obtained follows.

5.3.1 Leadeship Parent Node Analysis

Apostolopoulos et al.., (2015) explained that risk and uncertainty affect all projects, however, leadership is the key for success. Change leaders can help stakeholders by encouragement and focus on change. Their active involvement is dynamic; learning is based on the initial recognition that there is a problem, then exploring for a solution, then persisting in helpful directions. Consequently, learning is the best route to low resistance of changes.

As far as RingTokk project is concerned, it was rather obvious that the lack of long term and clear strategy was causing additional problems to the operation of the

company. Even though, each department's head, had the authority to engage people work together, conflict at lower levels of the hierarchy was something that had to be addressed. Figure 5.2, shows the leadership's attributes results.
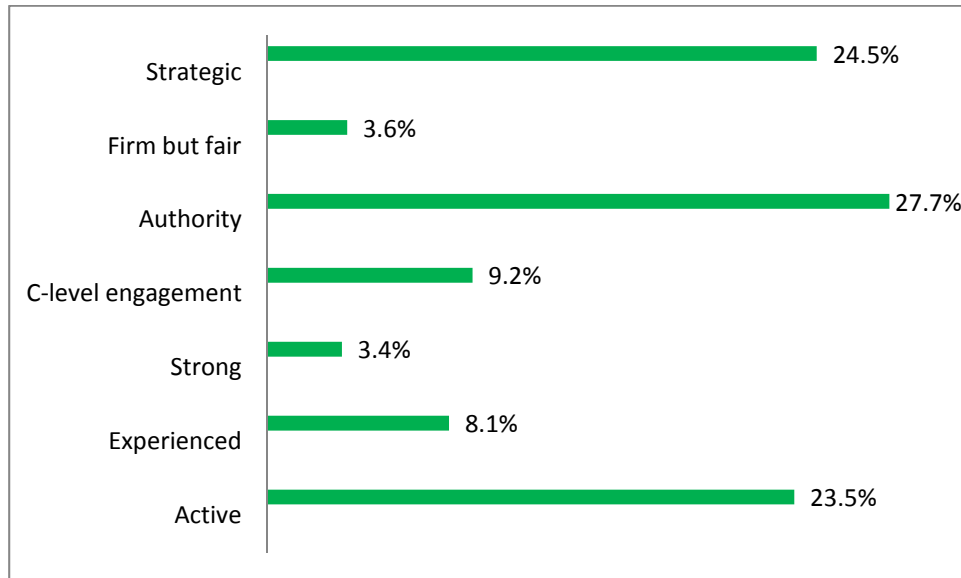
Figure 5.2: Leadership's Attributes Results

Leadership as a risk factor was ranked as the top most influential one with 27.99%. Moreover, related attributes with high influence were *authority* (27.7%), *strategic* (24.5%) and *active* (23.5%).

Success is related in turn with acceptance, support and agreement to the influencer's proposals or objectives. Successful influencing is related to understanding groups or individuals pattern of attitude, behaviour, emotion and decision making. "A pragmatic project manager must balance the theories of leadership with the practical need to deliver the project objectives and the limits on their authority to lead" (APM, 2012, p.69).

For successful project management among the roles that the project manager has to take is the role of the leader. The project manager is the 'glue' between the project and the team members, ensuring that stakeholders remain focused on the project goals.

In relation to change management, the project manager acting as a leader has to make sure that team members understand the change management system. In terms of change management, the project manager is the one who has the authority to approve changes based on what is within the project's scope. Effectively, the project manager can handle the change requests accordingly, by analysing the impact the changes will have on the project plan or the requirements (Apostolopoulos et. al., 2015).

Zaleznik (1977) made an attempt to differentiate leaders and managers (Table 5.4). Zaccaro (2001), specifically argued about executive leaders who are at the top of the pyramid or at the nexus of a network in organisations.

Dimension for Comparison	Leaders	Managers
Attitude toward goals	Personal, active	Impersonal, reactive, passive
Conceptions of work	Projecting ideas into images that excite people; developing options	An enabling process of coordinating and balancing; limiting options
Relations with others	Prefer solitary activities; relate intuitively and empathetically	Prefer to work with people; relate according to roles
Senses of self	Feel separate from their environment; depend on personal mastery of events for identity	Belong to their environment; depend on memberships, roles, and so on, for identity

Table 5.4: Leader vs. Manager comparison; Zaleznik (1977)

Schmid and Adams (2008) elaborated that project managers by the application of various leadership styles, have the power to influence team motivation like for example giving feedback and offering rewards. One managing attribute of the project manager, further to leadership is authority. Other opinions (Lewis, 1998; Frame,

2003) agree that project managers' authority is disproportionate to the overall projects' responsibility.

Dvir et. al., (2006) in their respective work related project manager's personality with project success and project types. A project is more successful if it fits with project's manager personality. Actually the project's manager personality together with leadership skills may influence the project success (Turner and Müller, 2005). Lester (1998) after conducting a research on critical success factors, identified leadership as a major factor. Leadership is critical taking into account that team members; spend at least 50% of time on team activities.

5.3.2 Communication Parent Node Analysis

Results (Figure 5.3) showed that the top three most important risk factors which have to be controlled in order for project to be successful are: *knowledge sharing* (24%), *involvement* (21%), and *conflict management* (16.7%). APM (2012) explained that there exist various factors which affect the effectiveness of communications, such as: cultural background and transient features, current environment and team dynamics. Indeed, for RingTokk case study, the cultural background together with the professional background mix was conflicting and problematic.
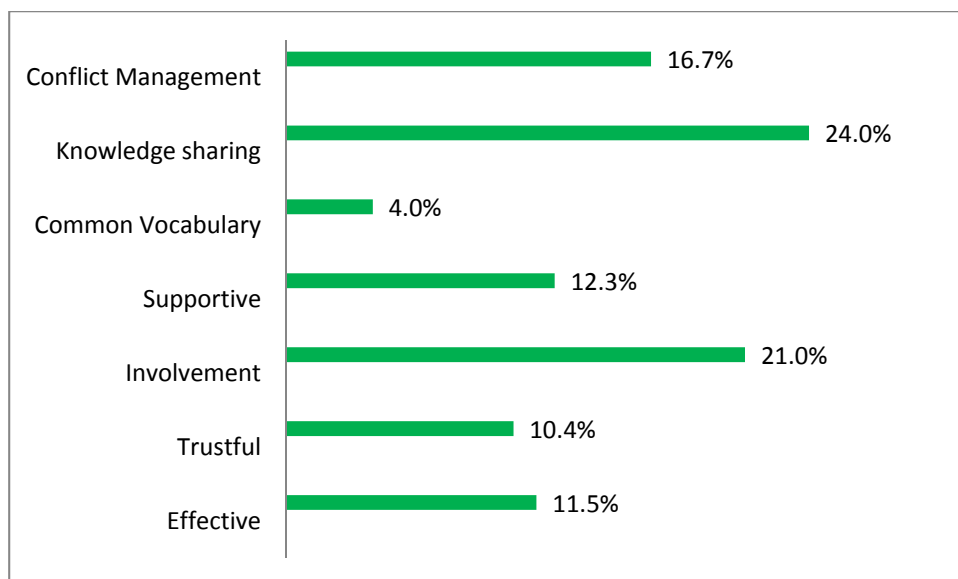
Figure 5.3: Communication's Attributes Results

Further to the results, the high importance of communication as far as change management is concerned, was pointed out by Baca (2005); Helman (2005); Mulcahy (2013), by stressing that communication is 90% of the project's manager job. Moreover, Heldman (2005) argued for risk management and project management being both iterative processes, both position communication at their core.

Another key issue is the language, which needs to be understandable by all stakeholders and convey the communicator's meaning as accurately as possible (APM, 2012; Robertson and Robertson, 2008).

For example, Ringtokk was facing severe problems in cross department communication. Most of the problems were recorded between technical and marketing departments. Moreover, the Human Resources department did not clearly document the job descriptions of business analysts, engineers, s/w designers, suppliers, testers or anyone whose input is necessary. Irrespective of the fact, that all the above named professionals have different skills, they also have different views of what is important to communicate or share. Nevertheless, *common vocabulary* was ranked as last attribute with 4%. To this frame, Corvellec (2009) explored organisational risk management in a context which risk is absent from managerial vocabulary or organisational communication.

PRINCE2 (2013, p. 41) defines stakeholder engagement (involvement) as "the process of identifying and communicating effectively with those people or groups who have an interest or influence on the project's outcome". The communication process can be managed by the Communication Management Strategy as the frequency of communication among stakeholders is controlled and monitored. Taking into account the model's results, *involvement* was ranked as second risk attribute with 21%.

Apostolopoulos et. al., (2014) argued that, as organisations become larger and more complex, the need for a structured project management methodology arises. At the same time, complexity might mean more management layers that have to be addressed properly. Consequently, this may lead to additional communication

linkages. PMBOK (2013, p.292) explains that "the total number of potential communication channels (CC) is given by equation 5.2, where n represents the number of stakeholders. For example, if the stakeholders are eight (8) then, the potential communication channels are 28.

$$CC = n(n-1)/2 \hspace{8cm} \text{Eq. 5.2}$$

Morgenstern (1951) argued that there exist multiple, complex, multi-level dimensions to an organisation that simply cannot be ignored, taking into consideration, organisation behaviour theory. Actually, he observed that the bigger the size of organisations, the greater the complexity of operations within the same organisation.

Among other success factors PMBOK (2013) explains that project management success depends highly on an effective organisational communication style; as globalisation has affected the ways projects are managed. Even if project managers are in distant locations (which is true for RingTokk) this does not stop them from an attempt to manage projects successfully but remotely. This can be justified by the fact that, technology is so advanced that they can communicate with a variety of means, like for example: e-mails, instant messaging, social media, video and web conferencing.

In a similar approach, Dingyong et. al., (2009) examined the differences among R&D enterprises and other organisations coming to the conclusion that a culture of *knowledge sharing* (ranked first, 24%) by using documents , templates or in general shared information systems is necessary to be created. Nevertheless, knowledge management and consequently knowledge sharing is complicated.

Sharing these opinions Burns and Stalker (1961) explained that this happens because project teams are composed of members with diverse backgrounds (skills, experience, attitudes, culture) which work together. In project based organisations, team members work only for a limited time and the entire company is organised by projects.

In either way, managing projects and trying to control associated risks is complex. In view of this, conflict cannot be avoided; however, the project manager has to handle disagreements and solve the problems taking into account project success (Mulcahy, 2013; APM 2012, Gobeli et. al., 1998).

Conflict (16.7%) is also related to communication style, for example is it direct or indirect. Usually, conflicts happen when the project manager follows a boss to subordinates relationship, 'I order and you follow'. A true leader tries to say what she/he means in an open and constructive way, listening to opinions of others (Apostolopoulos et. al,. 2015).

For PMBOK (2013, p.281) conflict is inevitable in a project environment. Sources of conflict might be the following:

- Scarce resources
- Scheduling priorities
- Personal work styles

Conflict should be resolved in early stages of the project because it strongly affects the collaborative work among team members, jeopardises successful outcome and can lead to uncontrolled situations. Management of conflict is seen also as successful criteria for project managers as the ability to tackle unpleasant situations may lead to success. It is not rate the fact that conflict can be internal to disengaged team (Heldman, 2005). In such sad situations, team members loose trust to the project manager, have severe conflicts among them with an immediate effect of project failure since they don't believe in the project's goals.

Especially when discussing about change, openness to change and tolerance to the accompanying risks may be rather profound. Also, culture can impact the speed of work, the decision-making process, and the impulse to act without appropriate planning. This may lead to conflict and stress in some organisations, thereby affecting the performance of the project managers and project teams.

This was another issue which was heavily recorded; RingTokk's high level management even though, was trying to be supportive to lower level employees, information was not shared equally and properly. Ringtokk's culture did impact the speed of work, the decision-making process, and the impulse to act without appropriate planning. This lead to employee conflict and stress, thereby, affecting the business performance.

5.3.3 Culture Parent Node Analysis

The cultural factor is evident in culturally diverse multinational business environments, where the different ways of thinking and behaving sometimes contradict but sometimes reinforce successful changes. (Apostolopoulos and Karamitsos, 2009; Apostolopoulos and Maroukian 2011). Even though being difficult to be defined, as it differs among organisations or individuals; Kroeber (1985) indicated that there are more than 160 different definitions of culture.

PMBOK (2013, p.19) explains that organisational culture, style and structure can influence the ways projects are performed. More specifically, it is "the organisation's level of project management maturity and its project management systems can also influence the project", shaped by common experiences of members of the organisation.

Some of these common experiences (but not limited to) are the following:

- Shared visions, mission, values, beliefs, and expectations
- Regulations, policies, methods and procedures
- Motivation and rewards systems
- Risk tolerance
- View of leadership, hierarchy, and authority relationship
- Code of conduct, work ethic, and work hours, and
- Operating environments

The most common definition for organisational culture is "the way we do things here" (Lundy and Cowling, 1996). In most definitions, culture is related to characteristics and assumptions of the organisation like, for example, behaviour, values, norms and rules. Robbins (1996) argued that organisational culture forms an integral part of organisational functioning.

In another approach, Beedy and Simpson (1995) defined organisational culture as "the patterns of meaning and understanding, anchored in core values, which are shared by members of an organisation or management team". Robbins (1996) argued that organisational culture forms an integral part of organisational functioning.

RingTokk sells services mainly to Asia (Middle East), but customers are based worldwide. In effect, they way of thinking had to be changed and adopt international practices of business conduction. This was very hard to achieve taking into account that 65% of RingTokk's employees are based in India (mainly software engineers / testers). Even though, testers have no direct interaction with the customer, it is them who design and transform their requirements into code.

The results obtained (Figure 5.4), concerning culture's attributes come into total agreement with the result of level 1. Actually the top three ranking is as follows: *leadership* (37.9%), *communication* (31.7%) *and integration* (17%).
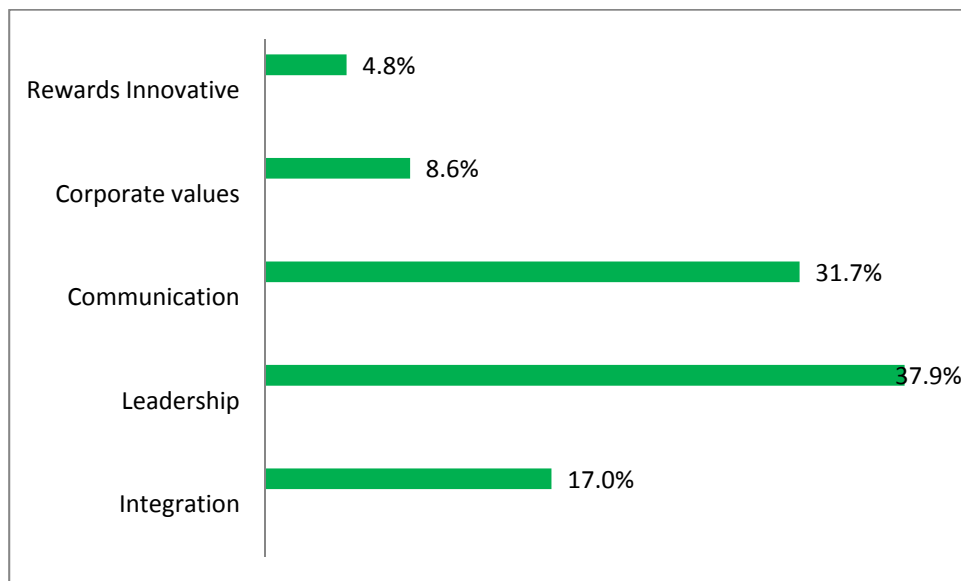
Figure 5.4: Culture's Attributes Results

If the culture is strong, the values are shared and everybody is aligned. It offers a shared system of meanings, forming the basis of communication and formal understanding (Furnham and Gunter, 1993).

In some other cases it might be the right tool in the hands of managers influencing behaviour; filling the gap between what is formally announced and what actually takes place (Martin, 1992). Douglas et. al., (2013) argued that modern risk management practices stress the importance of connecting risk management policy and practices with organisational culture and values.

Discussing about business environment, Senge (1990), argued that organisational culture which has a base of commitment to truth, empowers individuals to reflect on their actions and see if these actions can cause problems, recognise the need for change/s and perceive their own roles in the change process. Culture must not be seen as soft skill, as this is a serious mistake which can have negative impact on the business bottom line (Peterson, 2004).

Especially for project management, problems might occur because; the culture of the stakeholders differs in a variety of ways (e.g experience, authority), as they might have their own individual culture of work which comes in conflict with others (Ruuska, 1999). Effectively, project culture has to share both organisational culture and professional culture of individuals. Actually this was the bet for all RingTokks's employees which they had to win.

In a similar view, Capaldo et.al., (2008) expressed the views that organisational critical factors are related to business process reengineering, top management lack of commitment and change management activities. Especially for change management, they elaborated that the missing activities are related to cultural resistance to change inadequate qualifications of end-users, job rotation activities and lack of face time among team members.

Sometimes, in order for the organisational culture to change, this has to involve rebuilding the existing cultural assumptions into the organisational structure, and perhaps replacing with new ones. In light of this Bellasi et. al., (2007), related constructive work environment with strong leadership and new product development project success. Effectively, organisations that enforce strong communication channels among project team members and foresee for effective collaboration are expected to have better performance and project success.

However, in many cases, organisational changes are linked to organisational culture. Shein (1985) expressed the view that, the implementation of project management is rather seen as a cultural change than as a process change. Nevertheless, organisational culture, even though it is a powerful force, it is also resistant to change.

5.3.4 Resistance Parent Node Analysis

Actually, people don't always do things as planned. There are people who resist or even sabotage change as they are forced to move to something new. Feeling anxious for the anticipated change is more or less emotionally normal. Buerke (2008, p.91) argued that "the phenomenon of resistance to change is not necessarily that of resisting the change per se but is more accurately resistance to losing something of value to a person". For example, this might be loss of vested interests, loss of power or position, financial benefits loss and others incentives, as these differ per person and situation.

Because change actually changes the way things operate in projects, resistance, conflicts and complex negotiations are situations frequently observed. In this light, Baca (2005) explained that negotiation in terms of project management has to do with finding a solution. More specifically a solution which facilitates requested changes but at the same time stays within the boundaries of time, cost and quality.

For PMBOK (2013, p.517) negotiation is seen as "a strategy of conferring with parties of shared or opposed interests with a view toward compromise or reaching an agreement. Negotiation is an integral part of project management and done well, increases the probability of project success".
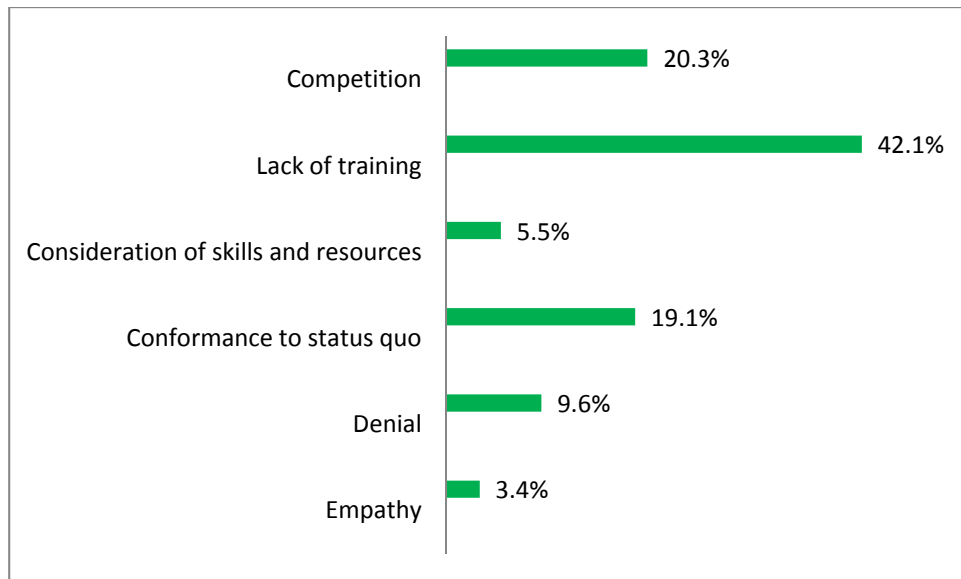
Figure 5.5: Resistance's Attributes Results

Concerning Resistance parent node, and as seen from Figure 5.5, the respondents replied that *lack of training* (42.1 %) and *competition* (20.3%) are the two most influential factors. Actually, Ringtokk did not provide any training to the employees which both the CEO and HR manager admitted as a mistake and serious business omission. RingTokk was a startup, effectively it was out of budget to provide any kind of training.

Nevertheless, after the deployment and results' analysis of the model, it was decided that sales marketing training will be provided to all the account managers in an effort to increase sales and customers' base. After a discussion with the deputy managing director, the high replies rate concerning competition was related to inter-department competition; mainly between technical and sales departments. For this issue, the roles and authority in the company were clarified by the CEO and a new organisation chart was communicated to all company employees.

Actually, an orgnanisation whose normative cultural characteristics are continual self examination and improvement will be able to adapt to current environment trends easier. For such kind of organisations, fear and resistance to change will be minimized (Senge, 1990).

In relation to project management, those projects that are governed by radical changes and require organisational cultures as the one described by Senge operate more effectively (Kenny, 2003).

In another approach, resistance to change is not necessarily bad, apathy is worse (Burke, 2008). Resistance can be associated with an initial denial stage, however it can be seen throughout the whole project's life cycle. One of the goals of change management in regards to human aspects is overcoming resistance to change. Changes are not always beneficial for stakeholders individually but, for the project outcome. One of the best approaches to minimise resistance and try to increase team's performance is communication and a later step rewarding those who tried really hard.

5.3.5 Requirements Parent Node Analysis

In order to execute a project and attempt to lead it successfully, conforming to project's requirements, and realising an expected outcome (whether embedding or not change), a project management team is required. "Expectations are like land mines. If you aren't clear about them, they can explode as the worst possible moment and destroy the trust you have worked so hard to develop" (Nelson, 1996).

Usually, when managers discuss about 'Requirements Analysis' they mean understanding customers' needs and *expectations* (12%). For this reason there are several methodologies (expect contemporary project management ones) proposed to address the problem of failure such as: Goal Driven Analysis, Agile Methodologies, Lean Analysis, etc.

In many cases, since the stakeholders might have different opinions about the requirements of a project or which strategy should be followed, conflict might be a factor that should be avoided or in effect lead to project failure; this is why requirements have to be *traceable* (33.8%). When the requirements of a project change or a common strategy cannot be followed, negative emotions among the stakeholders start to arise; adaptation to the requirements of the project is the key solution (Apostolopoulos and Simpson, 2009).

In other situations, stakeholders do not feel comfortable when the requirements of the project do change or required to change, as requirements have to be *specific* (12.3%). Non-conformance to initial requirements might mean that something was mistaken from the very beginning rather than conformance to new requirements will lead to better project performance and perhaps success (Apostolopoulos and Simpson, 2009).
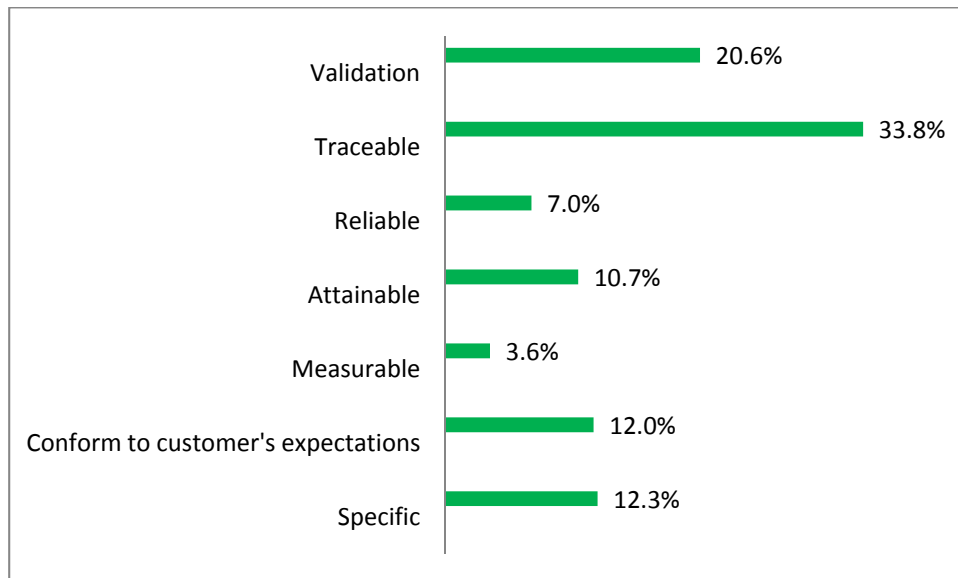
Figure 5.6: Requirements' Attributes Results

Concerning RingTokk, most of the requirements fall in the technical category. For example, the features and the integration with an existing mobile application can be enriched, the accuracy of the billing system and others. As seen from Figure 5.6, *conformance to customer's requirements* (12%) is quite high. At the end it is the customer who can decide if the services provided by Ringtokk are at an acceptable level or not. Such services are for example: cost, the call quality or even the web page layout (user friendly environment).

5.3.6 Monitoring Parent Nodel Analysis

Projects are getting more and more complex as the stakeholders' requirements increase. Because not all projects are successful, *learn from failure* (13.65%) is vital. Project managers have to adapt their knowledge and experiences from earlier projects as they need "to acquire and assimilate knowledge that resides in organisational memory" (Ajmal and Koskinen, 2008). Moreover, controlling in

terms of project management is related to *reporting* (23.85%) the projects' activities to ensure that goals and objectives are met.
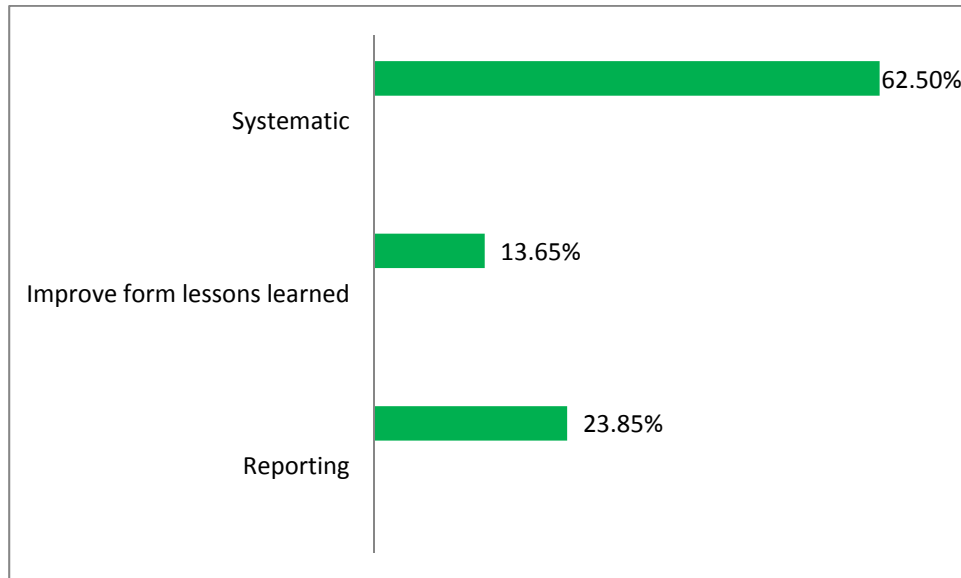
Figure 5.7: Monitoring's Attributes Results

More specifically, the principles on which PRINCE2 is based, originate from lessons learned. In terms of practicing, they can be considered a good framework based on (PRINCE2, 2009; p.11):

- Continued business justification
- Learn from experience
- Defined roles and responsibilities
- Manage by stages
- Manage by exception
- Focus on products
- Tailor to suit to the project environment

Monitoring, being an aspect of project management is performed during the whole life cycle of the project. As PMBOK (2013, p.87) describes, monitoring includes: collection, measuring, and distributing performance information, and assessing measurement and trends to effect process improvement. Nevertheless, Monitoring and Control as processes have to do with determining corrective or preventive

actions. Per case, such actions can be replaced to determine if the actions decided and executed can resolve related project's performance issues.

In relation to risks, monitoring concerns not only identification and analysis of new risks, but also tracking, and monitoring existing ones. It has to be ensured, that the identified risks are regularly reported about their status and that appropriate risk response plans are being executed.

Rigntokk did not use any risk or change logs. For this reason after the model's results analysis the technical manager was instructed to build a data base, that, all potential risks and associated changes will have to be recorded for every department.

An important task for the project manager and his team is to monitor the changes and risks. Depending on the project constraints, the project change log may be populated with a variety of information like for example: project name/number/date, description of the change requests, description concerning the risk of implementation or denial of the proposed change/s, duration, resources required and many other attributes per case.

In light of this, a change register can be populated with information concerning how to carry the risk processes. What risks are anticipated, which is their impact related to project's life cycle, a description of the risks, actions required, level of completion and other key information.

The documentation of risks is also very important as far as knowledge share is concerned. Project managers can look on "past experience" archives and perhaps get some interesting ideas on how risks were treated.

More specifically, based in PRINCE2 (2009, p.12) project teams learn from previous experience: "lessons are sought, recorded and acted upon throughout the life of a project".

To give an example, PRINCE2 defines the Risk Register as an attempt to capture and maintain information about all threats and opportunities, earlier identified. More

specifically, each Risk Register (RR) is allocated a unique identifier and details like the following (PRINCE2, 2013; 79):

- Who raised the risk
- When it was raised
- The category of risk
- The description of the risk
- Probability, impact and expected values
- Risk response category
- Risk response actions
- Risk status
- Risk owner
- Risk actionee

As explained to RingTokk's board of directors; risks and changes have to be documented, and actions decided upon on, monitored. Because of the impact, these changes might have to be communicated among stakeholders. Even if a change if rejected, it should be recorded also.

5.3.7 Flexibility/AdaptationParent Node Analysis

Based on the philosopher Alasdair MacIntyre (cited via Saaty, 2008), flexibility in adapting to change can be accomplished by planning, implementing and if new conditions require then re-plan and re-implement.

More specifically, Saaty (2008) concluded that leaders should avoid oversimplification concerning identification and evaluation of costs and benefits, but plan for the future and adapt to change. CRAM is flexible enough, that allows criteria revision (for example expansion/deletion of attributes), and further investigation of the outcome in terms of sensitivity analysis.

Specifically, for RingTokk's board of directors and for the company as a whole, it was the first time that a model was deployed so as to enrich overall business performance, find defects and via analysis propose business changes based on the company's environment risks.

The adaptation to the results' analysis was quite hard since, a lot of issues had to be taken into consideration and change. As seen in Figure 5.8, *past experience* (32.5%) is the most important factor, followed by *senior management buy-in* (28%) and customisation. Flexibility / Adaptation, parent node, refers to the ability to affect changes up to the level which are acceptable, based on the project's scope. Actually, without the influence and commitment of senior mangers any efforts for change are deemed to failure.

Flexibility is also related to the level of quick response to change. For example, there are cases where time is limited and quick decision making is required. Since not all organisations are adaptable to changes, responsiveness to change is an overall added value. Changes process flexibility results from the ability to embed changes in project management policies and procedures; sometimes proactively in response to anticipated changes in the project life cycle.
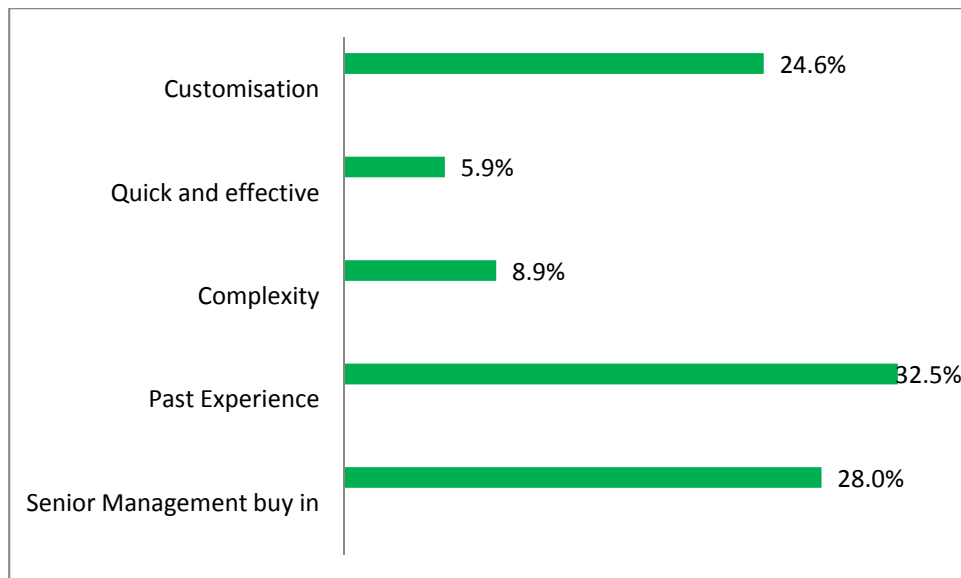
Figure 5.8: Flexibility's Attributes Results

For Schlossberg (1981), "Successful adaptation might involve establishing a structured methodology for responding to changes in the business environment or establishing coping mechanisms for responding to changes in the workplace such as new policies, or technologies." However, Parkes (1971) illustrated adaptation as an internal process of two stages. "Firstly, abandoning one set of assumptions and then developing a fresher frame, so as the person to cope with the new changes".

More specifically and in contrast to Parkes's two stages, Barry et. al., (1995) indicated that in order for employees to accept change, adaptation must be accomplished in three ways: Physically, Intellectually and Emotionally. Any change irrespective of the fact of being beneficial to employees and the organisation as a whole, will often meet high resistance which resides in each individual (Luderman & Erlandson, 2003).

5.3.8 Project Management Team; Parent Node Analysis

Projects are managed by different teams of people which have a common goal; project success. The project management team has in turn different characteristics like for example culture, experience and management level that have to be combined together to ensure projects' deliverables conform to customer requirements and expectations (Apostolopoulos et. al., 2015). In this light, Senge (1990) explained that the most effective project management processes are those whose team members facilitate innovation and learning as much as possible.

In either way, a project cannot run without team members; to stress this, Baca (2005, p.19) pointed out that team members "are the magic makers who spin straw into gold and create the product".

Table 5.5 shows the key competencies a project manager has to master in order to be able to successfully lead projects. In PRINCE2 the terminology used is 'facets', whereas PMBOK uses the wording, 'interpersonal skills'.

Project Manager's Competencies	
Leadership	Line Management
Team Building	Cost Management
Motivation	Communication
Communication	Quality
Influencing	Product Status

Decision Making	Product vs. Project needs
Political and Cultural Awareness	Changes
Negotiation	User needs
Trust building	Monitoring
Conflict Management	Planning
Coaching	Teamwork
	Strategy
PMBOK (2013)	**PRINCE2 (2009)**

Table 5.5: Project Manager's competencies
Source: PMBOK(2013, p.17), PRINCE(2009, p.38)

As it was seen in Figure 5.1, the 'Project Management Team' factor was ranked with a likelihood of 14.8% however; the importance of a strong and dedicated team is unquestionable. Taking a closer look at Figure 5.9, the most important attributes are: *motivation* (36.9%), *appraisal* (27.5%) and *rewards* (16.4%).
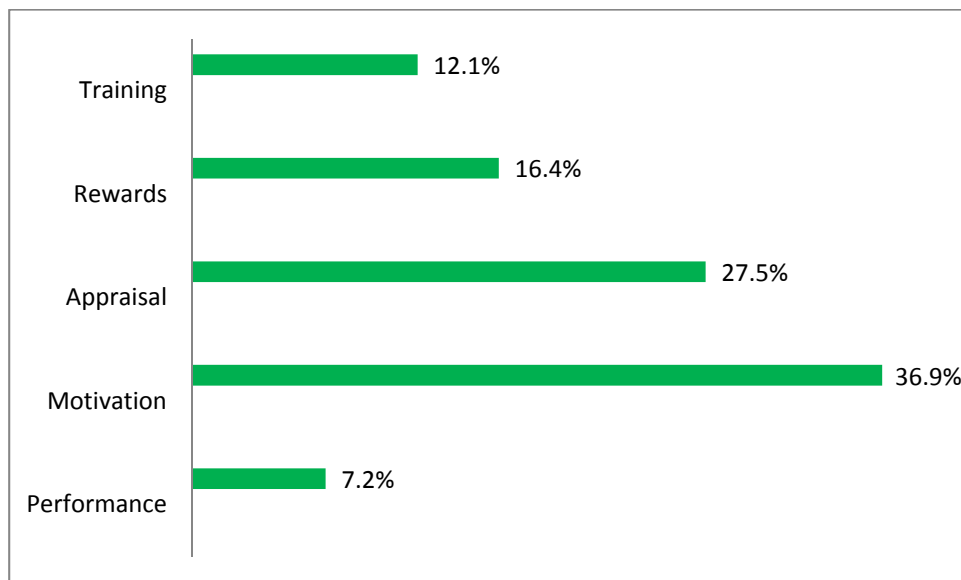
Figure 5.9: PMT's Attributes Results

White and Fortune (2002), prepared a questionnaire to examine the experiences of people in project management. In their study special focus was given to *performance* (7.2% of Project Management Team risk factor) as a success factor for managing

projects. In similar study, Chen and Cian (2010) measured the performance of project management teams by naming six factors which have the greatest impact on the execution phase of the projects. These were: financial constraints, management commitment, rewards system, organisational structure, education and training of project team.

Hashmi et. al., (2010) studied the growth of project management teams specifically for software development projects in terms of expertise, communication skills, working conditions and financial impact. Kerzner (2000) explained that project management's four basic values are: cooperation, teamwork, trust and effective communication.

More specifically, the project management team is "an integrated and multifunctional entity to deliver the specified project product (Kliem et. al, 1997)."

Rigntokk, prior to the CRAM results' analysis was not using any specific project management framework. In effect many department heads were actually the project managers of their department. As it will discussed further, in the conclusions section; RingTokk's CEO decided to formally engage contemporary project management frameworks and related process for the operational efficiency and benefit of the company (Apostolopoulos et. al., 2015).

In the next section, the five child attributes of project management team parent node factor are discussed.

5.3.9 Project Management Team; Child Attributes Analysis

Provided that the team works in an empowerment context, this can be overall assistive in fostering greater motivation leading to project success (Peterson, 2007). Moreover, the project team has an important role in the planning phase related to requirements, risk review, and quality plans. Capaldo et. al., (2008) stressed the fact that the team responsible (leader) should be carefully chosen on the basis of specific competencies and professional experience.

In PMBOK (2013, p.116) is it explained that *Benchmarking* (7.7% of Performance attribute) "involves comparing actual or planned practices, such as processes and operations, to those of comparable organisations to identify best practices, generate ideas for improvement, and provide a basis for measuring performance". From the discussions followed with the board of directors, it was noted that RingTokk had a problem beating competition and gaining a competitive advantage. The company's performance is rather low compared to what was initially planned. However, RingTokk is a start-up, in effect beating competition is a strategic plan which will take time for results to be successful.

Actually, it is much easier to measure project success, if known what it is being defined as deliverables (*clear targets*, 41.3% of Performance risk factor) and what it will be like at the ending phase of a project (product). This is also related to the expectations that the project manager and the project team, have to define as much as possible accurately the soonest the possible.

When the targets are clearly set and assuming that they are *attainable* (10.7% of Requirements risk factor) and planned, stakeholders can know what is expected and how it can be achieved. They can also have a clear understanding of their contribution, which can be enhanced during the life the cycle of the project. Concerning planning and change, Kerzner (1995) argued that, "proper planning and organisation of the transition on a life-cycle basis will facilitate a successful change".

Peterson (2007) argued that motivation "can inspire, encourage, and stimulate individuals and project teams to achieve great accomplishments". Moreover, motivation can impact the four constraints (time, budget, quality and scope). Nevertheless, it is for the best interest of the project manager to drive the project towards success, as some teams will be stimulated to achieve success but some others will remain uninspired towards project completion goals.

Motivation in a project environment involves creating an environment to meet project objectives while offering maximum self-satisfaction related to what people value most. In the latest edition, PMBOK (2013; p.513) links directly motivation and project success as it is dependent upon the projects' team commitment, which is

directly related to their level of motivation. The values which an environment can create and to which people are motivated can be:

- job satisfaction
- challenging work
- sense of accomplishment
- achieving and growth
- sufficient financial compensation
- other rewards
- recognition

Specifically, PMBOK (2004, p.27), emphasizes that *motivation* (36.9%) is an overall interpersonal skill of the project manager required, so as the project management team to accomplish project's objectives and overall goals and overcome barriers to change.

Schmid and Adams (2008), made a research on motivation (36.9%) regarding projects' manager ability to influence motivation; respondents (77% North America, 13% Asia) were affiliated to PMI or had PMBOK processes knowledge. Concerning the impact of change and motivation, changes in scope was the factor which prevailed as the most influential factor affecting team motivation; followed by time, quality and cost. Findings also stressed that project managers have to be a good communicator (formally and informally), and that positive and constructive feedback is a successful motivation technique.

RingTokk's respondents were highly motivated by financial incentives (rewards, 16.4%) which for example, may take the form of monetary gains, commission, organisational shares, salary increase but at the same time they fear reprimand in case unexpected events occur. Usually, project stakeholders are inclined not to pursue responsibility on change process failure or misleading and ill-received decisions.

In most projects, *innovation* (15.1%) should mandatorily originate from the project leader which will influence the stakeholders. This is because innovation is related to formulation of creative and competitive solutions for the success of project changes. In complex and large-scale projects, there exist dedicated team members (e.g project

managers, change managers) who have as main responsibility change requests initiation, monitoring and execution. Key important is determining the right time to innovate, so that the project team and consequently the organisation can adapt to project's requirements or even reinvent itself.

Actually, *achievement of objectives* (73.1% of Appraisal's child node) has to do with conformance to predefined change targets.

Once the changes have been introduced successfully and have an overall positive impact, then in turn the result of the appraisal assessment should be beneficial for the appraise.

Specifically, Zwikael and Smyrk (2011) argued that project success is not only related to performance, but measured in terms of the output benefits realised (financial benefits 50.8% of Motivation child node). In their model, they used utilisation maps, examining cause and effect, between output utilisation and target outcome.

Schmid and Adams (2008) argued the philosophy underlying motivation of employees to stand out is rewards and *recognition* (9.7% of Rewards child node). In light of this, Peters and Waterman (1983) explained that successful companies let their employees stand out by repeatedly recognising their contribution. Moreover, this repetitive recognition is related to organisation goals setting. Deming (1988) and Drucker (1999) pointed out a different philosophy that no matter what happens it is almost certain that rewards will lead to competition and will eventually lower productivity and morale. Especially, underpayment inequity is one of the reasons which is linked to negative attitudes (Ambrose and Kulik, 1999).

One of the fundamental reasons for project improvement, is to realise benefits through change. Change can be proven the main key driver to put things back on track, try to minimize project risks and consequently avoid project failure. Managing change can result in different outcomes and desired outcomes can be quantified as benefits (Karamitsos et. al., 2010).

Training (12.1%) ranges from simple on-the-job instruction to educational and training courses offered by providers external to the organisation. Training, coupled with development, is apparent when organisations plan progression of key employees through the company, in which an attempt is made to reconcile organisational needs with individual career development" (Mckenna & Beech, 2002, pp.6-7).

In this way, project team members have the opportunity to develop *specialised skills* (26.5% in Motivation Attribute) based on the specific area, which in turn will assist them to fulfil their duties and responsibilities more effectively. Training might be powerful and useful tool in the hands of project managers; nevertheless, it is not a panacea.

A lot of RingTokk employees mentioned that the HR did not discuss any sort of training or training plans. However, after the initiative from the CEO and Deputy Managing Director, a cultural training will be mandatory for all new employees joining the company. Moreover, each department will prepare short training sessions (presentations) for all RingTokk's employees so as the communication to be enhanced and everybody to be aligned.

5.4 Summary

Apostolopoulos et. al., (2015) concluded that, with the aid of modelling and especially CRAM, business change risks can be assessed and prioritised in a top-down hierarchical approach. Several risk factors and related attributes are identified and categorised. Moreover, the severity of each factor is assessed numerically and in turn prioritised. This gives the power to project managers or other stakeholders to make proper decisions whether to take on or abandon respective project changes.

From the results' analysis, it was more than clear that RingTokk was facing key operational problems mainly lacking enhanced leadership, communication and culture awareness. The company offices spans from UAE to India. These two end points may function well enough as standalone entities, but when intercommunicate (mainly due to cultural reasons) problems occur. This is very critical, because

RingTokks's goal is to develop and build strong relationships with customers by providing high quality services worldwide.

However, if changes and associated risks are not monitored and controlled inside the company, it is quite likely that the problems will be passed to the customers reducing overall customer satisfaction and loyalty.

Finally, since project success is a key objective for today's organisations, successful projects can make use of a combination of skilful project manager, project team members and contemporary project management frameworks.

Next, the final chapter discusses the conclusions and future work driven out of this academic research work.

6

Conclusions and Future Work

"Incremental change isn't enough for many companies today.
They don't need to change what is; they need to create what isn't."

Goss, T et.al (1993)

C hange risk assessment modelling was thoroughly discussed throughout the chapters of this thesis, as an integrated process within project management, being also a rational process for exploring decision and behavior alternatives. Effectively, one of the best ways to integrate change management into successful project management processes is to involve people work together on solving business problems and achieve results (Apostolopoulos et al., 2015).

However, in order for projects to be successful and even though, communication may be based on vocabulary discrepancies, all stakeholders have to formulate a solution to model the customers' requirements and conform to what is being expected. Projects are hard to manage; however, what is harder to manage is the way leading to success.

On the other hand, there can not be a unique way to conform to project changes and assess the relative risks predefining the results of a project. Project difficulties and outcomes cannot be predicted easily. This is because what may seem to be applicable on an individual basis or at a business level might be inappropriate or insufficient for specific project conditions (Apostolopoulos et al., 2015).

Project conditions differ and a lot of factors should be taken into account. With the aid of CRAM several project risk factors are assessed and prioritised hierarchically.

Consequently, changes and the process of risks handling are different among organisations and more different across business cultures and people. Cultural differences or even cross cultural interactions can affect not only the ways business is conducted but also can influence the ways people operate with people.

In a wider spectrum, it can influence those people who operate in the project management team. Team coherence is a vital ingredient for project success. Not all team members have the same linguistic skills or to a broader frame communication skills. One of the most common examples of miscommunication problems often seen in business environments, are the problems which arise between the interaction of managerial and technical project team members.

As seen from CRAM's results, *culture* (14.32%) is a top influential factor for project success. More specifically, the organisation's culture as far as PMBOK is concerned is an enterprise environmental factor (PMBOK, 2013, p.29). In general, EEFs are conditions (internal or external to an organisation) which are not under the control of the project team, which can have either a positive or a negative feedback for the project's outcome.

However, it is within the responsibilities of a project manager to understand the different organisational styles and cultures that may affect a project. Taking into account globalisation, understanding the impact of cultural influences is critical in projects involving diverse organisations and locations around the world. This is also true, taking into account the mobility of project managers who might work on various projects around the globe.

To this frame, Project Team management (14.79%) leading is not easy task but requires a lot and extensive skills. Working with people is always difficult since different ideas and personalities have to mix up and balanced.

Balance is the key to success, balance in communicating the messages, balance when conflict arises, balance as far as leadership and negotiations are concerned. Projects sometimes are so complicated that balance is hard to be achieved in effect some stakeholders might feel they are threatened or abandoned. Nevertheless, an experienced leader will accept challenges and put things back on track, preserving the balance between people and successful project completion; in simpler words balance performance against risks.

As far as change risk assessment modelling is concerned, there is no one-size-fits-all or all-you-can-eat-model. Each customer is different, but what stays the same is the expectation for project success, delivery of services and overall customers' expectations conformance. Every organisation is different in terms of management style, operation, aim, objectives, following a certain management pattern of executing activities and in effect handling business culture.

Depending on projects' requirements, each project requires different changes and risk handling which may be reflected in culture, leadership, decision making, norms and directives and consequently in the general way of implementing and managing projects.

CRAM as a novel modelling approach, attempts to take into account various environmental change risk factors which influence project success. These factors are modelled (assessed numerically) and together with the expert's opinion, foresee to close the gap (missing from current literature) of effective change risk management. This gives the power to project managers or other stakeholders to make proper decisions whether to take on or abandon respective project changes. At minimum, they can have a numerical indication and prioritisation of change risks.

When trying to change a certain way of doing things such as key project requirements, a lot of other factors must be taken into serious consideration. For example, changes over changes may be the root cause of project failure. If the customers' requirements are not analysed in a systematic and comprehensive way, then, trying to take corrective actions over and over again might be a blocking point for success.

Even though, there is no right way to manage project change, flexibility (5.7%) is mandatory. In a broader organisational frame, managing business culture with determined change leadership style might be the solution. However, nothing in life comes easy; when people are used to specific leadership patterns and business management, dealing with change is a process that may lead to resistance. A simple explanation can be given by the fact that change, changes the status quo. Some people are affected by the changes more some less and some not at all.

Involvement and participation of all engaged parties is essential, as much essential is managing resources. This is because, planning determines resources and projects' needs and in effect unequivocally enhances success.

Changing the projects' requirements or better projects' processes flow is a process which requires time and patience, it is hard to change the fundamental ways of doing things or change the ways things are done. Translating the vision from words into actions requires strong leadership. In general, weak project management is a major constraint of the competitiveness of companies. Moreover, an organisational environment change can be considered as a source of ultimate uncertainty since frequent changes can influence the projects' outcome.

Contemporary project management frameworks dictate structured ways (processes) of managing complex projects. On the other hand, risk management can be considered a part of the overall integrated project management approach where change management (change requests) can be integrated in the control and monitoring processes.

Projects do fail for a variety of reasons (Denison, 1990; Standish Group, Chaos Reports: 1994, 2003, 2007; Gottesdiener, 2001; Faulconbridge and Ryan, 2002; Bourne and Walker, 2005; Taylor, 2006; Apostolopoulos and Karamitsos, 2009; Apostolopoulos and Simpson, 2009). The most common reasons are being related to lack of understanding stakeholders or customers' needs, poor leadership and miscommunication among engaged parties.

Nevertheless, not all risks are the same or have the same priorities. By priority it is meant the determination of the evaluation criteria the individual risk consequences

are going to be measured against. Most of the objectives have to be measured to some degree. For example, profit maximisation, loss limitation (tangible objectives), but measuring employee satisfaction or company's prestige (intangible objectives) is not to easy to have a word on.

Apostolopoulos et. al., (2014b) argued that the level (impact) of risk can have immediate consequences on the success or failure of a project. Effectively, it should have a low damage impact and fairly high level of predictability. For this case, Pareto's rule can be described as follows: 80 per cent of the negative consequences are caused by 20 percent of the risks. Sharing the author's experience, the most severe risks, are those that can affect the project in such a level that can stop it unexpectedly.

Going back to the vital requirement of communication, project managers have to communicate the messages, whether good or bad in the same effective way. Declaring victory (project success) is a common mistake the project managers do.

Successful change risk management is not for heroes, it is an analytic process that requires commitment to organisations strategic goals, a process which at the end must conform to what the customer has requested or agreed upon. Any change to the project's scope should be risk assessed and agreed with the customer (Apostolopoulos et. al., 2014b).

One of the values of CRAM, is that it is expected to be considered as a global changes risk assessment method that can be applied regardless of project size, type or organisation. Moreover, it has the advantage that it can be used by any project because the method is designed to be tailored to specific needs taking into account significant environmental change risk factors.

Because not all projects are the same and also not all risks can be identified, CRAM provides the flexibility and capability to the user to add or delete risk attributes accordingly on per case basis. In other words, CRAM is a fully dynamic model that can be changed on demand and moreover, can be implemented in various business sectors.

Among other benefits, CRAM can be integrated with contemporary project management frameworks like for example (PMBOK and PRINCE2). CRAM was also tested on a real business case study, results of which have been thoroughly discussed in chapter five. This has given the chance to the author to actually test the applicability of the model in a real business case environment and discuss the results with key stakeholders receiving valuable feedback.

More specifically, after deploying CRAM, the recommendations report was submitted to RingTokk's CEO and key actions were decided. The company's revised mission and vision was presented to all employees in order to promote the new operational business ideas. Concerning requirements analysis and project deliverables, it was agreed that the company will follow an established project management framework.

For this reason, the HR manager recruited one dedicated project manager in India and one in UAE. In this way, all operational and planning goals will be monitored closely, requirements will be recorded; any changes will have to be approved by the department's head.

In the marketing field, the company will take part in several international exhibitions as a sponsor, so as to advertise its products more efficiently and increase brand awareness.

Finally, in December, 2013, RingTokk's CEO announced company's key business figures, after almost two years of operation. Based on an extract from his speech "...RingTokk has gone under severe organisational changes, results of which I'm more than proud and I wish to express my gratitude to all of you. The accomplishments are impressive but there's still a lot to do. The customers' base was increased by 28% and operations efficiency was improved by 16%, overall our net profit was increased by 4.3%...."

6. 1 Future Work

Further to CRAM, and the results that have been captured and thoroughly discussed; during the last eight months, an important cooperation has started with King's College London so as CRAM to be incorporated with another model named Model Driven Business Engineering (MDBE).

The key idea behind CRAM and MDBE integration is that the combined framework will be capable of generating decisions, business documents (such as risk analysis charts) and activities (perform a list of tasks, e.g., automatically place an order) defined as business solutions provided that their corresponding meta-models are present.

In brief, MDBE can be utilised as a solution generation tool to offer artefacts given the appropriate meta-model or pool of metamodels, model transformations and/or reusable MDBE artefacts (meta-model or transformation). In effect, MDBE can also become a valuable tool in maintaining expected productivity levels for organisations with high employee attrition levels whereby modelled business templates can readily guide newcomers to get accustomed with activities of the various corporate teams.

6.2 Model Driven Business Engineering (MDBE) Framework

MDBE upon completion, will attempt to address and formalise real business problems by operating at a higher level and help project managers and other stakeholders to generate day to day business documents and/or perform activities in an automated manner. Model Driven Business Engineering (MDBE) can be characterised as:

Definition: *"a structured approach to automated generation of modelled business decisions or business data that leads to them".*

MDBE reaches its end result through three layers; Environment Model (CRAM), Project Specific Model and Business Solution. The end result can be decisions and/or documentation and/or a set of actions that may or may not be automatically

performed by the system. MDBE encourages efficient use of business models in the business development process and it supports reuse of best practices when creating families of business solutions. MDBE can become a way to organise and manage business environments supported by automated tools and services for both defining the models and facilitating transformations between different model types.

The *Environment Model* (EM) is the first MDBE layer (Figure 6.1), which mainly signifies the environmental boundaries and constraints that provide a formal formation of the business environment in which a solution is to be modelled. The Environment Model also provides ground so that references can be made to business independent frameworks, ISO standards, methodologies, techniques, and a pool of best practices. The *Project Specific Model* (PSM) ensures a modelled business and leads to business solution. The *Business Solution* (BS) would effectively depict the real data, relating information fed in the previous MDBE layers.
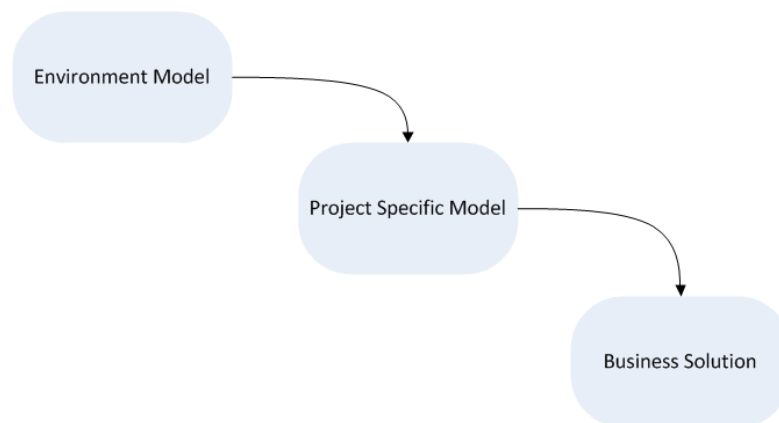
Figure 6.1: Model Driven Business Engineering

Even if MDBE provides a structured way for approaching a business solution, it does not force the user to go through all the layers. However, having additional layers allow information to be captured in a more structured way, which makes information management easier but most importantly it allows its user to commit changes at each layer, which propagate to all layers instead of having a monolithic transformation.

6.2.1 Environment Model

Specifically, CRAM will be used to asses factors which will be related to the enviroment model. As a result organisational teams might not have control over these influential environment factors or models.

One aspect that MDBE attempts to address, regards business environments in multinational companies. Cross-cultural issues can affect planned changes and schedules in project management frameworks. It is challenging to attain the same level of team performance using similar project frameworks for projects in different global regions. Even if change is one perspective of MDBE, as far as the environment layer is considered, another one might be adaptation or resistance. Thus, the Environment Model can be defined as:

Definition: *"The MDBE layer where the data captured is in regard to the business domain specific information acting independently of the organisational dynamics".*

The term 'business environment' is defined, but not limited to as the set of factors (irrespective of being internal or external) like political, economic, social and technological forces that influence the behaviour of a business; nevertheless their impact can potentially be either positive or negative. Other factors might be for example the cultural and social business environment, in terms of team orientation, innovation, risk taking, overall management, and manpower.

For example, in case the 'business cultural environment' is taken into account, this can be described by basic values, behaviours and preferences which have an effect on stakeholders' decisions. In many other cases the demographic environment information like for e.g. a country or region, is related to the study of human populations in terms of different attributes like for example size, location, age, education level, employement-status, and other information.

In addition, the 'economic environment' might consist of different factors such as wage levels, pricing strategy and possible financial risks. Working with colleagues, customers or clients from different cultural backgrounds, with different values and

etiquettes can occasionally lead to problems. Usually, managers' business behaviour is directly related to the country's culture.

In light of this, Apostolopoulos and Maroukian (2011) argued that 'Environment models' holds information that can be outside the scope of a project but related to the business domain and culture of organisational teams. Nevertheless, these teams have no control over these influential environment factors or models. Information captured by environment models cannot be affected by the project but affect the project outcome.

However, today businesses in order to succeed in the fierce competitive environment, more information and knowledge about marketplace trends are needed. As stated previously, structured project management methodologies might be a solution for project success and prove to be effective and efficient tools in the hands of project managers. MDBE with the aid of CRAM attempts to accommodate the business environment proactively by diagnosing problems and provide solutions to interpersonal cultural differences, prior to the initiation of a project.

Most of the structured management frameworks pursue the formation of a project team whereby appointing a project leader who has to combine different business culture views, escalate and solve problems. Structured frameworks do describe the steps accurately and in detail. However, cross cultural issues and more specifically environmental reasoning is not taken into serious account.

MDBE with the aid of CRAM, can become a way to organise and manage business environments supported by automated tools and services for both defining the models and facilitating transformations between different model types.

6.2.2 Project Specific Model

In the PSM layer, it is recommended to select models from well established frameworks or industry standards with worldwide recognition. The accuracy of the result will heavily depend on the selected framework.

The Project Specific Model can be defined as:

Definition: "The MDBE layer where the information captured is in regard to project specific information facilitating real world business solutions".

Taking into consideration the information available at Environment layer, and a meta-model that states that for example: the more certified project managers in structured project management frameworks the more successful that project management framework could prove to be in an organisation at the PSM layer, it is clear that a structured project management framework would be selected for use within the enterprise.

The business solution described in details next, would relate to real data such as strategic corporate decision of whether to use a structured or agile PM framework. The business solution can be anything from a simple decision to complex models supported by vast documentation. In the scenario considered the business solution can either be a 'Yes' or a 'No'. In order to reach this stage, the data from PSM has to be extracted.

6.2.3 The Business Solution

The business solution layer, contains the produced business documents such as business plans, progress reports, status reports, risk analysis documents, time tables, schedules and more artifacts that can be used for both day to day operation or strategic level information. The ability of MDBE to auto-generate all these documents from live data makes it capable to providing an updated status of the business or project on demand. Before MDBE can generate these static documents it requires their corresponding meta-models.

The business solution can be defined as:

Definition: "The MDBE layer that presents the product of the MDBE framework, such as business documents and actions".

Additionally, MDBE can produce dynamic artifacts defined as actions. These actions are defined as automatic or semi-automatic activities to be performed by a human or software agent. Such actions can include: sending emails, perform transactions, make payments and more. To support the generation of such dynamic artifacts their corresponding meta-models should also include triggers with pre and post conditions.

The generation of sophisticated business solutions in an automated manner is the main aim of the MDBE framework. MDBE opens new frontiers in the area of business automation.

6.3 Epilogue

Highest level of integration among change management and project management requires being effective in situations requiring an ability to orchestrate multi-task levels of high responsibility; match complicated investments goals and balancing risk against performance.

The change management plan, like risk management plan, is the roadmap for dealing with project change. Uncertainty has a degree, and in many cases this level of degree can be related to the amount of changes it will bring as consequence.

Change requests may bring about their own risks. Project changes are inevitable and most project managers deal with several changes during the life cycle of a project. It is more than common to think change in terms of problems or negative consequences. Similarly, risk usually introduces uncertainty, dealing with confusing situations and potential failure. Nevertheless, even though project changes can possess a negative demeanour, they may also drive leadership to project success.

In order to minimise risk failure, changes may be required to realign activities to planned work. Both change and risks have impacts which have to be initially identified. Actually, professionals (e.g. project managers, change managers, risk managers) cannot deal with something they have not identified first.

Contemporary project management frameworks define in a structured ways the processes for the successful outcome of a project; nonetheless, they are not a panacea. Project success is an integration of a lot of different factors. If project change and risk estimation are seen as opportunities rather than as potential threats then it is quite likely that project success will be more probable.

Not everybody will adapt to change. The problem can be rooted also from outside the company, for example from stakeholders which have vested interests. With the help of change leaders initiatives both from inside and outside the company can be maintained.

Irrespective of the project management framework and the process to be followed so as to control change, the first step and prior to the need of change is the awareness for the need of change. Initially, a time consuming assessment of the current organisational environmental situation is required.

Even if the best choices and the most suitable framework are chosen, people have to work together, communicate, take decisions and share knowledge. Even if the best framework in the world would describe in detail what should be done, every project is different and the outcome cannot be predicted.

Because different people have different characteristics (for example: knowledge, culture, perception, experience) they respond differently in different environments. In effect, a strong leader is required to combine the various characteristics of a team of people. Perhaps it is difficult to change the people or the projects' requirements, however it is easier to grasp the very best and capable people and encourage them that project success can be accomplished.

When trying to change a certain way of doing things, for example a project's requirements, 'culture' is a factor that must be taken into serious consideration. In cultural changes some things need to be abandoned, some others to be redeveloped and some others to be created. Different individuals have different sets of cultural preferences and different ways in which they learn or adapt to changes.

Even though, there is no right way to manage change, flexibility is mandatory; in a broader corporate organisational frame, managing culture is the solution (Apostolopoulos and Simpson, 2009).

Concluding, CRAM has the capacity to capture actual business risk factors and assess them, so that the end users need no additional training. Overall, CRAM will contribute significantly to the missing formality of business models especially in the change risk assessment area.

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CRAM Questionnaire

The CRAM's 'risk' questioannaire was used as a primary source of data collection from which useful information, facts, figures and professional views can be recorded. The survey is available for download at web page link: http://www.changemodel.net, released in December 2012. Respondents, can download the survey in excel format and upon completion return to info@changemodel.net.
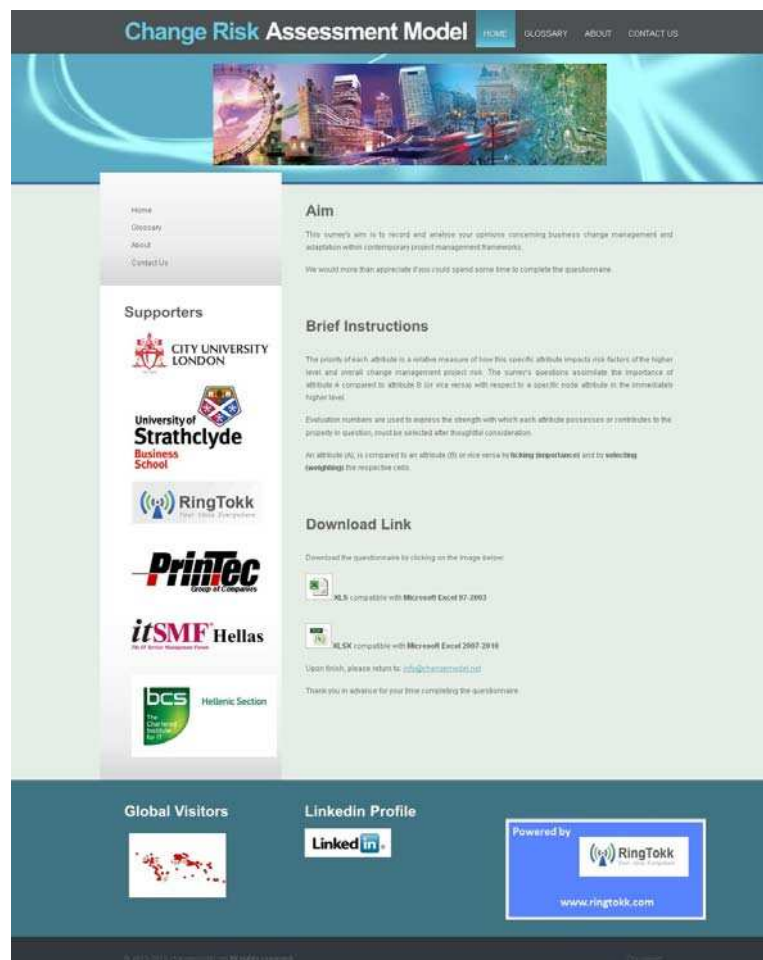
Figure A1.1: CRAM Web Page Layout

More specifically, CRAM uses the survey approach extensively, in an attempt to document and weight the impact of risks. Since there is no risk free project, at the same

time there can be no model that can accommodate the needs of all cases. The web-page layout was designed in user friendly and simple format (Figure A1.1).

Visitors of the web page can download the survey (Microsoft Excel Format) via the dedicated links as seen in figure A1.2:

Download the questionnaire by clicking on the image below:

XLS compatible with **Microsoft Excel 97-2003**

XLSX compatible with **Microsoft Excel 2007-2010**

Upon finish, please return to: info@changemodel.net

Thank you in advance for your time completing the questionnaire.
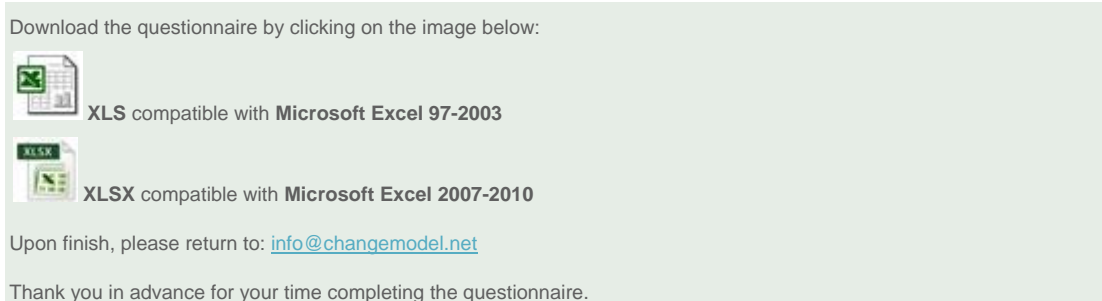
Figure A1.2: Download Section

Also, brief 'Instructions' are provided in the initial web page:

The priority of each attribute is a relative measure of how this specific attribute impacts risk factors of the higher level and overall change management project risk. The survey's questions assimilate the importance of attribute A compared to attribute B (or vice versa) with respect to a specific node attribute in the immediately higher level.

Evaluation numbers are used to express the strength with which each attribute possesses or contributes to the property in question, must be selected after thoughtful consideration. An attribute (A), is compared to an attribute (B) or vice versa by ticking (importance) and by selecting (weighting) the respective cells.

Moreover, it is very important that respondents have a shared understanding of concepts used in CRAM model. For this reason a 'Glossary of the Risk Nodes and related attributes was created to avoid confusion so and professionals gain a better understanding of the terminology used (Appendix A2).

Survey Excel File

The excel survey has various tabs, that respondents are requested to complete. Prior to completing the survey an example excel tab descibes the basic functionalities (Figures A1.3, A1.4, A1.5):

Step 1: **Click** *'Definition' to* have a more concrete understanding of the each attributes.
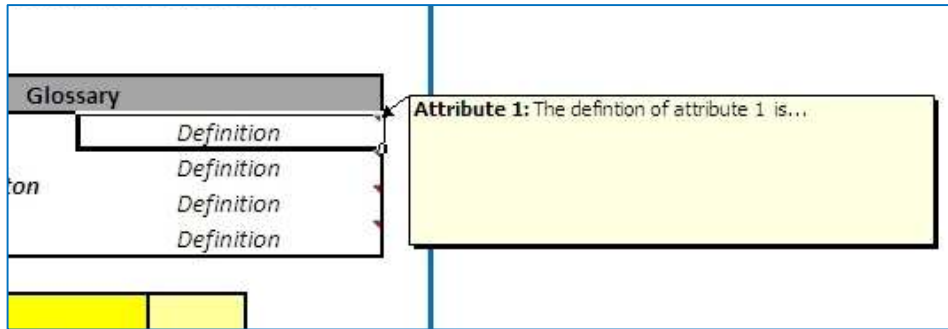
Figure A1.3: Attributes' Definition

Step 2: **Tick** 'A or B' to address which of the two attributes in comparison is more important.

Figure A1.4: Attributes' Importance Selection

Step 3: **Select** the 'weight' (1-9) of each attribute based on the table provided:

Figure A1.5: Attributes' Weight

CRAM Risk Attributes Glossary

The intention of this glossary is to provide a short description / definition of the CRAM's Risk Nodes and Attributes, so that professionals gain a better understanding of the terminology used.

Level 1(Root Node)	Level 2 (Parent Nodes)	Level 3 (Child Nodes)
Change Risk	Leadership	Performance
	Communication	Motivation
	Culture	Appraisal
	Resistance	Rewards
	Requirements	Training
	Monitoring	
	Flexibility	
	Project Management Team	

Table A2.1: CRAM Nodes Hierarchy

Successful Change Management (Level 1)

Change management mostly observed and utilised as an integrated process within project management, is a rational process for exploring decision and behaviour alternatives in an attempt to realign the course of 'derailed' deliverables due to change and ensure project success.

As long as business environments are subject to constant change and cultural diversity, frameworks require processes such as change management to maintain an up-to-date set of specifications for business requirements which can be applied to model depictions.

The introduction of **CRAM** (Change Risk Assessment Model) will allow the identification and definition of speculative relationships, between change risk events in the form of hierarchical risk tree analysis. The overall method is dynamic and flexible enough that can be tailored to various project requirements, taking into account significant environmental risk factors which influence project deliverables.

Leadership: Project success is accounted in many ways to strong leadership and commitment to project scope and objectives. Active leadership remains important throughout the entire project lifecycle, with the application of skills and determinacy to succeed. Therefore, efficient resource management is necessary to complete each task in its predefined priority. Senior management's accountability is key to effective decision making in the context of 'firm but fair' handling, to inspire and lead the project team in achieving high performance levels and overall high adaptation rate to proposed and authorised changes.

Leadership Attributes:

Active: Project Managers and in general stakeholders should not conform only to results. It is rather desirable to stay aligned to project's scope and objectives; put things back on track when required and lead to success. For example: participate in meetings, express objective and sincere opinion, follow directives and decisions until the project is closed. Provided that a leader is committed, people will place change effort on their priorities list and participate. In many cases, people first believe leaders (show faith to persons and their abilities) and then to their ideas.

Experienced: Refers to the knowledge and skills which have been gained through years of managing involvement and/or training. Effectively, refers also to influence of behavior. Trying to lead without the required knowledge of the change processes, could potentially lead to failure.

Strong: The ability to put things back on track, persuade others, set and accomplish goals. Determined, motivated to succeed, overcome obstacles and commitment to excellence. Provide overall guidance throughout the project life cycle and follow closely the change processes. In problematic situations the project leader should move forward, change things and inspire team members with associated paradigm.

C-level Engagement: A group of key managerial decision makers. Commitment of C-level executives is rather necessary since they represent the highest level of the company's decision makers along with the board. Actually, an organisation's CEO is the key driver for the change process; there is no substitute for a strong leader, it is the one who sets the priorities and leads the directions.

Authority: The power (right) to approve or deny; make the required changes which will ensure that the projects aligns with the scope and project's objectives. Authorised changes should be recorded for further reference and monitored during the life cycle of the project. Concerning change(s) risks these should be within the tolerance limits of the project.

Firm but Fair: During the change life cycle, people will pass through various emotional changes, get angry or even depressed. Changes should be firm but fair so that stakeholders maintain a feeling of objectiveness and equal judge treatment. Nevertheless, since changes sometimes are inevitable and per case necessary, effectively the right attitude is necessary.

Strategic: Overall align the vision, mission of the company to the project's scope and objectives. Engage required synergies, seek for competitive advantage and adapt to internal and external corporate forces. Compare outcome to the company's strategy and projects' success. The strategic vision should incorporate, not only the short-term after-effects of change but also mid and long terms effects of change (e.g. where the organisation will be in the next three to five years). It incorporates the notion of innovative thinking to tackle changes according to strategic planning for change.

Communication: Refers to the exchange of ideas or information among stakeholders e.g. project manager, team members, board of directors, which are related to change and associated risks. The more complex the organisational structure or the proposed changes, the more communication channels have to be engaged. Effective communication is a bi-directional activity which has to be controlled and monitored. Communication is an important business environment factor incorporating cultural values) as project's success is highly dependent on communication.

An example lies in speech variations of American, British, Canadian and Australian counterparts when speaking the same English language and the cultural inconsistencies experienced in each of these countries affect the level of interaction and communication. At the same time, change complexity might mean more management levels that have to be addressed properly. Consequently, this may lead to additional communication linkages.

Communication Attributes:

Effective: Using correct wording, passing the key messages (information) without leaving ambiguities. In respect to change, pass the message for the necessity of change, discuss an action plan without making things complicated and also cross-check for recipient's feedback. In short, do the right things. Effective communication can be regarded as a premium on teamwork and participation. Communication media between individuals can be active (face-to-face, chat via IM tool, phone, etc.) or passive (email, fax, etc).

Trustful: Trustful communication can be seen a requirement for the adoption of successful change requests. Trust cannot be guaranteed, though, it takes time to develop among stakeholders. Levels of trust can distinguished based on other sub-factors like for example experience and knowledge. For example team members may have to trust the leader's skills, knowledge and experience. In low trust business environments conflicts often arise. In any case trustful communication has to be a two way (bi-directional) approach.

Involvement (participation): Stakeholders have to be engaged in the change process as it is a transitional, time consuming and risky process. For example: involving employees makes them feel part of the project, increases their performance and overall productivity. Some team members may have the need to feel that their opinion matters; however, it does not mean that the level of information should be passed to all irrespective of the interest or influence on the project's outcome. Without stakeholder's active participation and contribution, changes have a high risk of failure.

Supportive: Refers to developing a mutual comfort among the stakeholders; requires clarity of actions, examination of change options. The next steps are selection and implementation of the change process. If problem(s) occur, discuss and propose alternatives so as to reinforce new behaviour. From time to time, the pace of changes are so intense that not everybody can cope with; effectively support is required for those which are left behind, have innovative ideas, wish to assist overall.

Common Vocabulary: Message should be communicated using a common vocabulary that the project management team understands and leaves not space for ambiguity or misunderstandings. The message for change should be clear irrespective of stakeholder's background, managerial, technical, administrative, etc. For example anchor the changes in culture. Sometimes the 'language' of the problem is different from the 'language' of the organization, as a result cautious handling is more than required at all communication levels.

Knowledge Sharing: Sharing information is important for the success of the project since project team members have diverse backgrounds like for example: skills, experience, culture, level of influence. Though, it is better information sharing to be regarded as multi-directional rather than top down. Knowledge dissemination empowers and motivates stakeholders to comprehend certain corporate decisions or strategic orientation; in effect authorised, planned and accepted change(s).

Conflict Management: Reduce collective uncertainties and misunderstandings. Changes, especially revolutionary may lead to conflict among stakeholders since changes cannot be 'good' for everyone. The project manager has to resolve conflict in a fair manner but at the same time communicate the message (necessity for changes) effectively.

Culture: Collection (but not limited to) of beliefs, attitudes, core values, ways of acting and thinking shared among members or organisations. Culture can impact the way of business conduction, decision making process, communication attitude and in effect influence project success. A supportive, knowledge sharing organisational culture can be enough 'risk taking' so as to match complicated project's scope and objectives with success. A risk averse business culture might be problematic against accepting proposed changes which in turn, might cause problems to over decision making, communication and leadership of the project.

Culture Attributes:

Integration: Culture and change in isolation is meaningless. It should be integrated with corporate values, mission and vision of the company's and overall strategy.
Change brings anticipation when, the organisational culture and values are negative, then, resistance occurs naturally. On the other hand, should there be determination and authorisation for change(s), then it is beyond what any organisation or individuals can resist. The message is better communicated when change ideas are responded openly in a fair and impartial manner. Individual change is welcome; however, integrated and collective behaviors are highly appreciated and supported accordingly.

Leadership: Make prompt decisions about change, match right people to the right job, recognize change impact and overall risks on time, take corrective measures if necessary, lead to success. Be change and results oriented. Lead success, not follow. Organisational change efforts following a structured project management methodology or not may be condemned to fail if organisational culture remains unchanged. A leader should give solutions and not short term problems escalation.

Communication: Encourage openness, from the beginning to and from all participants, share the information available, and avoid communication pitfalls. Communicating the change message is not an easy task, nevertheless necessary. Bidirectional communication will allow employees to make suggestions, participate and accept the message easier.

Corporate Values: Stay aligned to corporate values (for example mission and vision of the company), prefer incremental changes, communicate the message and the need for change; change what is necessary. Build an environment that fosters good change management; team building and leading to project success. In other words, being part of an individual's daily work rather than being a 'change program' that employee hear sporadically.

As a walkthrough, goals can be created (along with organisation's corporate values) in a way which link success and change effort. Nevertheless, from implementation point of view, can hamper change execution timeframes since the simplest of activities require a number of authorisations prior to activity execution.

Rewards Innovative: Change is a transitional process, which among others requires cross functional teamwork. It is vital for stakeholders to be praised (rewarded) for their actions conforming to and follow the changes. A successful leader (project manager) recognizes and awards accordingly team's efforts; especially innovative and hard working individuals. Rewards can be tangible or in intangible depending among other factors on the project circumstances.

Resistance: Change is a time consuming (transitional) and risky process, often resisted by employees. If changes are not communicated in the right way, then team members might feel threatened and undervalued. Because change actually 'changes' the way things used to operate in projects, resistance is frequently observed as a phenomenon which might jeopardise project's success. Feeling anxious which is associated to anticipated changes is more or less normal, nevertheless the project processes have to run as planned.

Resistance Attributes:

Empathy: Changing the way things were done, may cause conflict, tension and empathy to the initiators of change. Such behaviors affect mostly those who make key decisions on a project like for example what, when and who to change. The first reaction is 'why?' from the ones that are affected most.

Denial: Not everybody can cope with changes. Some team members will accept them and some other will deny them. In any case, changes which are finally accepted and planned have to be followed. Overall, even if the denial is strong the benchmark is to stay aligned to project's scope and objectives.

Conformance to Status Quo: Change brings change and fear for the unknown; effectively resulting to a degree of conformance to current 'steady state' and hesitance towards a rather transitional and 'unstable' one. To an extent, change, changes stakeholders established routines; people are used to what they know best.

Consideration of skills and resources: People might believe that changes will threaten their benefits, their expertise, limit their influence and in some cases they will be blamed for potential failure even if this out of the question. When positions are allocated (project roles) consideration of skills and resources is a prerequisite so as people to be matched with the most suitable position.

Lack of Training: Lack of employees training can make the difference between maintaining success, and ultimate failure. (e.g. training on how changes will be embedded in the new requirements which leads to successful project completion). Problems occur by lack of training, especially when people handle change processes with which they are neither familiar nor qualified. Trained stakeholders can recognize potential problematic change situations more effectively than inexperienced ones who may not be able to make resolute decisions on changes. Nevertheless, prior to training, the project manager has to communicate the necessity of change and elaborate on the feedback so as to minimize, for example, potential denial or resistance.

Competition: The change processes are more or less solid and everybody has to do the assigned part. Competition is unavoidable in a business environment, nevertheless is should not be the cause for project failure or conflicts among project members. Fair competition, may be regarded as a critical driver of project performance and innovation.

Requirements: Conditions often dictated by the project's user which the deliverables of the project should meet. Any non conformance to customer's requirements may lead to partially or full unacceptance of the project's deliverables. Change requirements have to be documented and closely monitored from start till end of the project.

Requirements Attributes:

Specific: Clear, no ambiguities or misunderstandings. Consistent with corporate culture and change processes. Requirements should be simple without double meanings. Moreover, specific entails that requirements are explained at an acceptable level. Discrepancies have to be reported and communicated accordingly from the initial stage of the project. For example, change requirements are expressed in terms of what will be changed and how well it will be changed, not how it will be accomplished.

Conform to customers expectations: The product (deliverables), even when the changes are applied, has to conform to what has been agreed with the user (supplier, customer). Any nonconformance to customers need may lead to failure or for example change in the constraints (scope, time, cost, quality, benefits, risks, resources, etc). Customers may have good ideas about required changes.
However, early changes implementation may be rather impossible, impractical or even unnecessary. Perhaps, discussing the absolutely necessary changes for the

success of the project and then develop to meet stakeholders needs is a profound solution.

Measurable: Goals and targets have to be recorded and measured against success criteria. The more requirements are aligned to the scope and objectives of the project, the less changes may be required.

Attainable: Under specific project change requirements the result should be confirmable and realistic. When the goals are being identified and based on the project's team skills then requirements should be in turn attainable. For example specific change requirements should be attainable at costs considered affordable or risks should be taken within the tolerance limits of the project.

Reliable: Aligned and relevant with the project's goals and objectives towards the ultimate scope; project success. Changes have to be appropriate for the level being specified. Changes at the early stages of the project should be looked at the beginning not in the middle of end stage.

Traceable: Refers to documenting the requirements so as to be traceable in levels and if necessary changed easier and more effectively. Changes have levels, for example based on: complexity, impact, project phase applicability etc. Lower level requirements (children) must clearly flow from and support higher level requirements (parents); or else are considered as orphans and assessed per case.

Validation: The validation process ensures that the set of required changes follow the triple rule being: correct, complete and overall compatible. Required changes have to be defined correctly and have a meaning of intention. Moreover, they have to be self-consistent conforming to the key project goal which is success. Project changes happen for a reason as any pitfall may influence the scope and consequently the result.

Monitoring: The change process monitoring should be continuous (but have an end at some point), involving benchmarking, milestones establishment, Key Performance Indicators (KPIs) and proper feedback. The end at some point, may become unnecessary for a reason e.g. if the change becomes obsolete and does not serve any purpose anymore.

Monitoring Attributes:

Reporting: Proposed, denied and accepted changes have to be documented. In this frame, it is easier to check what changes have been requested (who is the initiator of the change request) and which of those finally have been accepted or rejected. The same procedure should be followed for associated risks.

Improve from lessons learned: Not all changes will be successful or projects will be successful; effectively conforming to scope and objectives. Past experience can be proven a strong motive to be taught and avoid failure. In simple words avoid pitfalls of the past and learn. Since mistakes cannot be avoided there should be a slight tolerance to first-time mistakes, especially when the change program is initiated. The

more people hear about success recipes in specific environments, the more likely change projects are to succeed within an organisation.

Systematic: Periodic monitor and control of changes and associated risks. For example set up, weekly or bi-weekly meetings. The project manager has to be in control of the change process as it never stops until the project is closed.

Flexibility (Adaptation): Refers to the ability to affect changes, and to the level which are adaptable to the project scope. Flexibility is also related to the level of quick response to change. For example, there are cases where time is limited and quick decision making is required. Since not all organisations are adaptable to changes the responsiveness to change is an overall added value. Changes process flexibility results from ability to embed changes in project management policies and procedures; sometimes proactively in response to anticipated changes in the project life cycle.

Flexibility/Adaptation Attributes:

Snr. Management buy in: Commitment for participation and support by upper level management. It is typically concerned with a change shared vision to providing a general direction. Provided that senior managers and related stakeholders agree to change(s) the rest will have to follow.

Past Experience: Can take the form of information database (for example changes risk log), of ways related to treatment of change risks either successfully or unsuccessfully. Taking into account that the biggest enemy of past experience is undocumented (unregistered) past experience; the documentation of changes and associated risks is of great importance. For example, project managers can look on 'past experience' archives and perhaps get some interesting ideas on how change risks were treated.

Complexity: The interaction of stakeholders and change processes involved in a rather intricate way. For example: because of lacking of common understanding, communication barriers exist, project managers do not understand what their clients really expect (lack of user input) and projects fail. In other cases, changes are considered unclear out of scope and budget, the deliverables may be low quality and consequently the level of complexity is high which in effect raises the rate of failure.

Quick and Effective: Stay within predefined time limits, doing the right things; use proper resources and stick to the point. Change process should be kept accurate within the final and ultimate scope of project; which is success.

Customisation: Changes strategy has to be fully customised based on variety of factors but not limited to like: Project's scope and objectives, project's deliverables, customer's expectations, organisation's culture, country's legislative framework, HR, environment, sociotechnical conditions, financial policies and financial capacity to handle the customisation, etc.

Project Management Team (PMT): Project team members who are directly involved in project management activities, processes and in effect 'execute' the project within defined scope and objectives.

Performance: Based on the achievement of preset metrics such as KPI's (Key Performance Indicators), Balanced Score Cards, KSFs, (Key Success Factors), 360, SLAs (Service Level Agreements); assessing measurement and trends to effect processes improvement and goals.

Audit and verify: Performance result based but not limited to objectives (goals, target, time frame, schedule, budget etc). For example, the number changes which were accepted and were fulfilled until the closing phase of the project.

Planning outcomes: Planning starts with the identification of anticipated changes and its associated risks. The more identified the better result can be expected. It is also related to quantification, confirmation of resources needed, management's authorisation, taking into account the processes to be followed , schedule time, costs etc. In order to avoid blocks, passive resisters or even deliberate attempts of the change programme; the organisation must to prepare and plan changes so as to facilitate successful change. The next stages are implementation and verification.

Benchmarking: Comparing one's business change processes and performance metrics to industry bests. Try to take advantage the good paradigm and avoid the pitfalls. Benchmarking can be really useful since best change practices can be identified and followed; overall can lead to increase of project's performance.

Review on agreed standards: Refers to industry management standards or procedures (defined, but not limited to, for example by: PMBOK, PRINCE2, ITIL, Scrum, ISO), etc. The respective review has to be systematic depending on the project's conditions. e.g. bi-monthly, quarter, etc.

Clear targets: Targets should be clear to all stakeholders from project initiation and connected to results; upon change they have to be communicated again. Performance is difficult to be measured against unambiguous targets. When organisations implement new change strategies they should ensure that the appropriate set of performance measures are in place in accordance to clear targets.

Motivation: Motivation can inspire and encourage individuals (create value) or groups of people who constitute the project management team to cope with the changes strategy and increase their overall performance. If motivation is weak then this might have serious effects on the project constraints which consequently might lead to project failure. Effectively, motivation can be seen also as a driver for successful project management.

Financial Benefits: Can take any form of monetary return, such as: commission, organisational shares, salary raise, bonuses, pension scheme, etc. May be indirect, for example: a promotion where in most of the cases it is accompanied by a salary increase or other compensational benefit(s).

Innovation: Formulation of creative and competitive solutions for the success of the project changes. In many cases, changes should be innovative, for example; incorporate and mix different people and ideas. The introduction of 'new' changes may involve the experiences of as many stakeholders as possible. Being part of an innovative 'think tank' not only is beneficial but also challenging.

Fear of punishment: Usually project stakeholders will wish to avoid taking the responsibility of change process failure or wrong decisions. Especially for revolutionary changes (which are sudden and rapid) any imposed failure in decision taking may have punishment as a consequence.

Skillset Improvement: Willingness to promote oneself by improving skills. For example: project change management may require improvement in leadership, communication, organisational strategy skills, improvement concerning technical knowledge in project management frameworks, etc. This can be accomplished either by self-willingness or by training. The more skills acquired as far as the change processes are concerned the stronger the position of the stakeholder can be.

Appraisal: Assessing the performance of employees against agreed change targets and consequently to project's deliverables. Appraisals are better conducted on a systematic, periodic basis. In such a way individual's job performance and productivity will be assessed in relation to certain pre-established criteria and organisational project change objectives.

Feedback: Communicate (systematically) change processes or change result either in documented or oral form where appropriate. Except the overall change process message, it can leverage areas like for example: more widely acceptable implementation paths, less intrusive methods to employee comfort zones, culture, rewards, strategy, etc. governed under a comprehensive master plan.

Achievement of objectives: Conformance to predefined and authorized change targets. Once the changes have been introduced successfully (positive project impact) then in turn the result of the appraisal assessment can be for the benefit of the appraisee. Nevertheless, the outcome could signal the need for training, enhancement of communication and leadership or even remuneration. The objectives set should be attainable in time and pace. Too many or too difficult change requirements may lead to massive failure.

Opportunity: Chance to improve tangible or intangible benefits and in general professional status, provide overall feedback, develop skills and competencies. Either positive or negative (but fair) feedback should be accounted as an opportunity for further development of skillset.

Rewards: Tangible and/or intangible benefits given or received in recompense for worthy behaviour, for example after the successful result of change/s have been acknowledged. In many cases rewards may lead to internal team member's competition which up to a point may be considered healthy. People who will place change effort on their priorities list, and especially those who will succeed change goals can be rewarded with benefits. The reward, if any, should not be an incentive for competition among team members rather than for effective cooperation and goals and performance accomplishments.

Realistic and clear: Is related to clarity of change goals and clear direction. The greater the tasks to be accomplished the greater the motive should be.

Behaviour: In general for multi-dimensional and complex projects and especially when changes are required a certain behavior is expected by all stakeholders. This can be seen for example in the stakeholder's leadership, communication style adopted. For example match effectiveness in situations requiring an ability to

orchestrate multi-task levels of high responsibility, match complicated project goals, and balancing risk against performance.

Recognition: Acknowledgment those stakeholders which have worked hard; being praised for their good change result. Peer acceptance of professional status, skills and experience.

Training: Training can be regarded as the acquisition of knowledge, skills, and competencies as a result of teaching and course taking. Irrespective of contemporary project management framework followed, change management training, can be seen as an overall advantage (value) since the knowledge gained is not only specific but necessary to identify, plan and validate changes, tackle risks in a structured and documented manner.

Networking: Opportunity to exchange ideas with fellow co-workers. Mix of professionals from different management backgrounds; exchanging ideas, learn from others experience. Change issues are handled more effectively when the stakeholders are experienced in the field and have the opportunity to exchange and develop their ideas.

Experience (Trainee): An informed professional is more likely to accept the change training messages more effectively and in a rather critical context. For example: the shared vision, necessity for changes, follow processes, motivate stakeholders, put things back on track, ensure misunderstandings do not take place, etc.

Learning and development: Improve skills and get educated about change/risk issues, put theory and knowledge into practice and improve out of lessons learned. Refers to the overall output of the training. For example: the usefulness of the training at individual and corporate level. The more educated are the stakeholders on change/risk processes the more likely are to understand the core ideas or more complex issues.

Experience (Trainer): How well the change processes message can be communicated; linking of a period of activity in a work setting with professional status. Raises the level of successfully transmitting the change messages, in terms of training. The trainer has to be in brief: professional, experienced with the specific field and competent.

Value added: Value added training determines precisely what the expectations of stakeholders are, focuses on important issues so as at the end everybody to be 'happy'. For example: increase ability to incorporate new project management frameworks, helps employees meet new challenges and responsibilities, increases overall job satisfaction, morale and motivation among employees, raises awareness on change implementation, etc.

Tailor made: For better result, training courses can be tailor made (flexible) so as to meet both individual and corporate needs. For example: participants or topics can be of a similar skillset level in order to avoid frustration and further misunderstandings from those left behind. For better results, training courses in many cases have to adapt to the organisations cultural norms.

g) *Progress*: the main importance of this theme is to facilitate the ongoing plans viability. Questions which are accommodated are for example: Where are we now? Where are we going? and whether we should carry on?

However, in the end of 2013, specifically for change, PMI published a dedicated practice guide named: Managing Change in Organisations, a Practice Guide. The key points of this guide are that not only executives today are aware of the changing business environment (rate of which increases) but also, organisations need to embrace and adopt change strategically in order to ensure long-term success.

A3. 3 Change and Structured Project Management Frameworks

In the beginning of 1990s the term 'modern project management' started to appear to appear in literature sources. In this context, every project is subject to changes; one of the aims of structured project management methodologies is to adapt to changes and in effect minimise risk and finally ensure project success. As far as the two well established project management frameworks are concerned and more specifically in PMBOK, there can be found some references about change, in monitoring and controlling process, whereas in PRINCE2 there exists a whole dedicated change theme. Baca (2005, p.41) illustrated the change management process in flow chart diagram figure A3.1:

Initially, someone wishes to make a change, for example the project manager, the client or someone from the board of directors. When a change request is initiated the respective team, reviews the change. For example: the type and reasoning of the requested change together with respective recording. The next step has to do with the workload required. Sometimes, changes are so complicated that a lot of stakeholders have to be engaged and results are not obvious until the whole process is finalised.

Provided that it is agreed to go on, at least at initial level the required work and people are accumulated. Nevertheless, as it has been explained earlier, changes incur risk and risk is related to impact. In effect, every required change can have potential impact on the success or failure of the project. The final stage is determination whether the requested change affects the triple constraints (time, cost, quality) and

the overall scope of the project. CRAM goes far beyond the three constraints examining a variety of other factors, as it is believed that the three constraints are just the peak of the iceberg.
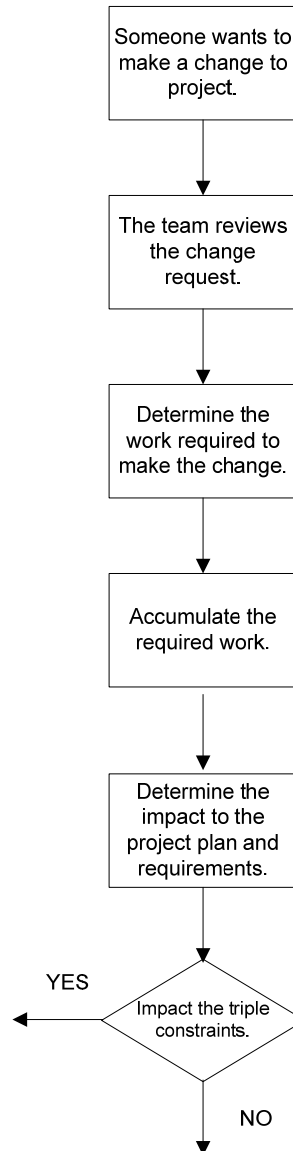
Figure A3.1: Change Management Process, PMBOK (2009), p.41

A3.3.1 Change Integrated into PMBOK Processes and Knowledge Areas

Specifically, PMBOK discusses about changes in the project management plan that result from the project risk management process. These processes may require decisions at the appropriate level of management to reassign personnel, establish or

modify budgets, make commitments to others outside the project, interact with regulators, and comply with the accounting and legal rules (PMI Risk, p.5).

Nevertheless, when issues are found while project work is being initiated, "change requests are issued which can modify project policies or procedures, project scope, project cost or budget, project schedule, or project quality. Other change requests cover needed preventive or corrective actions to forestall negative impact later in the project.

Requests for a change can be direct or indirect, externally or internally initiated, and can be optional or legally/contractually mandated" (PMBOK, 2009, p.87). Changes can impact the project management plan, project documents, or product deliverables. The three basic categories are the following (PMBOK, 2013, p.80-91):

- Corrective action
- Preventive action
- Defect repair

Figure A3.2 shows the inputs and outputs as described in PMBOK (2013) concerning the change control process.

Inputs	Tools & Techniques	Outputs
1. Project Management Plan 2. Schedule Forecasts 3. Cost Forecasts 4. Validated changes 5. Work performance information 6. Enterprise environmental factors 7. Organisational process assets	1. Expert judgement 2. Analytical techniques 3. Project management information system 4. Meetings	1. Change requests 2. Work performance 3. Project management plan updates 4. Project documents updates

Figure A3.2: Perform Integrated Change Control: Inputs, Tools & Techniques and Outputs, PMBOK (2013), p.85

Provided that the business alignment for a project is constant, the chance for project success greatly increases. This is because the project remains aligned with the

strategic direction of the organisation. In effect, if something changes then in turn, projects should change accordingly PMBOK (2013, p.14).

It is rather important to note that, even though, change as a generic term is mentioned in the PMBOK guide, in regards to scope management, time management, cost management, quality management or even risk management, there is still lack of knowledge area for change management.

In PMBOK (2013), 'change' is mentioned several times as it is integrated almost in all of the five process groups and ten knowledge areas. One of the key differences with PRINCE2 framework, is that OGC devoted a whole theme named 'change', which in PMI's terminology would mean a whole new 'change' knowledge area currently seem to be missing.

A3.3.2 Change as a Theme in PRINCE2

OGC's managing successful projects with PRINCE2 describes change with a view to link change with project's requirements. In light of this, a change in the environment applicable to the project may be for example: a legislative change, a corporate change of direction, a new customer or supplier, an unexpected change to a member of the project management team, actions by a competitor, a programme management directive or even a corporate reorganisation (OCG, PRINCE2, p.286).

The purpose of the Change theme as described in chapter two is to identify, assess and control any potential and approved changes to the baseline. "Without an ongoing and effective issue and change control procedure, a project will either become totally unresponsive to its stakeholders or quickly drift out of control" PRINCE2 (2009, p. 91).

Compared to PMBOK, PRINCE2 is overall more advanced and explanatory as far as the notion of change is concerned. In greater details, changes may arise from project team members, stakeholder requests, complaints or a wider range of factors. PRINCE2 goal is a systematic and common approach so as to manage project's performance targets. These targets are for example: time, cost, quality, scope, risk

and benefits (PRINCE2, 2009, p. 91). As in PMBOK, change is a continuous process throughout the lifecycle of the project.

Managing successful projects with PRINCE2 describes clearly that managing the project issues, involves proper recording and documenting of all actions required and respective conformation of their completion. There is also a dedicated 'risk log', where the impacts of existing risks are recorded, together with the views whether if new project issues would create new risks. This can have many advantages as past experience can be shared among stakeholders.

Moreover, PRINCE2 links the implementation of changes so as to meet the requirements or specifications of a project. Failure or non conformance to a project's requirements or even lack of controlling changes can actually lead to high risk of failure, unless controlled properly.

Overall, change at individual, team, and organisational business level. It can be said, that it focuses on changing behaviors and practices with a view to improvement. For example, improve organisational performance, project deliverables, etc.

In PRINCE2, controlling changes in regards to products or scope of a project is referred as 'change control'. Especially for the change control procedure, PRINCE2 (2009, p. 94) elaborates on a common approach to dealing with requests for change, off-specifications and problems /concerns:

- Capture
- Examine
- Propose
- Decide
- Implement

Also, PRINCE2 (2009, p.92) defines the following types of change issues[2]:

- Request for change

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[2] A relevant event that has happened was not planned but requires management action; PRINCE2 (2009, p.307).

- Off - specification (Something that should be provided by the project, but currently is not (or is forecast not to be) provided. This might be a missing product or product not meeting its specification.
- Problem/Concern

Subsequently, issues have to be prioritised based on a scale, the scale in turn is a measurement instrument for rating and based on the severity of issues these have to be accommodated/escalated to the respective management level.

AHP Calculations Examples

A4.1 Initilal Consistency Calculations

Suppose the following pairwise comparisons are given as in table A2.1:

Factor F	Attribute A	Attribute B	Attribute C	Attribute D	Attribute E	5th root of Product	Priority Vector
Attribute A	1	1/4	3	1/5	1/5	0.496	0.079
Attribute B	4	1	5	3	1/3	1.821	0.288
Attribute C	1/3	1/5	1	1/5	1/3	0.339	0.054
Attribute D	5	1/3	5	1	5	2.108	0.334
Attribute E	5	3	3	1/5	1	1.552	0.245
Sum of Row	15.333	4.783	17.000	4.600	6.867	6.315	1.000
Priority Row	1.204	1.379	0.911	1.536	1.687	6.717	

Table A4.1: Sample Pairwise Comparisons

The first step is related to the computation of the nth root of the products of the values in each row, where n is the number of attributes (criteria) is a follows:

$$0.496 = \sqrt[5]{1 x \frac{1}{4} x 3 x \frac{1}{5} x \frac{1}{5}}$$, the same is repeated for row two, three, four and row five.

Following next, the *Priority Vector or Eigenvector* is the nth root calculated above, divided by the sum of the nth root values. Actually Saaty (2003) explained that the priority vector can be either as a numerical ranking of the alternatives that indicates an order of preference among them or that the ordering itself has to reflect intensity or cardinal preference. Moreover, a priority vector 'x' must satisfy the relation:

Ax = Cx, C > 0

Going back to the calculations:

0.079 = 0.496/6.315

Then, Sum row = Sum of each column and,

Priority row = (Sum of row value) x (Priority vector), in effect:

λ_{max} = 6.717 (Sum of Priority row), then:

$$C.I = \frac{\lambda_{max} - n}{n-1} = \frac{6.717 - 5}{4} = 0.429$$

Finally the consistency ratio has to be calculated, as follows:

C R = C. I/R.I = 0.429 / 1.12 = 0.383, indicating a rather not good result (0.383 > 0.100). Effectively the judgements are inconsistent. Either the respondent has to rethink judgements or even change attributes with more relative ones.

Satty (1987, p.162) gave the following explanation why the tolerance level should be of 0.100. "Although the mind is primarily concerned with constructing a consistent decision, it must allow a modicum of inconsistency in order to admit new information, giving rise to change in the old judgments. However, inconsistency is less important than consistency by one order of magnitude (the 10% tolerance range)".

A4.2 Re-determination of consistency

As seen from the above example, the consistency is not accepted since it exceeds (0.383) the tolerance level or 0.1. Suppose that new judgments on the same attributes are being made, but now the pairwise comparison table is the following:

Factor F	Attribute A	Attribute B	Attribute C	Attribute D	Attribute E	5th root of Product	Priority Vector
Attribute A	1	1/4	3	1/5	1/5	0.496	0.079
Attribute B	4	1	5	3	1/3	1.821	0.264
Attribute C	1/3	1/5	1	1/5	1/3	0.306	0.043
Attribute D	5	1/3	5	1	1/3	1.227	0.180
Attribute E	5	3	3	3	1	2.954	0.434
Sum of Row	15.333	4.783	19.000	7.400	2.067	6.803	1.000
Priority Row	1.118	1.280	0.854	1.334	0.897	5.483	

Table A4.2: Re-determination of Pairwise Comparisons

Suppose that now the following changes are being made:

- Attribute D in comparison to Attribute E is changed to 1/3 (was 5),

- Attribute E in comparison to Attribute D is changed to 3 (was 1/5),

With the above changes, Sum of Row, Priority Row and Eigenvector values change.

Now: Priority Row = λ_{max} = 5.483

$$C.I = \frac{\lambda_{max} - n}{n-1} = \frac{5.483 - 5}{4} = 0.121$$

In effect:

C R = *C. I/R.I = 0.121 / 1.12 =* **0.108**

This time, the CR is very close to what Saaty has indicated as the limit. In most of the cases a CR up to 0.15 and maximum to 0.20 is acceptable. A CR high for example to 0.9 would mean that the pair wise criteria judgments are random and completely untrustworthy.

Since now the CR is accepted, then the next step is to normalise the matrix (divide each value with the sum row). The average would give the weights of the five criteria.

For example for Attribute A:

Factor F	Attribute A	Attribute B	Attribute C	Attribute D	Attribute E	Average	Attribute weight
Attribute A	1/15.333= 0.065	0.052	0.158	0.027	0.097	0.080	0.080

Table A4.3: Normalisation of Attribute A

Average$_{Cri\_A}$ = 0.065 + 0.052 +0.158 + 0.027 +0.097 /5

So:

Average$_{Cri\_A}$ = 0.339 / 5 = 0.0798 $\approx$ 0.08 or 8%

Criteria	Criteria Weight (Normalized)
Attribute A	8%
Attribute B	27%
Attribute C	4%
Attribute D	18%
Attribute E	43%
Total	**100%**

Table A4.4: Final Results (ranking)

Effectively, if the above criteria were risk factors, then the most influential on the decision would be in turn: Attribute E, Attribute B, Attribute D, Attribute A and Attribute C.

A4.3 Results Consolidation

For the consolidation of inputs, the geometric mean of replies is used, due to higher accuracy in result than the respective arithmetic mean.

$$b_{ij} = (a_{1ij} \cdot a_{2ij} \cdots a_{kij})^{\frac{1}{k}}$$

(Eq. A4.1)

For example:

k = 3 (number of participants)

n = 3 (number of criteria), with respective pairwise values as seen below:

1	3	1/5
1/3	1	1/7
5	7	1

Respondent 1 (R1)

CR = 0.07 (Acceptable)

1	1	1/4
1	1	1/2
4	7	1

Respondent 2 (R2)

CR = 0.04 (Acceptable)

1	2	1
1/2	1	1
1	1	1

Respondent 3 (R3)

CR = 0.06 (Acceptable)

For the consolidated matrix, taking as an example the pairwise comparison of $n_{1,2}$ (shaded light gray) then:

$$\sqrt[3]{3x1x2} = 1.8171 \approx 1.82$$

All remaining elements of the consolidated matrix as calculated with the use of geometric mean formula.

So:

n	n1	n2	n3	weight	rank
n1	1	1.82	0.37	24.6%	2
n2	0.55	1	0.27	15.0%	3
n3	2.71	3.66	1	60.4%	1

Consolidated Results (all three respondents)

λ_{max} = 3,010

CR = 0.04 or 4% (Acceptable)

However, depending on the pair wise comparison and the number of respodents, it is natural that a standalone respondent's result may be not acceptable, but the consolidated to be within the acceptance limit of <0.1 or 10%.

1	3	5
1/3	1	1/7
1/5	7	1

Respondent 1'(R1')

CR = 0.74 (Non Acceptable; highly inconsistent result, rather random)

But, taking into account the consolidated results (R1', R2, R3), then:

n	n1	n2	n3	weight	rank
n1	1	1.82	1.08	38.1%	1
n2	0.55	1	0.27	16.2%	3
n3	0.93	3.66	1	45.7%	2

$\lambda_{max} = 3,067$

CR = 0.025 or 2.5% (Acceptable), but raking of consolidated results is now different.

Of course the more standalone results produce non acceptable results (CR> 0.1) then in turn the consolidated ones will tend to a non acceptable result.

A5

AHP Case Study Tables

As seen thought-out the thesis's chapters, the hierarchy of CRAM consists of one (1) core (root) node, eight (8) parent nodes, five (5) child nodes and its respective sixty-one (61) attributes. As for as the RingTokk case study in concerned, the consolidated weights per level can be seen below:

Level 1(Root Node)	Level 2 (Parent Nodes)	Level 3 (Child Nodes)
Change Risk	Leadership	Performance
	Communication	Motivation
	Culture	Appraisal
	Resistance	Rewards
	Requirements	Training
	Monitoring	
	Flexibility	
	Project Management Team	

Table A5.1: CRAM Nodes Hierarchy

Parent Factors Change Management	Leadership Risk	Communication Risk	Requirements Risk	Cultural Risk	Resistance Risk	Monitoring Risk	Flexibility/ Adaptation Risk	Project Management Team Risk
Leadership Risk	1	9	3	5	7	5	1	7
Communication Risk	1/9	1	3	1	7	9	5	9
Requirements Risk	1/3	1/3	1	5	3	5	7	3
Cultural Risk	1/5	1	1/5	1	7	5	5	9
Resistance Risk	1/7	1/7	1/3	1/7	1	3	1	5
Monitoring Risk	1/5	1/9	1/5	1/5	1/3	1	1	5
Flexibility/ Adaptation Risk	1	1/5	1/7	1/5	1	1	1	3
Project Management Team Risk	1/7	1/9	1/3	1/9	1/5	1/5	1/3	1

Table A5.2: Successful Change Management Root Node Factors

Child Factors Leadership	Committed	Experienced	Determinant	High Level (CXO)	Authority	Firm but Fair	Inspiring	Strategic
Committed	1	1	1	3	3	1	3	3
Experienced	1	1	9	5	7	5	3	1
Determinant	1	1/9	1	5	7	1	5	3
High Level CXO	1/3	1/5	1/5	1	3	7	7	3
Authority	1/3	1/7	1/7	1/3	1	9	5	3
Firm but Fair	1	1/5	1	1/7	1/9	1	7	3
Inspiring	1/3	1/3	1/5	1/7	1/5	1/7	1	1
Strategic	1/3	1	1/3	1/3	1/3	1/3	1	1

Table A5.3: Leadership Risks

Child Factors Communication	Effective	Trustful	Involvement	Supportive	Common Vocabulary	Knowledge Sharing	Conflict Management
Effective	**1**	1	7	3	1	1	1
Trustful	1	**1**	7	5	7	5	9
Involvement	1/7	1/7	**1**	5	1	5	3
Supportive	1/3	1/5	1/5	**1**	3	1	5
Common Vocabulary	1	1/7	1	1/3	**1**	7	5
Knowledge Sharing	1	1/5	1/5	1	1/7	**1**	5
Conflict Management	1	1/9	1/3	5	1/5	1/5	**1**

Table A5.4: Communication Risks

Child Factors Culture	Integration	Leadership	Communication	Corporate Values	Embed Change	Rewards Innovative	Cross - Functional Teamwork
Integration	**1**	7	3	5	1	3	7
Leadership	1/7	**1**	7	5	7	5	9
Communication	1/3	1/7	**1**	7	1	3	5
Corporate Values	1/5	1/5	1/7	**1**	1	1	1
Embed Change	1	1/7	1	1	**1**	9	7
Rewards Innovative	1/3	1/5	1/3	1	1/9	**1**	5
Cross Functional Teamwork	1/7	1/9	1/5	1	1/7	1/5	**1**

Table A5.5: Cultural Risks

Child Factors Resistance	Empathy	Denial	Conformance to Status Quo	Consideration of Skills and Resources	Lack of Training	Loss of Benefits	Competition	Negotiation
Empathy Risk	**1**	1	1	1	1	3	1	1
Denial	1	**1**	3	1	3	1	3	1
Conformance to Status Quo	1	1/3	**1**	5	3	1	3	1
Consideration of Skills and Resources	1	1	1/5	**1**	7	5	7	5
Lack of Training	1	1/3	1/3	1/7	**1**	1	1	9
Loss of Benefits	1/3	1	1	1/5	1	**1**	7	9
Competition	1	1/3	1/3	1/7	1	1/7	**1**	5
Negotiations	1	1	1	1/5	1/9	1/9	1/5	**1**

Table A5.6: Resistance Risks

Child Factors Requirements	Specific	Measurable	Attainable	Reliable	Traceable	Corporate Policy	Alignment
Specific	**1**	5	3	7	5	1	1
Measurable	1/5	**1**	1	3	5	3	1
Attainable	1/3	1	**1**	9	7	1	3
Reliable	1/7	1/3	1/9	**1**	3	1	1
Traceable	1/5	1/5	1/7	1/3	**1**	1	1
Corporate Policy	1	1/3	1	1	1	**1**	7
Alignment	1	1	1/3	1	1	1/7	**1**

Table A5.7: Requirements Risks

Child Factors Monitoring	Reporting	Learn from Failure	Corporate Policy Alignment	Systematic
Reporting	**1**	7	3	3
Learn from Failure	1/7	**1**	5	7
Corporate Policy Alignment	1/3	1/5	**1**	5
Systematic	1/3	1/7	1/5	**1**

Table A5.8: Monitoring Risks

Child Factors Flexibility / Adaptation	Corporate Policy	Snr Management Buy-In	Past Experience	Leadership	Complexity Risk	Quick and Effective	Customisation
Corporate Policy	**1**	7	3	1	7	5	5
Snr Managemet Buy-In	1/7	**1**	1	5	7	5	3
Past Experience	1/3	1	**1**	5	7	7	9
Leadership	1	1/5	1/5	**1**	7	5	7
Complexity	1/7	1/7	1/7	1/7	**1**	3	5
Quick and Effective	1/5	1/5	1/7	1/5	1/3	**1**	5
Customisation	1/5	1/3	1/9	1/7	1/5	1/5	**1**

Table A5.9: Flexibility/Adaptation Risks

Child Factors Project Management Team	Performance	Motivation	Appraisal	Rewards	Training
Performance	**1**	7	9	1	5
Motivation	1/7	**1**	1	1	7
Appraisal	1/9	1	**1**	1	1
Rewards Risk	1	1	1	**1**	9
Training Risk	1/5	1/7	1	1/9	**1**

Table A5.10: Project Management Team Risk Attributes

Performance Risk Factor	Planning Outcomes	Attaining Goals	Benchmarking	Acceptance Level	Audit and Verify	Regular Review	Review on Agreed Standards	Clear Targets
Planning Outcomes	**1**	5	5	3	1	1	1	1
Attaining Goals	1/5	**1**	7	7	3	9	7	1
Benchmarking	1/5	1/7	**1**	3	5	3	5	1
Acceptance Level	1/3	1/7	1/3	**1**	7	3	5	3
Audit and Verify	1	1/3	1/5	1/7	**1**	7	7	5
Regular Review	1	1/9	1/3	1/3	1/7	**1**	1	7
Review on Agreed Standards Adaptation	1	1/7	1/5	1/5	1/7	1	**1**	5
Clear Targets	1	1	1	1/3	1/5	1/7	1/5	**1**

Table A5.11: Performance Risk Attributes

Motivation Risk Factor	Promotion	Improve skills	Innovation	Fear of punishment	Financial Benefits	Recognition	Competitiveness
Promotion Risk	**1**	5	3	7	1	5	7
Improve skills	1/5	**1**	9	7	1	7	7
Innovation	1/3	1/9	**1**	5	3	7	5
Fear of punishment	1/7	1/7	1/5	**1**	1	1	1
Financial Benefits	1	1	1/3	1	**1**	5	7
Recognition	1/5	1/7	1/7	1	1/5	**1**	9
Competitiveness	1/7	1/7	1/5	1	1/7	1/9	**1**

Table A5.12: Motivation Risk Attributes

Appraisal Risk Factor	Performance	Feedback	Achievement of Objectives	Routine	Opportunity	Rewards	Attainable Results
Performance	**1**	9	7	7	9	1	7
Feedback	1/9	**1**	5	7	5	1	1
Achievement of Objectives	1/7	1/5	**1**	7	9	1	5
Routine	1/7	1/7	1/7	**1**	1	1	1
Opportunity	1/9	1/5	1/9	1	**1**	7	5
Rewards	1	1	1	1	1/7	**1**	9
Attainable Results	1/7	1	1/5	1	1/5	1/9	**1**

Table A5.13: Appraisal Risk Attributes

Rewards Risk Factor	Benefits	Self-Esteem	Realistic and Clear	Motivation	Recognition
Benefits	**1**	9	7	9	9
Self-Esteem	1/9	**1**	7	9	9
Realistic and Clear	1/7	1/7	**1**	3	1
Motivation	1/9	1/9	1/3	**1**	1
Recognition	1/9	1/9	1	1	**1**

Table A5.14: Reward Risk Attributes

Performance Risk Factor	Management Level (Target Audience)	Networking	Experience (Trainee)	Learning and Development	Experience (Trainer)	Motivational Benefits	Value Added	Clear Targets
Management Level (Target Audience)	**1**	7	3	1	1	1	1	1
Networking	1/7	**1**	5	5	7	5	3	7
Experience (Trainee)	1/3	1/5	**1**	7	3	7	5	3
Learing and Development	1	1/5	1/7	**1**	7	3	7	9
Experience (Trainer)	1	1/7	1/3	1/7	**1**	5	1	1
Motivational Benefits	1	1/5	1/7	1/3	1/5	**1**	7	3
Value Added	1	1/3	1/5	1/7	1	1/7	**1**	9
Clear Targets	1	1/7	1/3	1/9	1	1/3	1/9	**1**

Table A5.15: Training Risk Attributes