Goal based Risk Management

A thesis presented to

Faculty of Basic & Applied Sciences

Department of Software Engineering

In partial fulfillment of

the requirement for the degree

of

Master of Sciences (Software Engineering)

By

Uzma Chishti
Reg. No. 160-FAS/MSSE/F07

Supervised by: Dr. Naveed Ikram

International Islamic University, Islamabad

Acknowledgment

I am extremely thankful to Dr. Naveed Ikram for his leadership, guidance and necessary support for completion of this research work. He always has been a great source of aspiration in looking into the minute details, understanding the arguments and keeping focus in achieving the desired objectives of the research.

I am grateful to my friends, family members and peers for their precious encouragement and support during the whole duration.

Faculty of Basic & Applied Sciences
Department of Software Engineering

Date: 13-12-2010

FINAL APPROVAL

It is certified that we have read the thesis, entitled **"Goal based risk management"**, submitted by Uzma Chishti Reg. No. 160-FAS/MSSE/F07 .It is our judgment that this thesis is of sufficient standard to warrant its acceptance by the International Islamic University Islamabad for MS Degree in Software Engineering.

External Examiner:
Dr. Fahim Arif
Associate Professor
Military College of Signals
NUST

Internal Examiner:
Muhammad Usman
Assistant Professor
International Islamic University, Islamabad

Internal Examiner:
Salma Imtiaz
Assistant Professor
International Islamic University, Islamabad

Supervisor:
Dr. Naveed Ikram
Associate Professor
International Islamic University, Islamabad

Declaration

I hereby declare and affirm that this thesis neither as a whole nor as part thereof has been copied out from any source. It is further declared that I have completed this thesis entirely on the basis of my personal effort, made under the sincere guidance of our supervisor. If any part of this report is proven to be copied out or found to be a reproduction of some other, we shall stand by the consequences. No portion of the work presented in this report has been submitted in support of an application for other degree or qualification of this or any other University or Institute of learning.

Uzma Chishti
160-FAS/MSSE/F07

Dedication

I would like to dedicate our work to

ALMIGHTY ALLAH,

Who has always showered His endless blessings upon us;

I also dedicate this work to my

PARENTS

Whose sincere prayers and love were a source of strength for me
and made this project successful.

Table of contents

Abstract

Software project managers opt for schedule, cost and performance of a software project. The study aims to explore whether cost, schedule and performance are the only goals for the software project and whether the risk expression carries these three issues only. Secondly what are the other goals for a software project beside cost, schedule and performance? Goal stakes is characterized by risk factors influencing the project goal employing goal based risk management. A case study validation has been conducted to explore that what is the impact of goal based risk expression (risk expression which incorporates goal stakes) compared to typical cost, schedule and performance notion of risk for a software project.

Chapter 1: Introduction

Software projects are vulnerable to failure [Bannerman, 2008] and most of them end up in failure. [Kiel et. al, 1998] Several projects had doomed to failure due to ineffective risk management practice even when extra budget and time was allocated e.g. Automated Baggage handling system [Gibbs, 1994] at Denver international airport, merging driver and vehicle registration systems [Gibbs, 1994] of California's Department of Motor Vehicles, SABRE of American airlines [Gibbs, 1994] and London Ambulance Service. [Davis, 1995]

In order to avoid failure it is important to identify and control factors that contribute towards failure. Analysis and management of such factors is performed by Risk Management. Since project failures are the result of the multiplicity of risks inherent in software project environment. [Kwak & Stoddard, 2004] Therefore software risk management aims to prevent failures. [Addison & Vallabh, 2002] *Thus risks are inevitable, and if left uncontrolled they will eventually lead to software failure.*

1.1 Risk in Software Engineering

Formal Risk Management practice in Software Engineering was introduced by Boehm [Boehm, 1991]

Risk in Software Engineering literature is defined as;

1. Product of probability of loss & size of loss, *P(L)x S(L)* [Boehm,1991]
2. Negative or unwanted consequences [Pfleeger, 2000]
3. Impede or threaten project success [Sumner, 2000] [Schmidt et al, 2001] [Wallace et. al, 2004]

Risk carries both threat and opportunity. [Bannerman, 2008] [ISO/IEC Guide 73:2002] Thus risk can be defined as *opportunity at stake.* Risk Management is defined as *a set of principles and practices aimed at identifying, analyzing and handling risk factors to improve the chances of achieving a successful project outcome and/or avoid project failure* [Bannerman, 2008] The major set of activities involved in Risk management approaches are; **Risk Assessment** constitutes Risk Identification, Risk Analysis and Risk

Prioritization. [Boehm, 1991] **Risk Identification** as the name implies, this activity identify potential risks vulnerable to the software project. **Risk Analysis** involves estimating probability of a risk item as well as loss associated with it. [Boehm, 1991] **Risk Prioritization** involves ranking the identified risk items. [Boehm, 1991] **Risk Evaluation** is then based on risk prioritization **Risk Monitoring** Monitor the project progress against risk factors and taking corrective actions when required. [Boehm, 1991] **Risk Mitigation** Risk Mitigation involves Contingency planning and Action planning and are described as; [Fairley, 1994] Contingency planning employs that risk is monitored in order to track whether future response is needed to address the risk. Action planning employs that risk can be addressed by immediate response.

Furthermore risk can be mitigated either by **Risk Avoidance** which aims to avoid occurrence or influence of negative effect onto project [Bannerman, 2008] or by **Risk Transference** which involves to shift the risk (e.g. outsourcing risk) [Bannerman, 2008] **Crisis Management** Failure of Contingency plan results a project into crisis, Crisis Management requires to plan in order to manage the project crisis it may include allocating resources, re-planning etc. [Fairley, 1994]

1.2 Research Questions

The aim of this research is to analyze the existing risk management approaches to determine that how risk is expressed by them. Restricting risk expression along schedule, cost and performance hinders to foresee risks beyond the software development activity. Whereas if the project goals are agreed upon by the software developers and management and the risk expression incorporates these project goals a different interpretation of risk with respect to goal stakes can be developed.

The research questions are as follows;

1. What is the impact of the risk expression of existing risk management approaches on Risk Identification, Risk Assessment and Risk Evaluation?
2. What is the impact of goal based risk expression on Risk Identification, Risk Assessment and Risk Evaluation.

1.3 Research Method

A case study was performed for the exploration of the second research question. Case study was conducted in a government sector organization, where in-house software was being developed. The goals of the software and risk influencing these goals in terms of goal stakes were identified. Chapter 5 provides further detail on case study design and results.

1.4 Thesis Outline

The remainder of the thesis is structured as follows;

Chapter 2: The second chapter presents an introduction to the risk management approaches. It reports the analysis of the risk management approaches with respect to risk identification, assessment and evaluation.

Chapter 3: The third chapter presents the proposed process for goal based risk management.

Chapter 4: The fourth chapter reports the case study validation of the proposed process. The chapter provides introduction to the case, case study design and results of the study.

Chapter 5: The fifth chapter provides the conclusion by discussing the contribution of the thesis and how the findings of case study answer the research question presented in the first chapter.

Chapter 2: Literature Review

2. Risk Management Approaches

There are many Risk Management approaches briefly described as follows;

Frameworks for risk management: Boehm [Boehm, 1991] presented a detail framework for risk management that groups risk identification, analysis and prioritization into risk assessment. The SEI (Software engineering institute) [Higuera & Haimes, 1996] has presented six activities (Identify, analyze, plan, track, control and communicate) arranged in a circular form centered with communication. A goal based approach [Turner & Hunsucker, 1999] emphasizes on organizational goals and measure risk in terms of program objectives. An integrated risk management framework [Bandyopadhyay et. al et. al, 1999] encompasses three levels of risk, application, organizational and inter-organizational level. The framework by PMBok [PMI 2004] involves six processes for risk management. A *ProRisk* management framework [Roy, 20004] addresses the risk within business and operational domain. The business domain employs the area in which the project is actually created whereas operational domain encompasses the implementation of the project. A six step framework proposed by [Kumar Dey et. al, 2007] focus on risk management from developer's perspective.

Risk Management Models: Just-in-time risk management model emphasize on six risk perspectives. [Karolok, 1996] An eight step risk management model is proposed by [Keshlaf & Hashim, 2000] A categorization and behavioral model for risk management by [Cule et. al, 2000] categorizes risk as inside (self and task related risks) and outside (client and environment risks). EPRAM (Evolutionary Prototyping with Risk Analysis and Mitigation) emphasizes on mitigating prototype related risks in e-commerce [Anton et. al, 2001]. A model of risk and performance [Wallace et. al, 2004] focuses on impact or risk on the software performance, the performance of the software development process and developed software product. Three distinct models have been proposed by

[Sik Na et. al, 2007] the first model focus on residual risk (risk remaining after the risk mitigation strategies are applied) and its impact on project cost and schedule. The second model focuses on impact of system functionality risk on project cost and schedule. The third model focuses on impact of system functionality risk on project performance by assessing quality of development process and quality of developed product. A six phase risk management model [Nyfjord & Mattson, 2008] presents a risk management model that focus on industrial compliance of risk management practice. A model for risk management by [Xiaosong et. al, 2009] focuses particularly on risk identification activities.

Process model: GRisk process model [Kirner et. al, 2006] incorporates five phases namely risk identification, risk analysis, risk prioritization, risk criticality determination and risk control throughout the software development life cycle. The Grisk model is supported by GRisk Tool to create knowledge base for risk and follow up the risk management activities.

Risk Management Processes: A seven step process for risk management is proposed by [Fairley, 1994] which involves risk identification, assessing probabilities of risk, developing strategies to mitigate risk, risk monitoring, invoke contingency planning, crisis management and crisis recovery. Risk management process for business process reengineering projects [Kliem, 2000] emphasizes on people, technical and management risks. RISKIT [Kontio et al, 2001] process for risk management traces risk to goals and stakeholder evaluating them in context of cost, schedule and technology issues. VRRM (Value based requirement risk management) process focus on requirements related risk associated with value proposition of stakeholders [Javeria et. al, 2008]

Checklists for risk factor identification: The checklists for risk factor identification in literature are categorized on the basis of the sources from which they are developed by [Keil et. al, 2008] e.g. whether the risk factors are derived from literature, surveys or judgment based (Delphi) studies. [Barki et. al, 1993] [Ropponen & Lyytinen, 2000] are survey reports from project managers, checklist by [Heemstra & Kusters, 1996] [Wallace,

et. al, 2004] is derived from literature and experience reports. Risk themes by [Moynihan, 1997] are derived by interviews with 14 developers. Risk factors are categorized along four quadrants by [Keil et. al, 1998] derived from Delphi study.

Checklist by [Schmidt et. al, 2001] is derived by Delphi study. [Tiwana & Keil, 2004] Checklist by [Han & Haung, 2007] is derived from analysis of software projects.

ERP (Enterprise Resource Planning) specific risk factors are identified by [Sumner, 2000] via literature and case study based experiences of seven companies.

The Risk management approaches that incorporate graphs and probabilistic weights assigned to factors that trigger risk includes Neural Network [Khoshgoftaar & Lanning 1995] and Belief Based Network [Josang et. al, 2004] [Hu et. al, 2007] A risk measure proposed by [Masticola, 2007] involves an equation to calculate the cost effectiveness of risk management activities being carried out in a project e.g. whether the risk management activity within a software project increases the chance of project's success or not?

Risk management standard includes [ISO/IEC Guide 73:2002] which focus on risk related to strategic, operational, financial, knowledge management and compliance. A risk management practice by [Pressman, 2005] categorizes risk factors within performance risk, cost risk, support risk and schedule risk.

2.1 Analysis of risk management approaches

The Risk management approaches within the literature are analyzed with respect to risk expression e.g. how risk identification, risk assessment and evaluation is carried out? This section discusses the risk expression of various risk management approaches and is summarized in table1.

2.1.1 Risk Identification

Most of the risk management approaches rely on checklists for identification of risk factors. [Boehm, 1991] [Sumner, 2000] [PMI 2004] Risk identification in RISKIT [Kontio et. al, 2001] is influenced by defining risk management mandate and goal definition. For risk identification, Fairley [Fairley, 1994] recommends to identify technical issues or resource adequacy for a software project which may cause schedule

delay. An ISO standard [ISO/IEC Guide 73:2002] had proposed the risk identification areas which are similar to the risk identification perspectives by [Karolok, 1996] such as strategic, operational whereas financial maps on business perspective and compliance maps on industry and practitioner perspectives. Risk Taxonomy for risk identification by SEI paradigm [Higuera & Haimes, 1996] includes product engineering (requirement, design, code & unit test, integration & test, engineering specialist) development environment (development process & system, management process & method, work environment) program constraints (resources, contract, program interfaces). A goal based approach [Turner & Hunsucker, 1999] emphasizes on organizational goals and measure risk with respect to project goals. The four quadrant risk categorization framework by [Keil et. al, 1998] and a categorization and behavioral model (inside and outside risk) by [Cule et. al, 2000] are somewhat similar. Inside risk includes self and task related risks whereas outside risk includes client and environment risk. Inside risk maps onto scope and requirement quadrants whereas outside risk maps onto customer mandate and environment. Risk management for business process reengineering projects [Kliem, 2000] emphasizes on people, technical and management for risk identification. Risk identification is regarded as a continuous process in a model by [Keshlaf & Hashim, 2000] risk identification is carried out constantly throughout the software development.

Risk identification in *ProRisk* management framework [Roy, 2004] emphasize on the risk factors proposed by SEI taxonomy.

Risk Management practice [Pressman, 2005] recommends use of generic subcategories for risk identification product size, business impact, customer characteristics, process definition, development environment, technology to built, staff size and experience.

GRisk process model [Kirner et. al, 2006] emphasizes on software development phase wise risk identification and five classes of risk Relationship Risk (risks related to interaction between developers & user) Organizational Risk (risks related to organizational changes influencing software under development) Management Risk (risks related to management of system development) Financial Risk (risks related to financial expenses) Technical Risk (risks related to lack of experience, use of inadequate methodologies or techniques) Legal Risk (risk related to laws e.g. fiscal requirements, software license)

A risk management model by [Nyfjord & Mattson, 2008] identified the risk factors as business, financial, project, process, planning, resource, technical, organizational, legal, partner/subcontractor, country, product and quality. The model suggests horizontal and vertical identification of risks. Such risk identification concerns whole software development process as well as stakeholders at different organizational level.

Neural network based approach identify risk factors based on software complexity [Khoshgoftaar & Lanning, 1995] A belief based network approach identifies risk as potential threats [Josang et. al, 2004] another belief based network [Hu et. al, 2007] approach recommends the use of Delphi method for risk identification.

The model by [Barati & Mohammadi, 2008]focuses particularly on risk identification, and identifies risk along enterprise environmental factors, organizational process assets, project scope statement, risk management plan and project management plan.

Risk identification in the model by [Xiaosong et. al, 2009] is focused on the risk categories based on mission and goals, program management, decision drivers, organization management, customer/user, project parameters, product content, deployment, development process, development environment, project management, project team, technology and maintenance.

2.1.2 Risk Assessment

Most of the risk management approaches rely on probabilistic determination of risk factors. Risk is assessed by risk exposure; RE=PxC (product of probability of occurrence & cost of a risk factor) [Boehm, 1991] [Fairley, 1994] [Pressman, 2005] [Nyfjord & Mattson, 2008] Some approaches focus on probabilistic as well as subjective risk assessment e.g. [Kliem, 2000] [PMI 2004] Risk metrics are used for risk assessment by [Karolok, 1996] Tracing risk with scenarios is carried out by [Turner & Hunsucker, 1999] [Kontio et. al, 2001] Network based approaches assess risk via probabilistic weight and graphs. [Khoshgoftaar & Lanning, 1995] [Josang et. al, 2004] [Hu et. al, 2007]

Risk assessment in *ProRisk* management framework [Roy, 2004] is employed by developing risk clusters which groups the risk factors that are related to a particular aspect of a project and represent them by using tree like structure. Risk assessment in the

model by [Barati & Mohammadi, 2008] employs quantitative as well as qualitative risk analysis.

2.1.3 Risk Evaluation

Risk management approaches evaluate risk based on probabilistic notion or impact of risk factor commonly categorized as high, medium and low. Table1 summarize risk evaluation of risk management approaches.

Most of the risk factors listed within the checklists address risks related to requirement issues, schedule and budget, personnel, user/customer risk, complexity, expertise, functionality, subcontracting, performance, technology and organizational environment. The risk factors such as requirement, complexity, functionality, performance and technology can be grouped into performance factor. Thus apart from user/customer, subcontracting and organizational environment risks, all other risk factors focused in checklists are schedule, cost and performance issues of a software product. Also some of the risk management approaches [Wallace et. al, 2004] [Sik Na et. al, 2007] [Masticola, 2007] rely on schedule, cost and performance notion of risk.

Table 1: Analysis of Risk Management approaches

Risk Management Approaches	Risk Expression			Goals Focused
	Risk Identification	Risk Assessment	Risk Evaluation	
Boehm [1991]	Checklist based (top ten risk factors)	Probabilistic notion	Prioritization w.r.t Probabilistic loss estimated for each risk factors	None
Fairley [Fairley,1994]	Symptoms that contributes towards schedule delays	Probabilistic notion	Probabilistic notion	None
SEI Paradigm [Higuera & Haimes, 1996]	Risk Taxonomy Product engineering Development Environment Program constraints	Risk is assessed along Temporal dimension, Methodological dimension & Human dimension	Risk Evaluation estimate loss in terms of High, Medium, Low	None
Just-in-time Risk Management model [Karalok, 1996]	Operational perspective Strategic perspective Technical perspective Business perspective Industry perspective Practitioner perspective	Risk Metrics	Evaluation w.r.t risk metrics	None
Effective risk management: a goal based approach [Turner & Hunsucker, 1999]	Higher level goals	Scenario based risk assessment R(m)=L(m)*C(m)*I(m)	Prioritization w.r.t abatement cost effectiveness function	Program objective and organizational goals
Framework for integrated risk management in information technology [Bandyopadhyay et. al et. al, 1999]	Application level, Organizational level & inter organizational level	Risk factors are assessed along the three levels	Risk evaluation is based on risk loss reduction measures	None
Risk Management for BPR projects [Kliem, 2000]	People, technical, management & business risks	Probabilistic as well as subjective judgment	Risk evaluated w.r.t to its impact	None
Categorization & behavioral model [Cule et. al, 2000]	Inside & Outside Risks	Link risk with class of risk	Subjective judgment	None

Table 1 (CONTD.): Analysis of Risk Management approaches

Risk Management Approaches	Risk Expression			Goals Focused
	Risk Identification	Risk Assessment	Risk Evaluation	
Risk factors in ERP [Sumner, 2000]	Organizational fit, skill mix, Management structure & strategy, software systems design, user involvement & training, technology planning, project management	Risk assessment w.r.t technology, organizational fit, people factors and project size	Subjective judgment	None
RISKIT [Kontio et. al, 2001]	Risk Management Mandate	Tracing risk with risk scenarios and goals	Risk evaluation w.r.t cost, schedule & technology	Project goals derived from Risk management mandate, particularly Cost, Schedule & technology
ISO/IEC Guide 73 [ISO/IEC Guide 73:2002]	Strategic Operational Financial Knowledge management Compliance	Probability estimation (consequences & probability of occurrence)	Risk evaluation (consequences & probability of occurrence) in terms of high, medium & low	Strategic objectives and financial Impact on organization
PMBok [PMI, 2004]	Checklist or experience based	Probabilistic notion	Probabilistic notion	Project objective
ProRisk management framework [Roy, 2004]	SEI taxonomy of risk factors	Groups related risks factors in tree like clusters	Probabilistic calculation of risk clusters and evaluated in terms of Extremely Low, Very Low, Low, Medium, High, Very High, and Extremely High	None
Risk Management practice [Pressman, 2005]	Generic sub categories & Risk components	Risk assessment via *risk exposure*, RE=PxC (product of probability of occurrence & cost to the project) & risk impact	Risk evaluated as to be catastrophic, critical, marginal or negligible	None

Table 1 (CONTD.): Analysis of Risk Management approaches

Risk Management Approaches	Risk Expression			Goals Focused
	Risk Identification	Risk Assessment	Risk Evaluation	
[Kirner et. al, 2006]	Classes of risk is proposed; Relationship Risk Organizational Risk Management Risk Financial Risk Technical Risk Legal Risk	Degree of risk impact determined by probabilistic notion	Prioritize as high, medium or low according to degree of risk impact	None
[Sik Na et. al, 2007]	Requirement uncertainty, functional & system development risk	Impact of risk on schedule, cost overruns as well as performance pitfalls	Responses from stakeholders (Development organization, Order/acquisition organization)	None
Risk Management Model [Nyfjord & Mattson, 2008]	Horizontal and vertical risk	Probabilistic notion as well as matrices and scenario analysis	A prioritized risk list is developed based on risk assessment results	None
[Javeria et. al, 2008]	Organizational policies & project management plan	Risk is linked with requirement and probabilistic notion	Risk is prioritized on the basis of requirement value against the scale of low, medium and high	Business objective
[Barati & Mohammadi, 2008]	Enterprise environmental factors, organizational process assets, project scope statement, risk management plan and project management plan	Quantitative (probabilistic) as well as qualitative (subjective) risk analysis.	Risk evaluation is based on Risk responses	None

Table 1 (CONTD.): Analysis of Risk Management approaches

Risk Management Approaches	Risk Expression			Goals focused
	Risk Identification	**Risk Assessment**	**Risk Evaluation**	
Risk Matrix [Xiaosong, 2009]	Mission and goals, program management, decision drivers, organization management, customer/user, project parameters, product content, deployment, development process, development environment, project management, project team, technology and maintenance	Probabilistic notion	Risk evaluation based on probabilistic notion and ranked against high, medium and low	Project mission and goals
Network based (belief based network or neural net) Approaches				
Neural Network [Khoshgoftaar & Lanning, 1995]	Software Complexity factors	Probability weight	Risk evaluation based on neural net outcome	None
Belief Based Network [Josang et. al, 2004]	Potential threats	Probability function of threats, vulnerabilities and asset impact cost	Risk evaluation based on Probability function	None
Belief Based Network [Hu et. al, 2007]	Delphi method	Graph to capture risk relations	Subjective	None
Risk Identification Checklists				
[Barki et. al, 1993]	5 Risk Categories			None
[Keil et. al, 1998]	Risk categorized along four risk quadrants customer mandate, scope & requirements, environment, execution			None
[Ropponen & Lyytinen, 2000]	6 Components of Risk			None
[Schmidt, 2001]	Detail Risk Items			None
[Wallace et. al, 2004]	6 Risk dimensions			None
[Tiwana & Keil, 2004]	Risk drivers			None
[Wallace et. al, 2004]	6 Risk dimensions			None

2.2 Impact of risk expression restricted along schedule, cost and performance issue

The risk management approaches discussed emphasizes on risk expression that is either restricted along checklist based risk identification or subjective identification based on experience. Project objectives or project goals are focused by few of the risk management approaches such as a goal based approach by [Turner & Hunsucker, 1999] RISKIT process by [Kontio et. al, 2001] However these approaches do not specifically focus on taxonomy of goals. Although importance of identifying project objective and goals is evident from the studies such as [Charette, 1996] which recommends for large scale project development, the first and top priority thing is to *"determine objectives."* Thus development of software project is carried out to fulfill some goal e.g. the services provided by the software plays a role to accomplish some objective, in case of information system the goal of developing software can be to assist in admin function, in case of hard real time system developed for industrial zone the goal can be pressure control etc.

Schedule, cost and performance issues are not the only goals for a software product. For a project there are goals other than these three issues, expressing risk along these three issues leads towards "obstruction of other project objectives" [Turner & Hunsucker, 1999]. The finding of the study [Odzaly et. al, 2009] reports that major emphasis of project is on schedule, quality and budget controls which results in risk management being least focused activity.

Schedule and cost issues have been repeatedly reported as a problem by several studies [Brooks, Jr., 1975] [Verner et. al, 1999] The popular example of schedule and cost overruns is of windows vista, performance pitfalls in terms of compatibility issues etc has been observed in windows vista. One of the reasons for such compatibility issues is that Microsoft tends to remove old features, whereas some users rely on the old features which requires a balance between risk and the usage of features [Howard, 2007] Thus the performance pitfalls have been compromised with the goal *"remove old windows features"* A goal that cannot be expressed in terms of cost, schedule or performance notion. *"Unanticipated & unarticulated project goals"* regarded as one of the factor for

software failure. [Charette, 2006] Also "*Clear Project goals and objectives*" is ranked as the most critical factor for software success. [White & Fortune, 2002] Therefore the stakes towards the accomplishment of project goals must be explicitly traced and managed. This requires a goal based risk expression tracing risk to various goals of a software project. The following section discusses Taxonomy of software goals.

2.3 Taxonomy of Software Goals

A goal *is an objective the system under consideration should achieve.* [Lamsweerde, 2001] also defined as *statement of intent* [Anwer & Ikram, 2006]

Achievement goals: Achievement goals are defined as *objectives of enterprise system* [Anton & Potts, 1998] [Regev, Wegmann, 2005] *or what organization currently want to achieve* [Kavakli, Loucopoulos, 2002]

Maintenance goal: Maintenance goals tend to *satisfy a target condition* [Anton & Potts, 1998] [Regev & Wegmann, 2005] the target condition can be an enterprise goal or a constraint upon an enterprise goal.

Avoidance goals: Constraints are captured by avoidance goals so in that context maintenance goals are related to avoidance goals. [Regev & Wegmann, 2005] Avoidance goal actually captures *state to be avoided.* [Kavakli & Loucopoulos, 2003] Avoidance goals can be regarded as constraints or obstructions.

Non functional goals: The approach by [Chung & Nixon, 1995] presented NFR *as potentially conflicting or synergistic goals to achieve*. Non functional goals in turn can be refined into performance and security goals [Chung & Nixon, 1995] [Lamsweerde, 2001]

Process Goals: Process goals are *demands to be satisfied or problem to be resolved* [Kavakli & Loucopoulos, 2003]

Evaluation Goals: Evaluation Goals describes *the stakeholders' criteria against which a system specification can be assessed.* [Kavakli & Loucopoulos, 2003] Stakeholders' criteria can be expressed in terms of functional or non functional parameters therefore the criteria can be refined and developed in terms of goals.

Functional goals: Functional goals present *system services*, [Lamsweerde, 2001] can be specialized into satisfaction and information goals [Lamsweerde, 2001] defined as satisfaction goal *satisfying agent requests*, information goal *informing about object states*. Much of security goals overlap with non functional requirements e.g. accuracy goals concerns with the correct state of software object. [Lamsweerde, 2001] This correctness ensures the establishment of security goals.

Performance goals: Performance goals are defined as *the efficient and responsive use of system resources.* [Chung & Nixon, 1995] The performance goals can be further refined into response and throughput.

Terminal goals: Terminal goals are goals that are obtained by refining goals into domain specific goal. *Terminal goals assigned to agents in the software-to-be become requirements; terminal goals assigned to agents in the environment become assumptions.* [Letier & Lamsweerde, 2002]

A distinction between goals in terms of hard and soft goals exist [Lamsweerde, 2001] which emphasize on the fact that whether goal accomplishment can be viewed in clear-cut sense (hard goal) or goal accomplishment cannot be viewed in clear-cut sense (soft goal)

2.4 The need to incorporate goals into Risk Identification, Assessment and Evaluation

Incorrect risk expression (e.g. an expression limited in terms of cost, schedule& performance goals only) can lead to inadequate management of risk which may result into failure.

Since risk identification is restricted along with these three issues, other risk factors within "strategic areas, political/social, environment, legal agreements, and *human* factors," [Rodrigues & Williams, 1996] are overlooked. For each software project, cost, schedule and performance issues are generic issues since every Project Manager opt to meet cost, schedule and performance goals.

The current era of software development has stepped beyond Information systems, real time systems, embedded systems. Now software development is also dealing with complex genetic engineering, hydraulic automobile engineering, biotechnology, robot technology etc. These newly introduced areas encompass a different risk expression i.e. as highlighted in study [Charette, 1996] issues with large and complex software like genetics involves uncertainty, disputes, decision stakes and the influence of such software on public. Thus we are presented with a situation where risk expression is broaden and is beyond the three issues (schedule, budget, performance).

The case of failed project is discussed in [Glass, 1999] there exist a conflict regarding the project failure between the management and practitioners. The management regarded the project as a failure because of cost and schedule overruns in spite of the fact that the software was completed and conformed to the requirements. The practitioners who developed the software on the other hand regarded this project as their best work, the reasons of project failure reported were unavailability of expert's advice and the higher expectations from the project since the beginning of its development. The situation presents a difference in opinion among management and practitioners. However if at the beginning of the project the success criteria of project (e.g. in terms of goals) would have been agreed upon by management and practitioners, then such difference in opinion would have not been occurred. Similarly the study [Verner et. al, 1999] has reported one developer's experience who stated that a project though regarded as success by management but was the most unpleasant work ever done by her. Thus there are multiple perspectives of several stakeholders towards the same software. Similarly the study [Procaccino, Verner & Lorenzet, 2006] emphasize on the developers view of the software and its contribution towards the success of the software to reduce the risk associated with the software. However a view that accommodate all success critical stakeholders e.g. in terms of project goals can present a comprehensive set of stakeholders perception. The

fact that project risk is perceived differently by different set of stakeholders (e.g. users and project managers) is explored by the study [Keil, Tiwana & Bush, 2002] concluding that risk expression must capture multiple stakeholders' perceptions.

Similarly the "*Support failure theory*" [Sauer, 1993] also presents a different scenario of failure. The core concept is that all stakeholders have their own particular interests from the software project, these interest or stakes are the main theme for which the development of project actually takes place. When the stakeholders conceive that the project fails to safeguard their particular stakes, they withdrew their support from the project. This with drawl dooms the project towards failure. However as long as the stakes are safeguarded the project development continues in spite of cost, schedule overruns and performance pitfalls. Thus incorrect risk expression influences the project's success. Therefore the risk expression must involve the stakes that are critical for software success.

A study [Boehm, 2000] discusses scenarios of project termination, projects are often terminated though not failed, the termination of project involves things such as; rapid change in technology, organizational and market trend. Identifying such risks earlier or prior to completion of project can be helpful to save resources that might have been used up by a project whose operational version will not be useful. But identification of such risk requires broadening the risk expression beyond three issues of schedule, budget and performance. Thus we can state it clearly that every project has schedule, budget and performance goals but these are not the only goals to achieve neither do they present correct risk expression. Although schedule, budget and performance issues are critical but the risk is regarded as those factors that are at stake due to schedule, budget and performance issues.

Chapter 3: Proposed Solution

The incorrect risk expression can lead to inadequate management of risk which may result into failure, and therefore there is a need to ensure accomplishment of software goals. The risk expression must trace the stakes towards the accomplishment of these goals. For example what in particular is at stake due to schedule, cost overruns and performance issues? The proposed solution is a process which structures the risk identification, assessment and evaluation with respect to software goals.

3.1 Goal based Risk Management

The study [Turner & Hunsuker, 1999] highlights the fact that methods for determining risk impact to the top organizational goals are scarce. Therefore the risk expression must capture the organizational and strategic goals. The point to focus is that what project aims to deliver e.g. strategic support (in house product), compete the market and earn profit (commercial product) or control/support of electronic appliances (industrial product)? This determines the objective for software project. Based on stakeholder's perspectives and project objective further goals are derived. These goals define the system-to-be (the software under development). Now once the goals are determined the next step is to safeguard these goals such that the system-to-be (software under development is referred as system-to-be) accomplishes the goals, which requires foreseeing the goal stakes involved to achieve the goals. The Figure 1 depicts the process for goal based software risk management. Following sections explains the activities within the process followed by the impact of risk identification, assessment and evaluation.

3.2 Proposed process for Goal based Risk Management

The steps for goal based risk management process are discussed in following sections.

3.2.1 Identify Stakeholder's perspectives

Understanding stakeholder's perspectives is very critical since it signifies that how system under development is perceived by the stakeholders. There are number of approaches for stakeholder identification [Bryson, 1995] [Eden & Ackermann, 1998] [Sharp, Finkelstein & Galal, 1999] [Bryson, Cunningham, Lokkesmoe, 2002] [Bryson, 2003] [McManus 2004] [Woolridge, McManus & Hale, 2007] [Ballejos & Montagna 2008] [Preiss & Wegmann 2009]. The technique by [Eden & Ackermann, 1998] helps to identify stakeholders who have the power and influence on the software project, since these stakeholders actually drive the software development. Secondly the study [Parent, & Deephouse, 2007] focus on the hierarchical level for stakeholder identification, recommending that interviews with the stakeholders along the hierarchical level must be conducted to elicit their perspectives.

Open ended interviews that could probe details of minor assumptions associated with the workflows of system-to-be are the best way to capture stakeholder's perspectives. Analyzing strategic documents of system-to-be is also a useful way to capture stakeholders' perspectives, which helps to understand that how the system-to-be is perceived to accomplish stakeholder's concerns. Another way to identify stakeholder's perspectives is to use a matrix which includes core functionality of system-to-be and space for the stakeholders to fill in how they perceive the particular functionality system-to-be. Although requirement elicitation is one more of a formal way to identify stakeholder's perspectives, however it is not sufficient since it focuses on system functionality rather than stakeholder's understanding of system functionality. Since there are stakeholder's perspectives in terms of assumptions associated with the requirements which are not explicitly stated and thus are not mentioned in system requirements.

Thus stakeholders' perspectives can be identified by;

1. Identify the stakeholders along the hierarchical level who have power and influence over the software project.

2. Conduct open ended interviews with the stakeholders to know how they for see the system-to-be.
3. Use a matrix or questionnaire enlisting the core functionality of the software requiring the stakeholders to fill in their perspectives regarding the software functionality.

3.2.2 Derive project objective and goals

Once stakeholder's perspectives are elicited the project objective is developed e.g. in case of strategic support which particular strategic area is of primary concern for the system-to-be? Or which specific software product's market is to compete in case of a commercial product or which sort of machinery or hard system control / support the system-to-be will deliver? The project objective along with stakeholder's perspectives derives project specific goals expressed in terms of the implementation methodology of system-to-be. Goals help to formulate stakeholder's perspectives such that all stakeholder's perspectives are summarized and expressed by project goals.

There are several goal based approaches that helps to identify goals e.g. GQM [Basili, 1993] identifies goals by establishing context from a *pre study* which considers preconditions and constraints, strategic objectives of the company, characteristics of organization, market and product, identification of goals is then based on the context established by the *pre study*. NFR Framework [Chung & Nixon, 1994] identifies non functional goals such as Security refined into accuracy, confidentiality and availability, Performance decomposed into time and space. GBRAM (Goal based requirement analysis method) [Anton & Potts, 1998] recommends to look for the verbs to extract goals from policy documents and interviews. Goal-Scenario Coupling (GSC) [Rolland et. al. 1998] discovers goals via scenarios such that it looks for the verbs. AGORA [Kaiya et. al. 2002] identifies goals by focusing on the needs of the customers stated in terms of initial goals and then further refined into sub goals. What, why and how questions can also help to identify goals [Letier & Lamsweerde, 2002], Goal oriented idea generation method (GOIG) [Kazuya et. al. 2003] places customer needs at the root of the goal graph and then discusses with the stakeholders to refine and decompose these goals. Visual Variability Analysis (VVA) [Baixauli et. al. 2004] uses two goal models, functional and

soft goal model, where functional goal model concerns the functions that system will perform whereas soft goal model presents the conditions and criteria for the system. The VVA approach provides visualization of goals via two models but there is no explicit steps for goal identification. GSTH [Regev & A. Wegmann, 2005] identifies goals by understanding stakeholders' problems and negating them, extracting intentional statements from; interview transcripts, enterprise policies, enterprise mission statements, enterprise goals, workflow diagrams, scenarios written with stakeholders, asking how and why questions about these initially identified goals. The process for Goal oriented requirement engineering (GORE) [Anwer, Ikram, 2008] emphasizes on high and low level goals such that high level goals are the goals that concerns with the quality of the survival of organization, these high level goals are refined to lower level goals.

Thus goal identification can be done by;

1. Analyze the organizational high level goals and objectives e.g. enterprise objectives.
2. Identify verbs and intentional statements from the project documentation, interview transcripts, business policies & strategies etc.
3. State customer needs in terms of goals.
4. Asking what, why and how questions.

3.2.3 Develop risk expression in terms of goal stakes

The goal stakes addresses the risk associated with a particular goal that could impede in its achievement. Goal stakes actually carries risk expression for the system-to-be developed by determining the potential threats towards the accomplishment of project objective and goals. The goal stakes in the proposed process however presents an abstract statement, which is further elaborated into risk factors by identifying the risk factors influencing the project goals.

Risk identification, assessment and evaluation is carried out in context of goals.

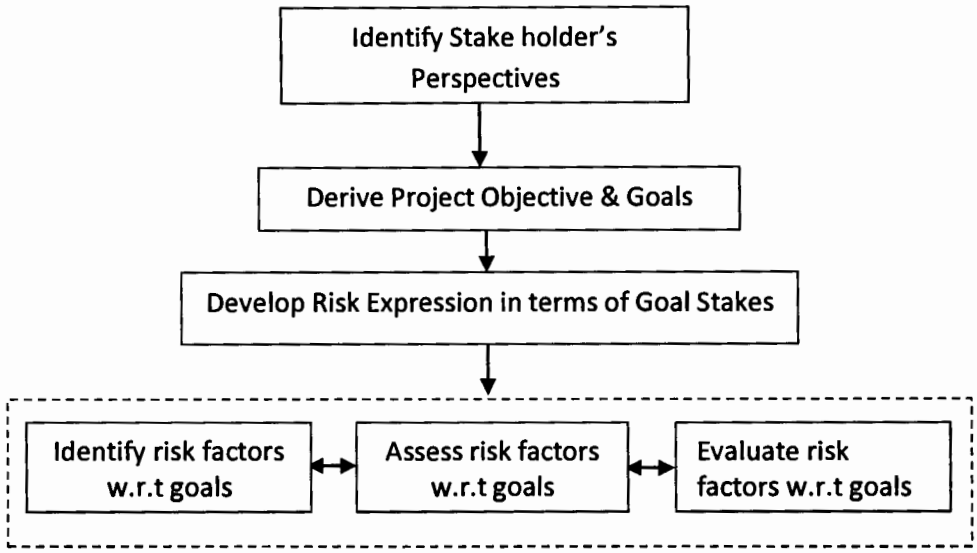
Risk Identification in context of goals provides a different risk interpretation. For example consider a goal "*Re-engineer manual business process to increase*

organizational efficiency" Now risk can be identified by considering the goal negations e.g. what factors can bring inefficiency and inconsistency within the business process obstructing to accomplish the goal? Misconceptions in workflows of business process, data inaccessible due to server down, delayed verification of misstatements etc are the potential risks influencing the above mentioned goal.

Risk Assessment in context of goals explores the relationship of project goals and risks for example it highlights the particular risks that are subject to a project goal. The Risk assessment requires a goal graph, developed by the goal identified earlier, onto which the potential risks influencing the particular goals can be listed.

Risk evaluation then depends on the criticality of goal which means that if the goal is very critical the risks influencing that particular goal are likely to be high as well. The risk can be evaluated along very high, high, medium, low, ignore.

The project goals are refined and elaborated along the development of system as the time line shown in figure 1 which signifies that the project goals and so are the other process activities are iterated along the system development. For example in case of system being developed in the domain of information system the main project goal of the analysis phase is to identify the accurate workflows of the business process then during development activity the goal is to operational-ize the identified goals by programming and within testing phase the goal is to ensure that operational version of software does conforms and aligned to the project goals identified in the early analysis phase. It depends on the person who implements the process whether to iterate the process monthly or more frequently. The process can be iterated according to the software process model being followed e.g. in case of RUP the process can be carried out during inception then during elaboration and so on.



Project lifetime

t_0 Analysis Phase t_1 Implementation Phase t_2.....

Figure 1: Proposed process for Goal based risk management

Represents the process activity

Groups similar process activities

Represents the transition between the process activity

3.3 Impact of goal based risk management on risk identification, assessment and evaluation

As discussed earlier that risk identification is carried out mainly via checklists and most of the risk factors focus on schedule, cost and performance issues. The risk expression in terms of goal stakes actually introduces a different notion of risk. The proposed process claims to encompass stakeholder's concerns defined in terms of goals. The *support failure theory* [Sauer, 1993] emphasize on the fact that when stakeholders foresee that the software under development does not sufficiently address their concerns or goals they

withdraw their support. Thus to indulge and commit the support of stakeholders it is important to identify and safeguard their goals. The study [Wallace & Keil, 2004] recommends that better understanding of risk influences project outcome that would result into decrease rate of project failures. Goals provide one way towards the better understanding of project risk since they present a different interpretation for risk factors in context of goals. The assessment of risk factors requires tracing them to project goals. Evaluation is then based on criticality of goals. As discussed in Chapter 2 that multiple perspectives exist regarding the same software. These perspectives are critical to bridge the gap between requirements and project goals. Due to the fact that project manager is more concerned to build a right product whereas project team is concerned to implement the product rightly e.g. adhere to signed off functionality. This results into incorporation of assumptions or misconceptions in implementation. Such assumptions or misconceptions than creates critical issues in compliance of software services. The proposed process aims to capture stakeholder's perspectives in terms of goals and aids risk identification, assessment and evaluation to analyze the critical nature of risk.

Chapter 4 Validation

The proposed process for risk management was validated via case study. Case study was selected as a validation method because this method provided project goals from real world scenario which could not be possible in case of a contrived or experimental study. The following section gives an introduction to the research design followed by details on selected case, data collection procedures and results of implementing the proposed process.

4.1 Research Design

A brief research design is described in the following table;

Research Method	**Case Study**
Type	Exploratory
Objective	Explore the impact of simple risk expression and goal based risk expression on Risk Identification, Risk Assessment and Risk Evaluation
Case	Two cases of in house software will be selected, One with goal based risk expression and other with simple risk expression.
Unit of analysis	Risk management approach
Subject	Success Critical Stakeholders
Object	Software development project
Data points	1. Project goals 2. Risks factors 3. Project cost, schedule and performance
Data collection Methods	Interviews (Preferably unstructured interview), Document Analysis, Artifact Analysis, Risk Catalogues and observations.

Table 2: Research Design

4.1.1 Introduction to the Case

The case selected was in-house software (software being developed within the organization) for an Enterprise Resource Planning (ERP) application and was being developed by the project team from a software house particularly specialized in providing ERP solution. Two projects were selected for case study. Project 1 was completed and has been implemented for the last three years in Company A. Whereas Project 2 is in progress (with one module completed). Both projects were implemented within Accelerated System Application Product (ASAP) methodology. These projects are part of several reform projects currently being carried out within the Company A. In house software was selected for the case study to capture/explore goals which are different as compared to industrial or commercial product, different in the sense that the goals of such software are to support or assist in particular business processes of a company. Commercial products however have goals such as to compete the market and earn profit etc. Similarly industrial product tends to establish some control over hard systems and encompasses goals that are critical in real time domain.

4.2 Data collection procedures

Data was collected from multiple sources to ensure data triangulation which helped to gather multiple perspectives/ concerns of various stakeholders from the system-to-be. Data collection mainly included open ended interviews and close-ended questionnaire/checklists, along with on-site observation. Policy document of Company A and project documentations were analyzed.

4.2.1 Interviews

The stakeholders interviewed were *Project team, member of client's steering committee and manager infrastructure.* Interviews helped to collect initial data regarding the project and probing further details. Semi-structured interviews were conducted to extract the common issues/problems in customization/development and its implementation in

Company A. Interviews with stakeholders regarding the reform projects within Company A and particularly about project 2 were conducted.

4.2.2 Questionnaires/Checklists

First questionnaire addressed the general issues regarding project team and implementation methodology followed by a checklist of general risk factors. The third questionnaire addressed domain specific errors/ problems in customization/development. The final questionnaire aims to determine impact of goals onto risk factors. The questionnaire and checklists are enclosed in the appendix.

4.2.3 Documents

Project documentation was analyzed for general understanding of process workflows. Strategic document with general details of Company A were studied for further exploration of project goals.

The configured application was analyzed alongside as well.

4.3 Background of Company A

Company A is a government sector organization, it plays a role of planning division or head quarter over regional offices across the country. Currently there are number of reform projects in progress within Company A. The goal graph of Company A is listed in figure 2. The enterprise goal of the Company A is to ensure the implementation of fiscal policy. Company A works with the collaboration of other government sector organizations. Company A was regarded as autonomous body in 2003, which introduced number of reform projects to improve the function of Company A.

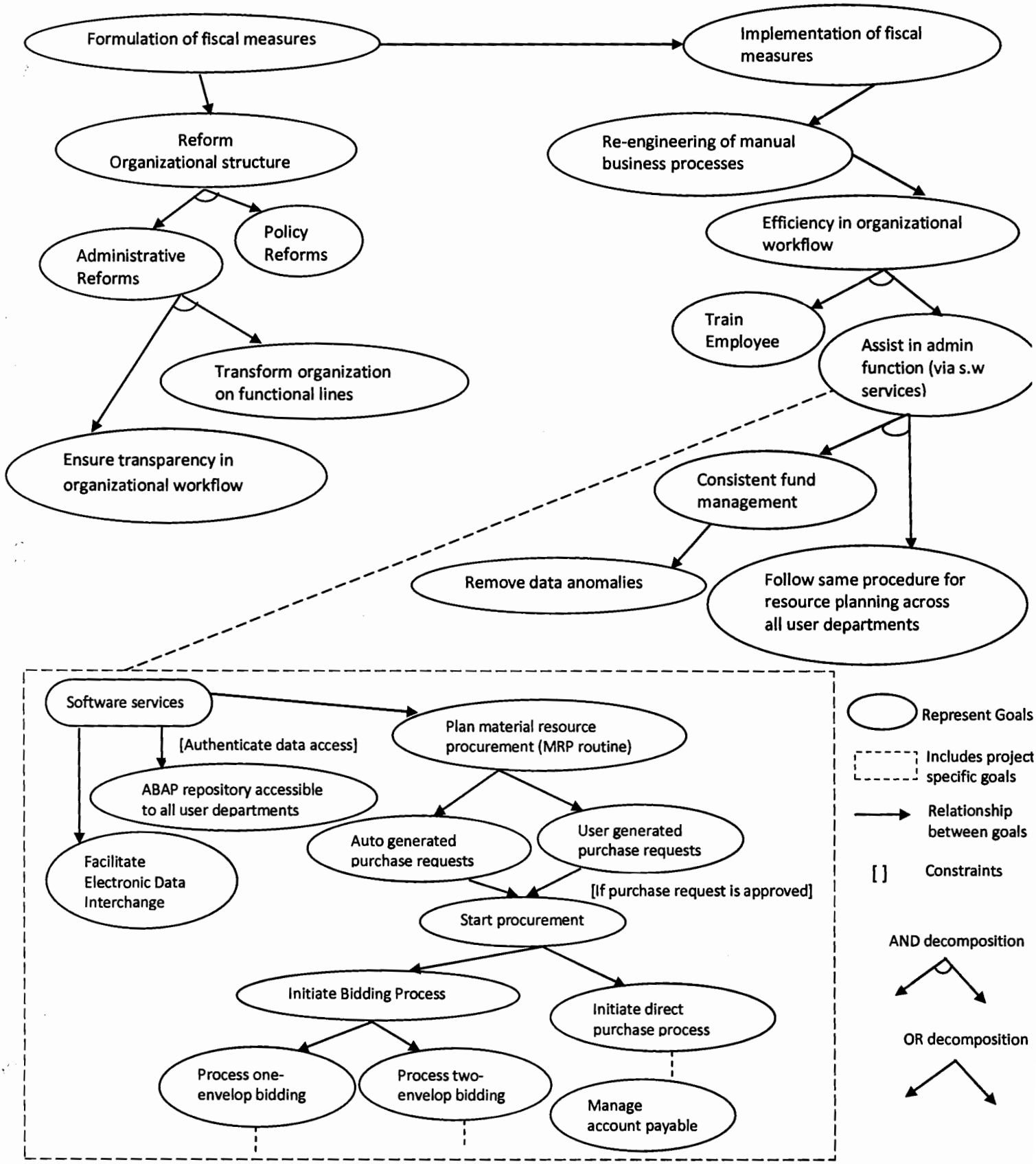
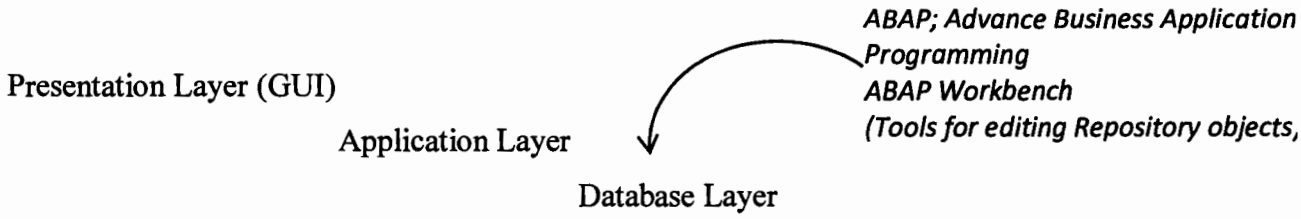


Figure 2: Goal graph of Company A

4.4 Implementation methodology

System Application and Product (SAP) was used for the implementation of ERP system in Company A. SAP has provided an integration and standardization of data model facilitating linking and coordination across separate functional units in organization [Schneider-Neureither, 2004] Accelerated SAP (ASAP) provides a framework for customization/development of SAP applications. Figure 3, shows the layers and the working of SAP.



SAP basis (low level to high level operating system services) & SAP Kernel (memory management, database communication or servicing web requests to end-user and admin tools)

Figure 3: Overview of SAP systems

Enterprise Resource Planning encompasses mainly three SAP modules financial management (general ledger, account payable, account receivable, asset accounting, leased assets, special purpose ledgers, legacy consolidation, financial accounting, information system etc), material management (procurement, inventory management, material planning, vendor evaluation, invoice verification, warehouse management, logistic information system, consumption-based planning) and human resource management [Khan, 2002]

Beside above mentioned functionalities application configured in SAP via ASAP also includes project control & basis component (ABAP/4 development workbench, computing center management system, multiple system utilities, user management & authorization, transport system, client management, data archiving, printer management and output control) [Khan, 2002]

4.5 Unit of analysis

The unit of analysis for the case study was risk management practice. Risk management practice relies on ASAP tools such as project estimator, risk assessment tool, and configuration conflicts for tracking and monitoring risks. However effective risk management is highly dependent on the project management expertise e.g. how the project manager addresses all risk underlying the project and ensures a minimized impact of risk onto the project.

The project manager has a seven years experience of managing the implementation of SAP projects.

4.6 Object

Two software projects were selected for case study. The following section provides detail on projects' functionality.

4.6.1 Project 1

Main SAP modules implemented by Project 1 are financial management and human resource management with a partial implementation of material management module. Project 1 has been successfully implemented across 117 site offices with about 3144 users. Key functionality provided by project 1 is to calculate budget for Company A and establishment of budget control on the transactions of Company A within financial management module. Human resource management module included Income tax deductions, pension/loans, general provident funds advance / off cycle payment for 2 million employees.

As mentioned in the earlier section that Company A works with the collaboration of other government sector organizations. Since enterprise objective is to establish and implement fiscal measures therefore it works closely with Ministry XYZ and government bank. The control of Company A is expanded till regional offices across the country. The regional finance departments operates under Company A. The regional offices govern the

controller general of accounts offices which are subdivided into sub offices and district offices. Thus the scope of project 1 spans from Company A to district offices.

4.6.2 Project 2

Main SAP modules implemented by Project 1 are financial management and material management. The customization/development of material management module has been completed whereas financial management module (general ledger, accounts payable, asset accounting, and funds management) is in progress. The material management module consists of processes for inventory purchasing and management, an automated routine for material resource planning (MRP), vendor management.

The scope of project 2 spans from Company A to regional finance departments to Account general head office and sub offices.

4.7 Risk Expression in context of Project Schedule, Cost and Performance

4.7.1 Project Schedule

Schedule overrun of 10 to 11 months were elapsed in project 1 due to business process reengineering. Project 2 suffered a schedule delay of 39 days in the initial analysis phase and 33 days in the realization phase of material management module. Project schedule was regarded as critical factor however not as a risk factor since goals such as to capture accurate business workflow to ensure strategic compliance of software services was of higher priority and schedule slippage against such goals were reported as acceptable.

4.7.2 Project Cost

Though schedule slippage involves cost slippage, however major cost overruns have been reported due to change requests. Change request is approved from change management procedure, in case of changes for additional user requirements or requirements that are not specified in earlier phase the client has to pay extra cost to address the changes. Change requests originates due to certain goals that resurface lately e.g. goals regarding

usage of software services. Change requests for project1 were *changes in reporting format, rounding off currency amounts, changes in workflow of payroll process.* Thus when stakeholders can accomplish their goals via software services, they are ready to pay for additional requirements even if it incurs cost.

4.7.3 Performance

As long as clients foresee that the software accomplishes their goals, schedule and cost overruns are compromised. In fact to optimize the system performance further changes are negotiated. However performance pitfalls are not acceptable by stakeholders as compared to schedule and cost overruns due to the fact that client assume such overruns would incur performance in the system-to-be resulting into an efficient solution.

4.8 Observation note

A change request was originated by bank to r*ound off currency after each transaction.* A conflict in project scope resulted from the change request and the claimed changes were accommodated without cost. This scenario presents *multiple perspectives* of stakeholders regarding same functionality implemented at various sites. It is obvious from the above example that one set of user community was satisfied from the functionality while other was not. Also the workflow discussed earlier among the project team and client does not explicitly included *round off* step. Project team assumed that functionality has been accurately implemented, acceptance testing approved the workflow however one set of user community was not satisfied.

4.9 Validation of proposed process

This section reports the experience on the implementation of the proposed process.

4.9.1 Identifying Stakeholders' perspectives

The first step of the proposed process is to determine stakeholders' perspectives. The following section lists the stakeholders' perspectives captured via interviews and document analysis.

4.9.1.2 Interview notes

This section reports the stakeholders' perspectives regarding the project 2 of Company A.

4.9.1.2.1 Interview note 1 (member of steering committee)

Client correspondent reported that Company A opt for process optimization, and is keen on accurate financial reporting so that at any time period of x, Company A or Ministry XYZ can inquire the financial position of the Company A, the transactions made in past, the resources procured and allocated etc.

4.9.1.2.2 Interview note 2 (manager infrastructure)

Before the development and implementation of the current projects the Company A had a software application for financial management but it turned out to be not sufficient enough when Company A was regarded as an autonomous body governing all the regional offices country wide. Currently there are number of software projects some completed and successfully implemented (e.g. Project1) whereas some are still in progress (e.g. Project 2)

4.9.1.2.3 Interview note 3 (project team)

Although ASAP methodology rely on tools to configure and develop SAP application, but much of the work is based on project manager's experience e.g. schedule slippage has been reported as somewhat normal as long as it contributes in requirement elaboration and validation in the initial phase of project or in later phases (realization or testing)

Schedule overruns however incurs cost and are not favorable unless they present a well defined opportunity as for example business process reengineering. Same is the case with cost slippage, major cost overrun apart from schedule overruns are from change requests. Employee turnover is another reason of schedule and cost drifts which introduces problems in understanding of domain and configured application. However in this particular case study no turnover was reported.

4.9.1.3 Document analysis

The policy documents of Company A provided detail on reform projects in Company A. The document included the fact that bidding process of the Company A has been changed from one envelop to two envelop in order to facilitate the bidding process for technical projects so that technical specifications can be enclosed separately.

4.9.2Derive Project objective and goals

The goal graph listed in figure 2 depicts the goals for Company A. The objective of project 2 is to *optimize planning and resource usage of organization,* whereas the achievement goals are *Efficiency in organizational workflow, Implementation of fiscal measures.* The goal stakes at highest level of abstraction is *ineffective re-engineering of manual process due to inaccurate customization/development of organizational workflow.*

The next section describes the risk expression in context of project goals and figure 4 presents risk assessment by listing goals and goal stakes. The rectangles within the figure 4 represent the risk factors. The lines connecting the goals are represented as dashed and hard coded, the dashed lines are used where some of the interlinked goals (present in figure 2) are not represented.

4.10 Risk expression in terms of Goals

The identified risk factors are listed as Goal Stakes in the following sections;

4.10.1. Strategic factors

Goals: Implementation of fiscal measures, Re-engineering of manual processes

Goal Stakes: *Strategically compliance of the services provided by the software are critical e.g. to assist in admin tasks the workflow of the organizational processes must be accurately customized/developed within the software. Accurate customization of workflows is obstructed by problems in requirement communication and elaboration from client and misconceptions, assumptions in customization.*

4.10.2. Human factor

Goals: Implementation of fiscal measures, Re-engineering of manual processes, Efficiency in organizational workflow, Train Employee

Goal Stakes: *End-user involvement and cooperation is critical for skillfully using the software in order to achieve efficiency in organization. Skillfully/efficient use of software depends on end-user involvement as well as how the software is customized to perform efficiently.*

4.10.3. Customization/development errors

Goals: Re-engineering of manual processes, Efficiency in organizational workflow, Assist in admin functions (via software services), Consistent fund management, Follow same procedure for material planning, Remove data anomalies

Goal Stakes: *Misstatements, delayed verification of misstatements, incomplete/inaccurate transactions, errors in batch mode processing, transactions posted onto wrong files/ledgers influence the data integrity obstructing to accomplish the goal 'Remove data anomalies' Secure access is subject to obstruction such as insufficiently configured data access rights, unauthorized program modifications. In case of data inaccessible to user departments decision making activities will be influenced since all decision making*

activities rely on data stored in central repository available to all user department such delays impact the efficiency of organization.

4.10.4 Open Issues (political impact)

Goals: Administrative reforms, Ensure transparency in organizational workflow

Goal Stakes: The appeals of potential clients of Company A for discounts/concessions have always been a cause for budget deficit. To avoid such situations Company A has enforced policies, laws and litigation but before legal prosecution, cases are processed by Company A's chairperson with the collaboration of a government authority and then proceeded for legal prosecution. Politically influencing parties can easily postpone their case appeals resulting into a gap of returns and recovery of Company A's budget. Workflows in beurucratic domain have always been subject to other issues (political canvassing), automation is just one way to assist admin functions and achieve efficiency in organizational workflow as it facilitates record keeping via central repository however the goal to *ensure transparency in organizational workflow* are subject to stakes of issues like political canvassing.

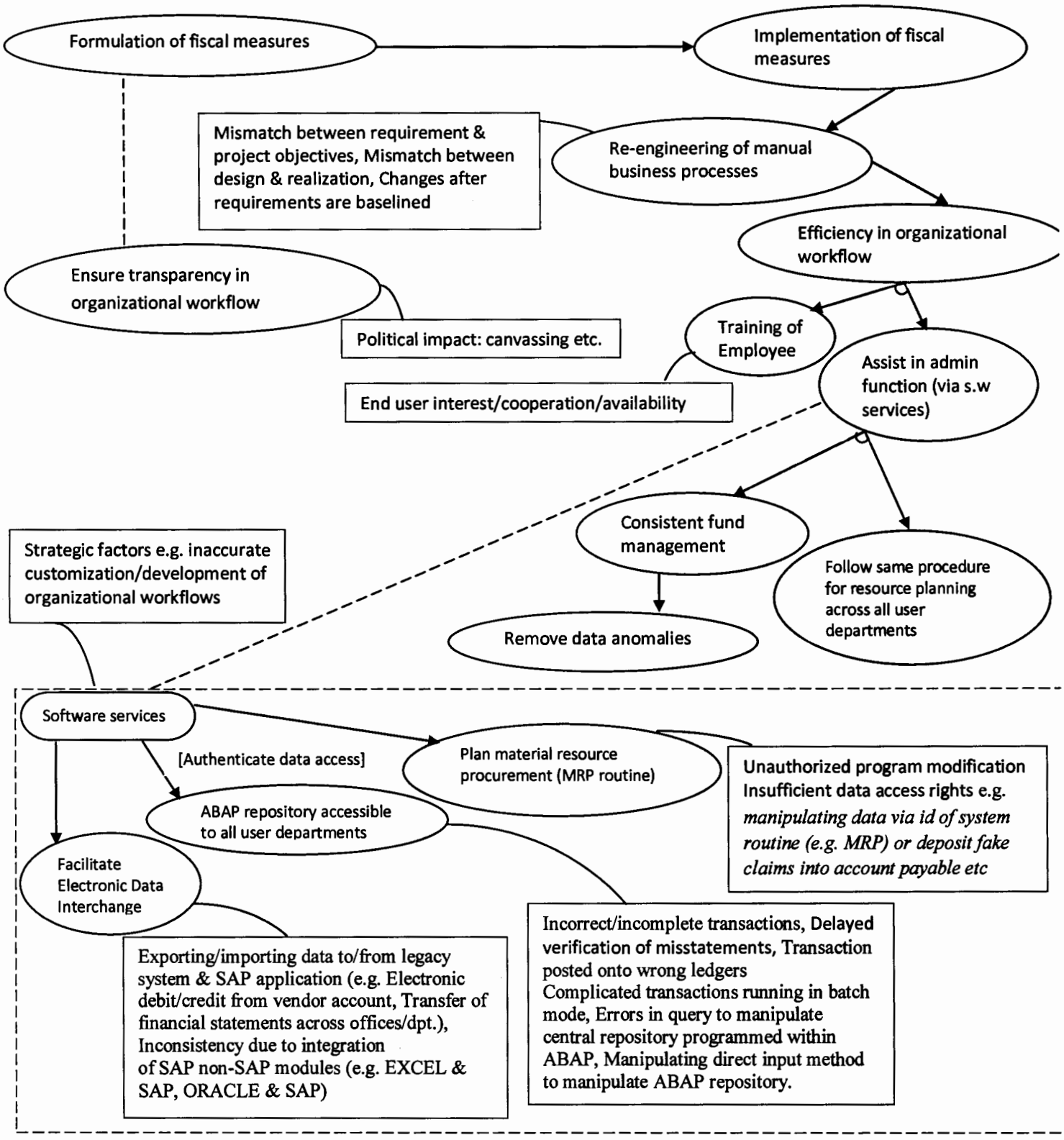


Figure 4: Goal stakes in context of project goals

4.11 Impact of Goals on Risk management

This section discusses the impact of goals onto risk identification, risk assessment and risk evaluation.

4.11.1 Risk Identification

Risk interpretation has presented a different perspective of risk factor, e.g. strategic compliance of services provided by system-to-be compared to risk factors such as Requirement communication an elaboration, domain knowledge, client's cooperation. The section 4.10 presented the risk factors with context of goals.

4.11.2 Risk Assessment

The context of goals for risk factors explores relationship between goals and risk factors (listed in figure 4), this helps in capturing links, and dependencies of risks onto goals.

4.11.3 Risk Evaluation

Influence of risks on goals aids to identify the criticality of risk factor e.g. strategic compliance of services provided by system was ranked as very high. However the risk factors (Requirement communication & elaboration, domain knowledge, client's cooperation) individually without context of goals ranked as high. The factor assumptions/misconception in customization/development was ranked as medium in context of goals whereas individual ranking was high. Errors/ misstatements by end user was reported as medium without goal context but was evaluated to be high in context of goals.

4.12 Comparison between goal based & non-goal risk expression

This section highlights the difference between the risk factors of project1 and project 2. The process for goal based risk management was implemented for project 2.

4.12.1 Risk factors of project 1

Risk factors of project1 were reported as follows;

- Functional Specifications
- System Architecture
- Geographical Challenges
- Change Management
- Site Infrastructure development
- Changes in system design
- Training

4.12.1.2 Functional specification

Schedule overrun of 10 to 11 months were elapsed in project 1 due to Business process reengineering. The core functionality of project1 was related to SAP Financial and HR, since this was the very first SAP implementation in Company A, the project team had difficulties regarding requirement communication and client's availability for requirement elaboration etc.

4.12.1.3 System Architecture

Due to the large scope of system (117 sites) and misconceptions within the analysis phase the baseline system configuration suffered from problems and required some rework in later phases

4.12.1.4 Geographical challenges

Geographical challenges mainly involved timely availability of data across 117 sites. Since data availability is subject to network server configuration as well as server availability (e.g. in case of heavy volume transactions running in batch mode the responses to the queries would either be delayed or not addressed)

4.12.1.5 Change Management

Change requests for project1 were reported as; *changes in reporting, rounding off currency amounts, changes in workflow of payroll process, round off currency after each transaction.* Such changes acquired rework of already developed system and scope conflict (in case of currency round off)

4.12.1.6 Changes in system design

System design suffered from changes due to change requests and problems in system architecture.

4.12.1.7 Site Infrastructure development

Site infrastructure development mainly involved server configuration and data access rights, since this was the first SAP implementation in Company A, therefore the implementation required revising work roles and responsibilities of workforce within company A.

4.12.1.8 Training

The senior employees within Company A who were not as such accustomed of using automated file systems posed problems to get used to the changes in the organizational workflow due to automation. Lack of interest and availability of end-users in training sessions caused problem in efficient usage of software services.

4.12.2 Risk factors of project 1 vs. Risk factors of project 2

The factor *strategically compliance of system-to-be services* carried more concrete risk interpretation as compared to functional specification. The factors *mismatch between project objective and requirements, mismatch between design and realization* coincides with the system architecture and changes in system design factor. And *lack of control on project scope, changes once requirements are baseline, client satisfaction* overlaps with the change management factors. *End user satisfaction/cooperation and interest in*

training contributes towards training risk. Thus there is no major difference in identification of risk factors. However the risk interpretation in context of goals presents a concrete picture (figure 4) by presenting dimensions of risk in terms of goals.

4.13 Limitation

Data was gathered via interviews and checklists. No manipulation was done on the reported data. Data triangulation was ensured by studying the policy documents of Company A, along with the project documentation. Apart from discussion with project team, the strategic issues were also discussed with the client community, to ensure the validity of goals and stakes that were identified. The risk checklists marked by project manager was however given the highest weight age due to his experience. The study intended to explore relationship between project goals and risk factors (as depicted in figure 4), but the case study is limited till the customization/development of one module. Therefore the relationships between project goals and risk factors are not completely captured.

4.14 Discussion and Analysis

Since *Terminal goals assigned to agents in the software-to-be become requirements* [Letier & Lamsweerde, 2002] therefore Requirements specifies goals of system-to-be at least abstraction level. Requirement related risks were evaluated to be very high whereas risks related to customization/development of system-to-be were evaluated as medium or low. One reason of such evaluation is that project team (to some extent) has control over customization/development pitfalls, much of the errors or problems that are likely to pose risk within the operational version of system-to-be are removed by technical reviews and testing. On the other hand requirement related risks are critical e.g. if requirements are elaborated differently and workflow is implemented within the system-to-be then strategic compliance of services provided by system-to-be would be at stake.

Network availability presents critical risk, as for large applications (e.g. in this particular case the scope of system-to-be is across 50 site offices of Company A) network availability or server down time results in data inaccessibility (influencing organization's efficiency) and incomplete transaction (influencing data integrity).

Training related risks were also evaluated to be very high due to the fact that efficient usage of system-to-be depends on two aspects 1) system is effectively customized/developed 2) end-users are educated and trained to utilize the system. For example not knowing how to use MS-OFFICE does not necessarily means that it is inappropriately developed. This is the reason that end user cooperation and interest is very critical risk factor.

Political impact (issues like political canvassing) is beyond the scope for project team, also on the behalf of project team, they do not foresee such risks and even if they do possibly occur, the team is not concerned about it since their part is to develop the system and provide technical services. In case of any manipulation in services of system-to-be by executives or directors of Company A, there are no steps/procedures to address such manipulations other than external audits. But as discussed earlier, the workflows in beurucratic domain have always been subject to such risks.

Goal based risk management presented a different risk interpretation e.g. strategic compliance of services provided by system-to-be compared to risk factors such as requirement communication and elaboration, domain knowledge, client's cooperation. This helps to identify the stakes contributing towards organizational goals exploring how organizational goals tend to be operationalized via services of system-to-be. The goals are presented at various level of abstraction (figure 4) and the stakes towards these goals are listed along side. In this particular case the goal of the system-to-be is process optimization, now how does the stakeholders define optimization of business process is it associated with the customization/development of system-to-be only or does the optimization is dependent on other goals such as training of employees to improve skills of workforce, assist in admin functions, transparency in organizational workflow etc. This implies that risk expression requires addressing issues beyond cost, schedule and performance.

Chapter 5: Conclusion

This chapter highlights the contribution of the thesis, summary of the findings and the future work along this direction.

5.1 Contribution

Risk management activities (mainly identification, assessment and evaluation) are approached differently by project managers as per their experiences. The widely used approaches for risk identification are checklist based or expert judgment. Risk assessment is also carried out either by expert judgment, risk metrics or by probabilistic weights assigned to individual risk factors.

The major contribution of this thesis includes: firstly the research explores whether cost, schedule and performance are the only goals for software project? Secondly a proposed process for goal based risk management which aids in identifying risk in context of project goals and tracing the identified risks to project goals. Since schedule, budget and performance issues are critical but the risk is regarded as those factors that are at stake due to schedule, budget and performance issues.

Schedule, cost and performance issues are reported as to be critical however schedule slippage is acceptable due to the fact that such schedule slippage contributes towards some higher priority goals e.g. to capture accurate business workflow to ensure strategic compliance. The main reasons for such schedule slippage were lack of client cooperation and availability to elaborate the aspects of system-to-be that required business process reengineering. Although schedule slippage do incur cost but the major reason for cost overrun was reported as change requests that were originated after requirements were signed off. As long as clients foresee that system-to-be accomplishes their goals schedule and cost overruns are compromised, in fact to optimize the system performance further changes are negotiated with the goal of enhancing system performance. However performance pitfalls are not acceptable compare to schedule and cost overruns due to the fact that client assume such overruns would improve performance of the system.

The proposed process focuses on exploring risk factors in dimensions of project goals. The validation of the process resulted in a concrete interpretation of risk factors in context of goals. However there was no major difference reported in the individual risk factor identification. Risk assessment is carried out by tracing risk factors to the project goals. Risk factors when explored with respect to project goals resulted into a different risk evaluation. Thus goals presented a broader view of risk expression. For example re-engineering of manual business process, efficiency in organizational workflow, transparency in organizational workflow, and assist in admin tasks are the goals that system services intends to deliver. However the particular stakes identified towards these goals are strategic compliance of system-to-be for the goal of re-engineering of manual business process, efficiency in organizational workflow is subject to user interest and availability in training and the goal of transparency in organizational workflow is subject to political impact.

5.2 Future Work

This thesis evaluated the process for goal based risk management in the domain of enterprise resource planning. Therefore further exploration of goals and their stakes especially in domain other than enterprise resource planning can further assess the effectiveness of the proposed approach. The limitations of the case study highlighted in section 4.13 emphasizes on the issue that it is limited till the customization/development of one module. Therefore there is a chance that relationships between project goals and risk factors are not completely captured. Further evaluation of the proposed process requires assessing project goals and goal stakes of other modules as well.

References

[Anton & Potts, 1998] Anton A.I. and Potts C., (1998) **The Use of Goals to Surface Requirements for Evolving Systems,** *20th International Conference on Software Engineering, Kyoto*

[Addison & Vallabh, 2002] Addison T., Vallabh S., (2002) **Controlling Software Project Risks – an Empirical Study of Methods used by Experienced Project Managers** *Proceedings of SAICSIT, pp. 128–140*

[Khan, 2002] Khan A., 2002 BOOK: **Implementing SAP with ASAP methodology focus**

[Anwer & Ikram, 2006] Anwer S., Ikram N., (2006) **Goal Oriented Requirement Engineering: A Critical Study of Techniques** *XIII Asia Pacific Software Engineering Conference (APSEC'06) 2006, IEEE*

[Barati & Mohammadi, 2008] Barati S ., Mohammadi S., (2008). **Enhancing Risk Management with an Efficient Risk Identification Approach** *Proceedings of the 2008 IEEE ICMIT*

[Ballejos & Montagna, 2008] Ballejos L. C. & Montagna J. M. (2008) **Method for stakeholder identification in inter-organizational Environments** *Requirements Eng (2008), Springer Verlag London Limited.*

[Bannerman, 2008] Bannerman P.L (2008) **Risk and risk management in software projects: A reassessment** *The Journal of Systems and Software vol.81, pp 2118-2133*

[Bryson, 1995] Bryson J. M. (1995) Book: **Strategic Planning for Public and Nonprofit Organizations Revised Edition**. *San Francisco CA: Jossey-Bass.*

[Bryson 2003] Bryson J. M. (2003) **What to do when stakeholders matter: A guide to stakeholder identification and analysis techniques** *A paper presented at the National Public Management Research Conference, October 2003,*

[Boehm, 1991] Boehm B, (1991) **Software Risk Management: Principles and Practices.** *IEEE Software vol. 8, pp.32-41*

[Boehm, 2000] Boehm B, (2000) **Project termination doesn't equal project failure** *Software Management, Computer vol. 33, pp. 94-96*

[Barki et. al. 1993] Barki H., Rivard S., Talbot J., (1993) **Toward an assessment of software development risk,** *Journal of Management Information Systems vol.10, pp. 203-225*

[Brooks, Jr., 1975] Brooks F. P, (1975) **The Mythical Man Month** *Addison-Wesley Daramarion pp. 44-52*

[Basili, 1993] Basili V. R., (1993) **Applying the Goal/Question/Metrics Paradigm in the Experience Factory** *The paper presented in 10th Annual CSR Workshop, Oct 1993.*

[Bubenko et. al. 1994] Bubenko J., Rolland C., Loucopoulos P., & DeAntonellis V., **Facilitating 'Fuzzy to Formal' Requirements Modeling** (1994) *The paper appeared in the proceedings of IEEE International Conference on Requirements Engineering, Colorado, April 1994.*

[Charette, 1996] Charette R. N., (1996) **Large scale project management is risk management,** *IEEE Software, pp. 110–117*

[Charette 2006] Charette R. N., (2006) **Why software Fails** *IEEE Spectrum vol. 42, pp. 42-49*

[Chung & Nixon, 1995] Chung L, Nixon B. A., (1995) **Dealing with non functional requirements: three experimental studies of process-oriented approaches.** *In Proceedings of the Seventeenth International Conference on Software Engineering pp. 25-37*

[Davis, 1995] Davis P.B., (1995) **Information Systems `Failure' and Risk Assesment: The Case of London Ambulance Service Computer Aided Despatch System** *Third European Conf. Information Systems, pp. 153-170, June 1995.*

[Eden & Ackermann, 1998] Eden,C. & Ackermann ,F. (1998). **Making Strategy: The Journey of Strategic Management London** *Sage Publications.*

[Fairly, 1994] Fairly R., (1994) **Risk Management for Software Projects,** *IEEE Software May 1994, pp. 57-67*

[Gibbs, 1994] Gibbs T., (1994) **Software's chronic crisis.** *Scientific American, vol. 271, pp. 86-95*

[Glass, 1999] Glass R. L., (1999) **Evolving a new theory of project success.** *Communications of the ACM November 1999 vol. 42, pp. 17-19*

[Howard, 2007] M. Howard, (2007) **Lessons learned from five years of building more secure software** *MSDN Magzine 2007*

[Higuera & Haimes, 1996] Higuera R. P., Haimes Y., (1996) **SEI Paradigm for Risk Management,** *Technical Report CMU/SEI-96-TR-012 ESC-TR-96-012 June 1996*

[Hu et. al, 2007] Yong H., Juhua C., Huang J., Liu M., Xie K., (2007) **Analyzing Software System Quality Risk Using Bayesian Belief Network,** *IEEE International Conference on Granular Computing 2007*

[ISO/IEC Guide 73:2002] **A Risk Management Standard ISO/IEC Guide 73:2002** *AIRMIC, ALARM, IRM: 2002*

[Josang et. al, 2004] Josang A., Bradley D., Knapskog S. J., (2004) **Belief-Based Risk Analysis** *The paper appeared at Australasian Information Security Workshop 2004 (AISW)*

[Javeria et. al, 2008] Javeria Samad, Naveed Ikram, Muhammad Usman **VRRM: A Value-Based Requirements' Risk Management Process** (2008) *Proceedings of the IASTED International Conference Software Engineering 2008 Innbrusk, Austria, pp. 184-191*

[Kaiya et. al. 2002] Kaiya H., Horai H., Saeki M., (2002) **AGORA: Attributed Goal-Oriented Requirements Analysis Method** *Proceedings of the IEEE Joint International Conference on Requirements Engineering, University of Essen, Germany, 2002.*

[Kavakli & Loucopolos, 2003] Kavakli E., Loucopoulos P. (2003) **Goal based Requirement Engineering: Evaluation of current methods** *EMMSAD'03*

[Kazuya et. al. 2003] Oshiro K., Watahiki K., Saeki M., (2003) **Goal-Oriented Idea Generation Method for Requirements Elicitation** Proceedings. *11th IEEE International Requirements Engineering Conference, California, 2003*

[Keil et. al. 1998] Keil M., Cule P. E., Lyytinen K., and Schmidt R. C., (1998) **A framework for identifying software risk,** *Communications of the ACM Vol. 41 pp. 76-83*

[Khoshgoftaar & Lanning, 1995] Khoshgaftar T. M., (1995) **A Neural Network Approach for Early Detection of Program Modules Having High Risk in the Maintenance Phase** *Journal of systems software vol. 29, pp. 85-91*

[Kwak & Stoddard, 2004] Kwak Y.H., Stoddard J., (2004) **Project risk management: lessons learned from software development environment.** *Elsevier Science Ltd. Technovation vol. 24, pp. 915–920.*

[Karolak, 1996] Karolak D.W, Book: **Software Engineering Risk Management,** *IEEE computer society press, 1996.*

[Bandyopadhyay et. al, 1999] Bandyopadhyay K., Mykytyn P., & Mykytyn K., (1999) **A framework for integrated risk management in information technology,** *Management Decision Management Decision 1999; vol. 37 pp.437-444*

[Kontio et. al. 2001] Kontio J., Freimut B., Hartkopf S., Kaiser P., Kobitzsch W., (2001) **An Industrial Case Study of Implementing Software Risk Management.** *Proceedings of the 8th European software engineering conference held jointly with 9th ACM SIGSOFT international symposium on Foundations of software engineering, 2001pp. 277-287*

[Keil, Tiwana & Bush, 2002] Keil M., Tiwana A., (2002) **Reconciling user and project manager perceptions of IT project risk: a Delphi study** *Information Systems Journal vol. 12, pp. 103–119*

[Lamsweerde, 2001] Lamsweerde A., (2001) **Goal oriented requirement engineering: A guided tour** *Proceedings RE'01, 5th IEEE International Symposium on Requirement Engineering, Toronto, August 2001*

[Letier & Lamsweerde, 2002] Letier E., Lamsweerde A., (2002) **Agent-Based Tactics for Goal-Oriented Requirements Elaboration**, *24th International Conference on Software Engineering, ACM Press, May 2002.*

[Little, 2006] Little T., (2006) **Schedule Estimation and uncertainty surrounding the cone of uncertainty** *Published by IEEE Computer society 2000, pp. 48-54*

[McConnell, 1996] McConnell S., **Rapid Development: Taming Wild Software Schedules,** *Microsoft Press, 1996.*

[McManus, 2004] McManus (2004), **A Stakeholder Perspective within Software Engineering Projects,** *International Engineering Management Conference 2004 IEEE.*

[Woolridge, McManus, & Hale, 2007] Woolridge R.W., McManus D. J., Hale J. E. (2007) **Stakeholder Risk Assessment: An Outcome-Based Approach.** *Published by the IEEE Computer Society, 2007 pp. 0740-7459*

[McManus, 2004] McManus J., (2004) **A stakeholder perspective within software engineering projects.** *International Engineering Management Conference 2004 IEEE.*

[Moynihan, 1997] Moynihan T., (1997) **How experienced project managers assess risk** *Software IEEE 1997*

[Odzaly et.al, 2009] Odzaly E.E, Greer D., Sage P. (2009) **Software Risk Management Barriers: an Empirical Study** *Third International Symposium on Empirical Software Engineering and Measurement* IEEE

[Parent & Deephouse, 2007] Parent M., Deephouse L., (2007) **A Case Study of Stakeholder Identification and Prioritization by Managers,** *Journal of Business Ethics (2007) vol. 75 pp.1–23 Springer.*

[Preiss & Wegmann 2009] Preiss O., Wegmann A., (2009) **Stakeholder's Discovery and Classification based on System Science Principles,** *2001 IEEE.*

[Pfleeger, 2000] Pfleeger S.L., (2000) **Risky business: what we have yet to learn about risk management.** *The Journal of Systems and Software vol. 53, pp. 265-273*

[Preiss & Wegmann, 2009] Otto Preiss and Alain Wegmann (2009) **Stakeholder's Discovery and Classification based on System Science Principles,**

[Pressman, 2005] Pressman R., (2005) BOOK: **Software Engineering - A practitioner's approach** (6th Edition), McGraw-Hill, New York

[Procaccino, Verner & Lorenzet, 2006] Procaccino J. D., Verner J. M., and Lorenzet S. J., (2006) **Defining and Contributing to Software Development Success** *COMMUNICATIONS OF THE ACM August 2006 vol. 49, page no. 79-83*

[Roy, 2004] Roy G., (2004). **A Risk Management Framework for Software Engineering Practice** *Proceedings of the 2004 Australian Software Engineering Conference (ASWEC'04) 2004 IEEE*

[Ropponen & Lyytinen, 2000] Ropponen, J., Lyytinen, K., (2000). **Components of software development risk: how to address them? A project manager survey** *IEEE Transactions on Software Development, vol. 26 pp. 98-112*

[Rodrigues & Williams, 1996] Rodrigues A. and Williams T., (1996) **System Dynamics in Software Project Management: towards the development of a formal integrated framework** *Management Science, theory, Method & Practice*

[Rolland et. al. 1998] Rolland C., Souveyet C., Achour C. B., (1998) **Guiding Goal Modeling Using Scenarios.** *TSE special issue on scenario management, CREWS report series 1998.*

[Regev & A. Wegmann, 2005] Regev G., Wegmann A., (2005) **Where do goals come from: The underlying principles of goal-oriented requirements engineering.** *13h IEEE International Requirements Engineering Conference, Paris, France, August 2005.*

[Selby, 2007] Selby R. W., (2007) **Software engineering: Barry W. Boehm's lifetime contributions to software** *Wiley-IEEE, 2007*

[Schneider-Neureither, 2004] Schneider-Neureither, (2004) BOOK: **SAP system landscape optimization** accessed from: *media.techtarget.com*

[Schmidt et. al. 2001] Schmidt R., Lyytinen K., Keil M., and Cule P., (2001) **Identifying Software Project Risks: An International Delphi Study** *Journal of Management Information Systems Spring 2001vol. 17, pp. 5-36*

[Sumner, 2000] Mary Sumner (2000). **Risk Factors in Enterprise Wide Information Management Systems Projects.** *Proceedings of the Americas Conference on Information Systems (AMCIS), pp. 232-4*

[Sauer, 1993] Sauer C., (1993) **Why Information System project fail, A case study Approach**

[Sharp, Finkelstein & Galal, 1999] Sharp H., Finkelstein A., & Galal G., (1999) **Stakeholder Identification in the Requirements Engineering Process** *1999 IEEE.*

[Tiwana & Keil, 2004] Tiwana A., Keil M., (2004) **The one minute Risk Assessment tool,** *Communications of the ACM November 2004 vol. 47, pp. 73-77*

[Turner & Hunsucker, 1999] Turner J. V., Hunsucker J. L., (1999) **Effective risk management: a goal based approach** *International Journal of Technology Management. 199, vol. 17 pp. 438-458*

[Verner et. al, 1999] Verner J.M., Overmyer S.P., McCain K.W., (1999) **In the 25 years since The Mythical Man Month what have we learned about project management?** *Information & Software technology, vol. 41, pp. 1021–1026*

[Woolridge, McManus & Hale, 2007] Woolridge W., McManus J., & Hale E., (2007); **Stakeholder Risk Assessment: An Outcome-Based Approach** *Published by the IEEE Computer Society IEEE.*

[Wallace et. al. 2004] L. Wallace, M. Keil, A. Rai, (2004) **Understanding software project risk: a cluster analysis.** *Information & Management December 2004 vol. 42, pp. 115-125*

[White & Fortune, 2002] White D. Fortune J. (2002) **Current Practice in Project Management – an Empirical Study** *International Journal of Project Management, vol. 20, pp. 1-11*

[Xiaosong et.al, 2009] Xiaosong L., Shushi L., Wenjun C., Songjiang F., (2009). **The Application of Risk Matrix to Software project Risk management** *International Forum on Information Technology and Applications 2009. IEEE*

[Yong et. al, 2007] Yong H., Huang J., Chen J., Liu M., Xie K., (2007) **Software Project Risk Management Modeling with Neural Network and Support Vector Machine Approaches** *Third International Conference on Natural Computation (ICNC 2007) IEEE*

APPENDIX

Questionnaire 1

Please tick the appropriate answer

1. The Team is experienced of developing this type of application

   Yes No May be

2. The Team has been working together for more than one year

   Yes No May be

3. Each member of team is familiar with the domain onto which system-to-be will operate

   Yes No May be

4. The system-to-be is comparatively complex from applications developed in past

   Yes No May be

5. Roles and Responsibilities are clearly defined within the team

   Often Rarely Never

6. Work packages developed are independent of each other

   Often Rarely Never

7. Knowledge corner tool sufficiently answers all queries regarding business process

   Often Rarely Never

8. Concept check tool precisely measure the implementation work

   Often Rarely Never

9. Project estimator tool coordinates to calculate realistic cost & budget estimates

   Often Rarely Never

10. Solution review has been effectively identifying parameters of business process

    Often Rarely Never

11. Technical review has been effective to analyze the operational versions of system-to-be

    Often Rarely Never

12. Development review has been effective to explore the design and implementation compatibility

    Often Rarely Never

13. Changes in the requirement are allowed once the project's scope is base lined

    Often Rarely Never

14. Risk assessment tool has been effective for risk factor identification and risk analysis

    Often Rarely Never

Questionnaire 2

Which type of risks have you experienced in past to develop software in SAP?

	Frequent	Less Frequent	Often	Rare	Never
Schedule overruns	☐	☐	☐	☐	☐
Budget overruns	☐	☐	☐	☐	☐
Implementing erroneous functionality	☐	☐	☐	☐	☐
Implementing wrong functionality	☐	☐	☐	☐	☐
Incorrect assumptions regarding functionality	☐	☐	☐	☐	☐
Inadequate representation of functionality on interface	☐	☐	☐	☐	☐
Requirements communication from clients	☐	☐	☐	☐	☐
Requirements communication to developers	☐	☐	☐	☐	☐
Misunderstood requirements	☐	☐	☐	☐	☐
Requirement elaboration	☐	☐	☐	☐	☐
Requirement validation	☐	☐	☐	☐	☐
Mismatch between requirements and actual project objectives	☐	☐	☐	☐	☐
Mismatch between design and realization of system-to-be	☐	☐	☐	☐	☐
Changes after Requirements are base lined	☐	☐	☐	☐	☐
Size of system-to-be	☐	☐	☐	☐	☐
Lack in client cooperation	☐	☐	☐	☐	☐

	Frequent	Less Frequent	Often	Rare	Never
Lack in end-user cooperation	☐	☐	☐	☐	☐
Lack in client satisfaction from system-to-be	☐	☐	☐	☐	☐
Lack in end-user satisfaction from system-to-be	☐	☐	☐	☐	☐
Inappropriate methodology to implement project	☐	☐	☐	☐	☐
Team coordination	☐	☐	☐	☐	☐
Lack of appropriate skills for project management	☐	☐	☐	☐	☐
Lack of appropriate skills for project development	☐	☐	☐	☐	☐
Use of new tool/technique/technology	☐	☐	☐	☐	☐
Team turn over	☐	☐	☐	☐	☐
Team absentees	☐	☐	☐	☐	☐
Improperly defined responsibilities	☐	☐	☐	☐	☐
Unclear task specifications	☐	☐	☐	☐	☐
Lack of control on project's scope	☐	☐	☐	☐	☐
Lack of domain knowledge in which system-to-be will operate	☐	☐	☐	☐	☐
Changes in enterprise work flow once system-to-be is ready to replace the existing system	☐	☐	☐	☐	☐
Missing to pinpoint issues via solution reviews	☐	☐	☐	☐	☐
Problems carried out by the maintenance phase once system-to-be is finally deployed	☐	☐	☐	☐	☐

Questionnaire 3

Please tick the appropriate answer

	FREQUENT	LESS FREQUENT	OFTEN	RARE	NEVER
Schedule overrun					
Cost overrun					
Exporting or importing data to/from legacy systems and SAP application					
Inconsistency due to integration of SAP & non-SAP functional modules					
Lack of client cooperation					
Lack of end user cooperation					
Requirements communication from clients					
Requirements communication to team members					
Requirement Elaboration					
Requirement Validation					
Misunderstood requirements					
Mismatch between requirements & project objective					
Errors in customization due to assumptions					
Errors in customization due to misconceptions					
Errors in transactions by end user					
Misstatements in transactions by end user					
Delayed verification of misstatements					
Errors in additionally designed checks via ASAP on input data					
Implementing erroneous functionality					
Implementing wrong functionality					
Transactions posted onto wrong files/ledgers by end user					
Transactions posted onto wrong files/ledgers by system routine					
Lack of domain knowledge in which system-to-be will operate					
Lack of control over project scope					
Insufficiently configured data access controls					
Unauthorized program modifications					
Problems with manipulation of checklists, templates etc via accelerators					
Inconsistency/Inaccuracy of data in files due to customization errors					
Inconsistency/Inaccuracy in transaction files due to error by end user					
Errors in complicated transactions running in batch mode					
Errors in electronic data interchange with vendors (automatic debit/credit from vendor bank accounts)					
Changes in enterprise workflow once system-to-be is ready to replace legacy system					
Project team members turnover					
Lack of client's satisfaction from system-to-be					
Problems to run the application due to server down					

Questionnaire 3 (CONTD.)

	VERY HIGH	HIGH	MEDIUM	LOW	IGNORE
Schedule overrun					
Cost overrun					
Exporting or importing data to/from legacy systems and SAP application					
Inconsistency due to integration of SAP & non-SAP functional modules					
Lack of client cooperation					
Lack of end user cooperation					
Requirements communication from clients					
Requirements communication to team members					
Requirement Elaboration					
Requirement Validation					
Misunderstood requirements					
Mismatch between requirements & project objective					
Errors in customization due to assumptions					
Errors in customization due to misconceptions					
Errors in transactions by end user					
Misstatements in transactions by end user					
Delayed verification of misstatements					
Errors in additionally designed checks via ASAP on input data					
Implementing erroneous functionality					
Implementing wrong functionality					
Transactions posted onto wrong files/ledgers by end user					
Transactions posted onto wrong files/ledgers by system routine					
Lack of domain knowledge in which system-to-be will operate					
Lack of control over project scope					
Insufficiently configured data access controls					
Unauthorized program modifications					
Problems with manipulation of checklists, templates etc via accelerators					
Inconsistency/Inaccuracy of data in files due to customization errors					
Inconsistency/Inaccuracy in transaction files due to error by end user					
Errors in complicated transactions running in batch mode					
Errors in electronic data interchange with vendors (automatic debit/credit from vendor bank accounts)					
Changes in enterprise workflow once system-to-be is ready to replace legacy system					
Project team members turnover					
Lack of client's satisfaction from system-to-be					
Problems to run the application due to server down					

Questionnaire 4

Please tick the appropriate answer

Efficiency in organizational workflow ⟶ Re-engineering of manual business processes

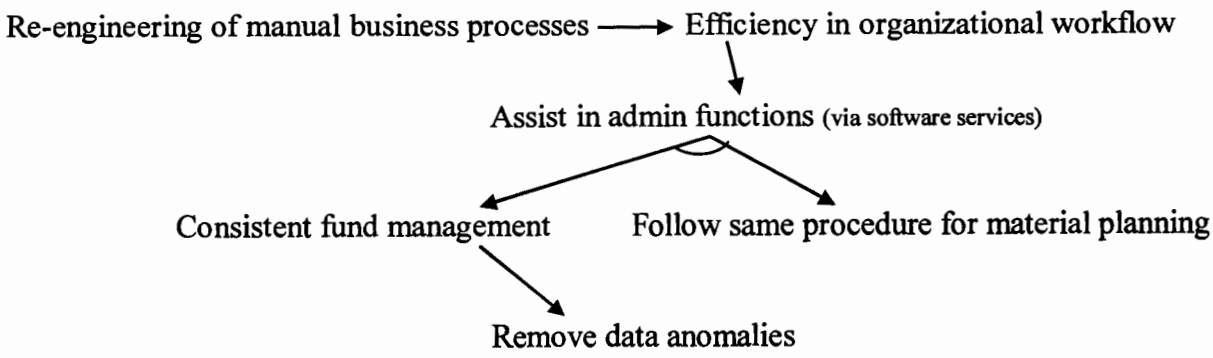
Goals: *Strategic Compliance of software services to improve organizational efficiency, accurate customization/development of organizational process's workflows within the software.*					
Risk factors	**Impact of Risk factors**				
	v. High	**High**	**Medium**	**Low**	**Ignore**
Requirement Communication from client					
Requirement Communication to team members					
Misconceptions in customization					
Assumptions in customization					
Changes in organization's workflow by replacing legacy system with software					

Efficiency in organizational workflow ⟶ Re-engineering of manual business processes

↙

Train Employee

Goals: Employee Training					
Risk factors	**Impact of Risk factors**				
	v. High	**High**	**Medium**	**Low**	**Ignore**
End-user cooperation (availability) in training					
End-user involvement (interest) in training					
Misstatements by end user					
Posting onto wrong files/ledgers by end user					
Inaccurate/Incomplete transactions due to end user mistakes					



Goals: *Consistent material/fund management, Same process for material planning, Data availability across user dpt., Remove data anomalies (Data Integrity)*					
Risk factors	**Impact of Risk factors**				
	v. High	**High**	**Medium**	**Low**	**Ignore**
Misstatements by software					
Delayed verification of misstatements					
Errors in transaction due to customization					
Errors in transaction due to batch mode transactions					
Errors in transaction due to EDI (electronic data interchange)					
Insufficient data access rights					
Unauthorized program modifications					
Data inaccessible (WAN)					