Investigating & Managing Software Project Risk in Software Development Houses: A Pakistani Perspectives

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FINAL APPROVAL

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ABSTRACT

Despite impressive advances in technology and a surfeit of Software development methods there remain copious stories of Software development project failure.

Risk Management promises a positive impact on Software Development and has raised hopes of alleviating such problems. According to the empirical findings, the application of Risk Management to Software Development is not a common practice. Furthermore, the positive effect of Risk Management on Software Development is not very high and practitioners hold the view that the application of Risk Management to software development is not an easy task. The empirical study further suggests that estimation, organization, and personnel capabilities are the most serious risk factors in Software Development. In the review of the literature about the Risk Management in the software development houses, the suggested factors & techniques are critiques and this lays down the basis for an empirical exploration, which includes a questionnaire survey. The empirical study undertaken investigates the nature of risk, current risk management practices, and their effect on Software development.

The study shows that there is a lack of rigorous research into Risk Management techniques & factors and the current literature provides useful knowledge and guidelines on Risk Management practices in software development houses working in Pakistan, but many of the claims made in the literature have no empirical validation.

Using this knowledge, a socio-technical model of Risk Management is suggested. In contrast to earlier adhoc methods, which have a technical perspective on Risk Management, this model presents a multiple perspective approach to the Management of Software Development Risks.

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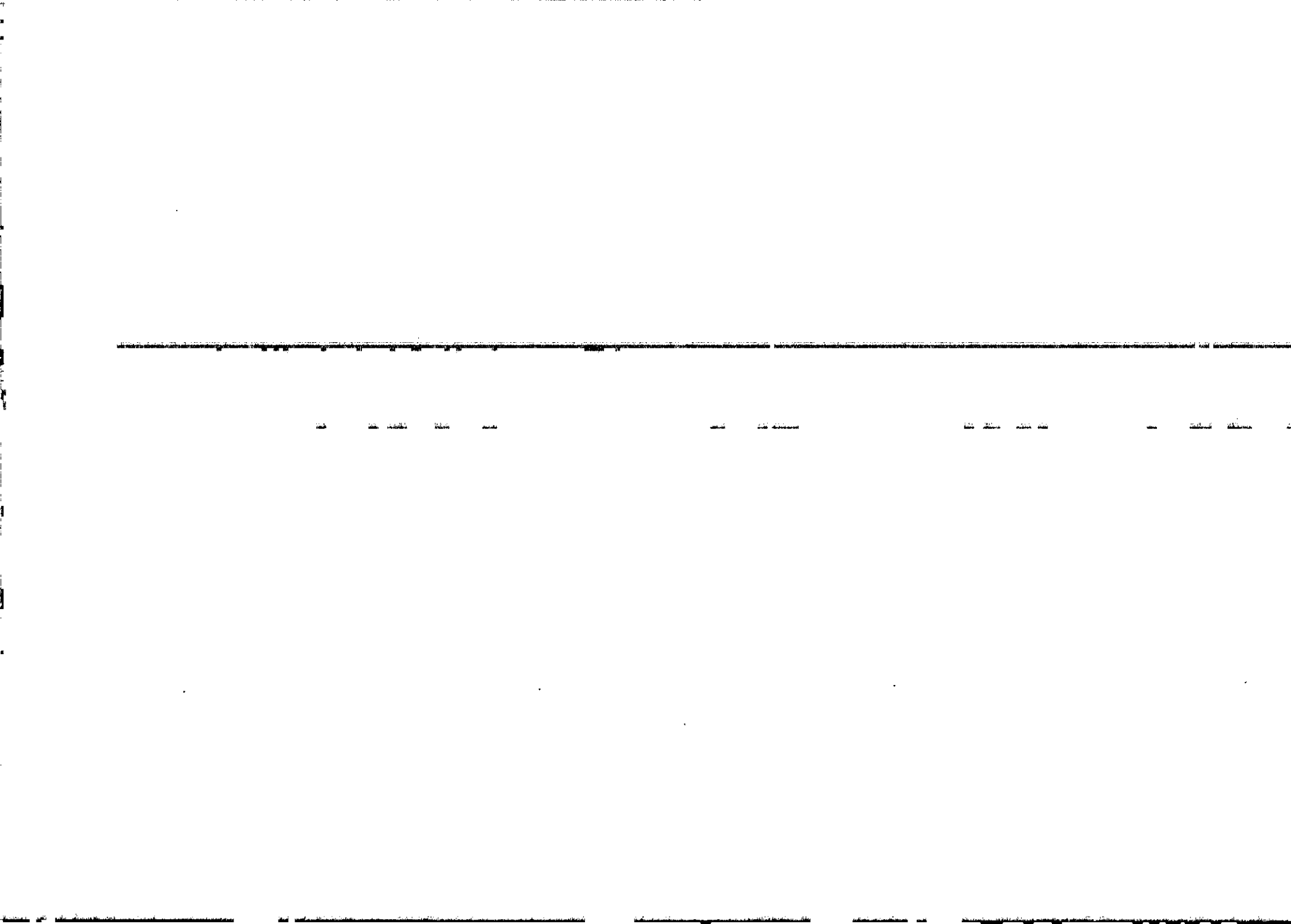


1. INTRODUCTION

1.1. Background

Software project risk has been defined as the product of uncertainty related with project risk factors and the enormity of impending loss due to project failure [Barki et al., 1993]. Thus the key elements to be controlled are the project risk factors [Wen-Hing Han et al., 2006]. In this thesis I define a risk factor as a provision that can present a serious risk to the successful completion of a software development project.

Today, software is always an element of enterprise business. The importance of software is increasing every day, along with the evolution of technology. Software Development activities associated with advanced technology and a high level of knowledge. Every software project is faced with a considerable degree of uncertainty. The success of software development is directly related to the risks (ie project managers, risk should b e limited to successful software development is complete). The conditions for the current global software market requires the most advanced software solutions for businesses to be competitive. Every aspect of a software development project can be affected by risks that the project may cause. So it is customary to say the risk is the price of that opportunity you've been using (ie a project with a large number of risks have a chance in the global software market, as the project on time and within the planned expenditure)

Many software development projects trying to get the current software capabilities to promote and not something that has been done to reach. Opportunity for advancement cannot be achieved without taking risks. The use of advanced and in most cases, unproven technology on software development projects for a variety of risks. For a complex software development project to be carried out within the foreseeable risks for the project is well understood and mitigated.

Risk is an inherent part of software development projects. Risk is present in all aspects of software development. Software development is based on knowledge and new technologies, and the success of a software development

project is closely linked to successful risk-addressing. A risk is a state or property of a development task or environment, which, if ignored, the probability that a project fails to increase. *"A risk can be defined as a consideration that has some degree of probability of compromising the success of software development project (karolak, 1995)"*. Risk defines the probability that software development project will experience unwanted events such as termination, delay in project schedule etc. Software development is an activity, *"which is connected with high level of knowledge & advanced technology. Risks on software development projects must be successfully mitigated o produce successful software systems. Every aspect of a software development project could be influenced by risks, which cause project failure"*.

"The key to risk management is the alleviation and identification of all true risks or the development of a contingency plan in case the potential risk becomes a reality (Tak Wah Kwan & Hareton K.N. Leung, 2007)". The risk management can be defined as "an organized process for identifying and handling risk factors; including initial identification and handling of risk factors as well as continuous risk management" (Fairley, 2005). Therefore, reducing the risk connected with the prevention of the loss of large software development. Risk Management should focus on risk reduction and prevention. Risk Management is a software development project, which will continually assess potential problems and the need to identify potential risks. Software risk management is defined as the application to manage the risk of software development projects (Hall, 1998).

1.2. Problem Identification and Motivation

According to Shaw, (Shaw, 2001) the major challenge in software is that software engineering has not been realized as a commonly used research paradigm as other disciplines in computer science. Software engineering is an immature discipline (Shaw, 2001) which lacks evaluative criteria. Therefore, the research results have been varied consistently in the studies (Tichy, Lickowicz, Prechelt & Heinz, 1995). There is a lack of cumulative empirical knowledge about best practices for Risk Management in Software Development. Such type of work does not exist in the literature that can increase awareness of

researchers and practitioners guide to choosing a method applied to risk management in software development in a particular conflict under certain conditions in software projects.

1.3. Aim of Research

The aim of this research is to find out different techniques that are directed in the literature. Used for risk management techniques are effective in which conditions? Ultimately, I will find out advantages and disadvantages of these techniques reported in the literature.

1.4. Research Question

In this Research, I had investigated the Managing of software project risks in Software Development. I examined the following questions:

I. Which Risk Factors present in Literature match with the present perceptions of managers in software Development Houses of Pakistan?

II. What Risk Management Techniques are being adopted for risk management in Pakistani software houses?

III. Which risk management techniques strategies are most suited to be adopted in local Software Houses to manage Risks w.r.t. our expert's perceptions?

1.5. Definitions

- **Risk**

The word 'risk' in everyday usage has two related meanings: (1) refers to the estimated probability that an undesirable event will occur and (2) refers to a situation where it is possible but not certain that an undesirable event will occur. [Hansson89]. Traditionally, the concept of risk is expressed in terms of the probability of occurrence (frequency) and the severity of loss (or gain) that will be a consequence of such an occurrence [RSSG83]. Risk, at the general level, involves two major components: (1) the existence of a possible unwanted consequence and (2) an uncertainty in the occurrence of that consequence which can be expressed in the form of a probability of occurrence. [Rowe88]. MacCrimmon et al (1986) notes that there are three components of risk – *the magnitude of loss, the chance of loss,* and *the exposure to loss*. The notion of probability is central to the idea of risk

in the literature although the interpretation of probability depends on whether it is viewed objectively or subjectively. Bowden and Linstone (1987) note that 'Risk is in the mind of the beholder', but risks are not only real but also perceived. A situation viewed by a person as 'risky' may be seen as 'not risky' by another and as an 'opportunity' by a third. If a would-be problem solver already possesses an adequate and relevant mental capacity developed from current knowledge and past experience then he may not perceive a situation as 'risky' whereas the same situation may be considered as risky because of the problem solver's ignorance [Yeo95] and vice versa.

- **Risk and Software Development**

Project risks affect all aspects of software development: organization, personnel, technology, etc. We can distinguish two types of risks: direct risks - the risk that a project has a high degree of control - and indirect risks - risk than a project has little or no control.

Risks can be described by different properties. Two of them are the likelihood of occurrence (hereinafter simply probability), and the cost mitigate this problem in the event of risk occurs. A detailed risk analysis reveals the risks that threaten a specific project, provides the strategies for how to reduce project risks if they occur, and ranks their characteristics.

- **Risk Management**

A risk is a presumption of a future problem that has not yet occurred. Thus management of risk relating to the future consequences of today's decisions and events. The purpose of risk management is to help a decision maker obtains an understanding of the situation by reducing uncertainty, and thus control and reduce risks to the level where its impact is low and stakeholders are ready to accept it. Scarff (1993) defines the management of risk as "the overall process by which risks are analyzed and managed". The UK Ministry of Defence (MoD) describes the process of Risk Management comprising of four phases, i. e. identification, analysis, planning, and management [RSSG92]. The description of Risk Management in the literature highlights three main features; i. e. a Risk Management process

identifies, evaluates and controls risks. The author defines Risk Management as involving "deliberate attempt to identify, assess and control risks that may affect the success, so that any adverse effects of the risks can be eliminated or reduced to acceptable levels."

- **Software Development Risk Management**

"Barki et al. (1993) defines software project risk as the product of uncertainty about a software development project and the size of potential losses associated with project failure. Uncertainty about a software development project due to factors that threaten its success" (Barki et al., 1993). These factors have been labeled *"risk factors"* which intimidate the successful completion of a software development project.

"Most of the researchers on software project risk and risk management broadly agreed on a two-step approach to software project risk management: risk assessment and control" (Boehm, 1991; Charette, 1996; Lyytinen, 1988; McFarlan, 1981). "Risk assessment is to identify, analyze and prioritize the risk factors that are likely to compromise a project's success, and risk control involves acting on each risk factor to eliminate or control it (Boehm, 1991)". It is clear that the second step cannot be continued without being completed. *"Managers can pursue software project development, which ultimately result in failure because they do not have sufficient knowledge of that risk. If managers have defective perception of the associated risks, their management efforts are likely to be misled, and they may unknowingly take risky decisions (Slovic, Fischhoff, and Lichtenstein, 1981)".*

"One of the most common methods for risk identification has been the use of risk factor checklists (Boehm, 1991; Barki et. al. 1993; Schmidt et. al. 1996; Keil et al, 1998)". These checklists present a list of all potential risks to the project manager and force him to check, and decide what Risks are in your particular project.

"A comprehensive list of software project risk can be achieved by combining the risk factors identified previously in the literature (e.g. Barki et al ,1993) with those factors acknowledged by practicing project managers (e.g. Schmidt et al.,1996)."

1.6. Survey

It is a method of collecting information from people about their characteristics, behaviors, attitudes, or perceptions.

1.7. Data Analysis

The analysis of the survey data employed statistical analysis methods using SPSS, AMOS and Quattro Pro software packages. Various issues will be identified from the responses to the questionnaire. The research findings is interpreted and generalized.

2. LITERATURE REVIEW

Quality and success of a research is often a reflection of the time and effort invested in developing research ideas and concepts. The immediate aim of a literature study is to determine whether the idea is worth pursuing or not. The first step of the process leads to specify the domain structures. (Pinder, Wilkinson and Demack, 2003). This includes outlining what is included and excluded from the notion under study (Churchill, 1979). Hence this study of software project risk and risk management began with an examination of the literature.

In order to obtain a better understanding of Investigating software project risk and risk management constructs, an extensive literature review was performed. It was conducted mainly to identify those features of software development projects which researchers and practitioners have pointed out as factors that increase the riskiness of a development effort and the strategies they adopt to counter these factors. There have been a number of research studies on the issue of "risk in software development" and attempts have been made to classify them into various categories based on their similarities (Sumner, 2000). An extensive amount of literature was surveyed in order to ensure that no important factor was overlooked. In order to identify as many factors as possible, two general resources served as the basis.

First source of literature was articles within Software Project Development research which addressed the problems associated with software Project development. Majority of Software Project Development articles dealt with the types of problems that occurred in specific phases of the Software development process. These articles either used empirical data to draw conclusions as to the effects of a particular risk factor or they proposed models that hypothesized how a few of the risk factors might impact a development effort. These articles taken individually do not provide a clear picture of the spectrum of the constructs. However, they provide a clear picture of the topics which have been studied by researchers. Second source of literature was articles written by

practitioners detailing their experiences with software development projects (e.g., Boehm, 1983; Burchett, 1982; Casher, 1984; Keider, 1984; Kindel, 1992). Majority of articles in this group described the author's experiences with a particular development project, or consisted of a summary of their generalized observations from previous studies. These articles tell us about problems that appear to be encountered frequently in software development projects and how these problems can be mitigated.

2.1. Software Development Project Risk

Cambridge Learner's Dictionary defines "risk" as the possibility of something bad happening. Researchers and practitioners in various domains have conducted studies on this topic. Though there are differences in perceptions and approaches to the same, an examination of literature reveals a great deal of similarity in conclusions. Typically, risk is described as some kind of an event that may or may not occur, coupled with a consequence that follows if the event occurs (Dedolph, 2003).

A simple definition of project risk states that it is a problem that has not yet occurred but which could cause loss to one's project if it did (Wiegers, 1998). The concept of risk is associated with a number of human endeavors ranging from space exploration and company acquisition to information systems development (Barki et. al., 1993).

The classical decision theory states that risk is perceived as reflecting variations in the distribution of likely outcomes, their subjective values. Hence a risky alternative is one where the variance is large and risk forms an important factor in evaluating alternative options. Decisions are said to be taken under risk when there is the possibility of more than one outcome resulting from the selection of an option. Furthermore, it is assumed that the probability of occurrence of each is known to the decision maker in advance. The variation in outcomes is said to be a consequence of factors which are beyond his control (Radford, 1978).

Empirical studies on how managers deal with risks show that the managers are not necessarily rational in reacting to risks. "*They look at a risky choice as one*

that contains a threat of a very poor performance (March and Shapira, 1987). Also, risk is not a probability concept; it deals with the magnitude of the bad outcome". Accordingly, managers act in a loss-aversive manner rather than a rational manner as predicted by the traditional theory. They seek to avoid risks rather than just accept them. They make fast decisions to avoid risks, negotiate uncertainty absorbing contracts, or just delay decisions if possible (MacCrimmon et al., 1984).

"A software project risk points to an aspect of a development task, process or environment, which if ignored tends to increase the likelihood of software project failure (Lyyttinen et al., 1993)". Software project risks are a major dilemma to Software project managers (Jiang et. al., 2000). The reasons for variations in success can be attributed to risk factors which are technical, economic and behavioral in nature (Barki et. al., 1993; Lyyttinen, 1988). *"Such incidents pose danger to the development of a successful project leading to inadequate software operations, software re-work, implementation difficulty, delay or uncertainty (Boehm, 1991)".* McFarlan (1981) viewed project risks as failure to obtain all of the anticipated benefits because of implementation difficulties, much-higher-than-expected implementation time, and thus resulting in the development systems whose technical performance is considerably below estimates.

To summarize, risk has two components:

- The chance / probability that an undesirable event will occur.
- The negative consequences / magnitude of loss because of the occurrence of this event.

Boehm (1989) defined Risk Exposure (RE) combining these two components as: RE = probability of an unsatisfactory outcome * Magnitude of loss arising from this outcome.

Sherer (1994) viewed that software project risk could be estimated from the possibility of failure multiplied by the magnitude of its loss. Similarly, Rainer, Snyder and Carr (1991) described risk as a function of the vulnerability of an asset to a threat multiplied by the probability of the threat becoming a reality.

A precise calculation of the probabilities of negative outcomes and their magnitude is necessary in order to calculate risk exposure. However, there are numerous complexities in software development that make a proper estimation of outcome probabilities hard. Hence, assessing risk via a quantitative evaluation of probabilities could be very difficult and unreliable (Kaplan and Garrick, 1981).

In lieu of estimating the probabilities of a negative outcome, an alternative method has been devised. Kangari and Boyer (1989) adopted a method of risk assessment based on the use of natural language. Accordingly people were asked to express in a natural language, the relative weight and severity of loss arising due to the identified risk factors. Barki et. al. (1993) put forth a modified definition of software project development risk by referring to the uncertainty surrounding a project.

As risk is a potential problem, an effective step to risk management would be through proper identification of risk factors (Fairley, 1994). The process of risk analysis can be broken down into three; risk identification, risk estimation and risk evaluation. This information enables managers to take steps to avoid potential problems before they become crisis situations. The initial step in the research process is the identification of potential software risks.

The extensive literature review resulted in the identification of over 100 risk factors. The next step was to try to group similar factors together in order to get a clearer picture of the general types of software project risk factors. This resulted in the creation of 12 general types of software project risk categories.

1. Team related factors
2. Effectiveness of Project Communication
3. Project Manager Characteristics
4. Organizational Climate and Support
5. External Factors
6. Role of the user
7. Formalization of project charter
8. Project estimation and planning

9. Tools and technology
10. Requirement stability and accuracy
11. Effectiveness of Project Monitoring
12. Cross cultural and gender issues

2.2. Risk Management Practices

This section provides an overview of the risk management practices suggested to address the risk factors identified in software development projects. Risk management is concerned with a phased and systematic approach to analyze and control the risks occurring in a specific context (Charette, 1996). The predominant purpose of risk management is to take the appropriate course of action to strike an optimal balance between likely benefits of such techniques and the exposure to risks (Powell et. al. 1996). Software project risk management is risk management applied to the development and/or deployment of software-intensive systems. Considerable improvements can be made in the software development process through the systematic applications of risk management techniques and guidelines (Alter et al. 1978; McFarlan 1982; Boehm 1989, 1991). Research on software risk management has primarily focused on crafting guidelines for specific tasks (Alter et al. 1978; McFarlan 1982; Boehm 1989; Charette 1996).

Boehm (1991) defined risk management as an emerging discipline whose objectives are to identify, address, and eliminate software risk items before they become either threats to successful operation or major sources of rework. A formal risk management programme is a structured way of evaluating risks to the software development process. A typical risk management framework involves implementing and monitoring measures to reduce risk. Project risk management encompasses both hard skills such as estimating and scheduling tasks, and soft skills, which include motivating and managing team members (Kirsch 1996).

Risk management strategies use observations from the past; they learn from analogical situations, and they use deductive reasoning to detect risky

incidents. Over time, observations are generalized by crafting specific theories of cause-effect chains into generic risk items. In addition, risk management approaches feature a repertoire of risk resolution techniques. These are derived from local causal theories on how risky incidents affect software development and how interventions affect development trajectories. The techniques help formulate schematic plans for interventions that decrease the likely impact of risky incidents, or avoid it altogether.

A thorough review of literature on risk management strategies for software projects, helped to identify a range of risk resolutions techniques which are discussed under nine categories, namely;

1. Leadership Strategies
2. HR Policies
3. Training
4. Project Coordination
5. User Coordination
6. Requirement Management
7. Estimation Techniques

Any significant deviations or variances from the plan require prompt attention from the project manager so that timely corrective action can be taken. Keil et al. (1998) stated that to avoid the problem of scope creep, project managers should inform users of the impact of scope changes about details of project cost and schedule. Project managers should be able to distinguish between desirable and absolutely necessary functionality. The project manager must be able to identify the source of the problem. If there is a major deviation from the plan, the project manager must decide whether re-planning future activities is warranted (Jurison, 1999).

Technical performance control, the process of assuring that all technical requirements are met, is normally exercised through a variety of design reviews. These reviews are usually held at major milestones (e.g. completion of requirements definition phase, design phase, or coding) but it

can be held at other times during the project also. The progress towards important technical goals should be tracked through appropriate metrics during the project. The metrics provide project managers visibility of what has been achieved, and their trends offer predictions of what can be expected in the future (Jurison, 1999). Software engineers use different types of software development technical review for the purpose of detecting defects in software products (Sauer et. al., 2000).

2.3. Review of Studies

The studies referred above consider software risks along several dimensions and have provided some empirically founded insights of typical software risks and risk management strategies to mitigate them. Overall, these studies provide insights into risk management deliberations, but are weak in explaining the true impact of risk and risk management practices on the project outcome. A few studies have gone further to establish how risk management efforts reduce the exposure to software risk and can thereby increase software quality and improve software development (e.g., Fairley, 1994; Nidumolu, 1995; Wallace et. al., 2004).

A number of system performance criteria have been developed and empirically tested. They include software usage, user satisfaction, quality of decision making, cost/benefit analysis, team effectiveness and project effectiveness. The triple criteria of project success – meeting cost, schedule and performance targets - have been widely used by researchers to analyze project success. Saarinen (1990) proposed a system success measure with four dimensions: system development process, system use, system quality, and organizational impacts. The identification of these distinct dimensions of system performance illustrates that a project can be both successful and unsuccessful at the same time depending on the metric selected. One of the most popular approaches is to categorize these measures under process performance measures and product performance measures (Barki et. al 2001; Nidumolu 1995; Deephouse, 2005; Wallace, 2000; Al-Hindi, 1996; Ravichandran, 1996). Product outcome refers to measures of the

"successfulness" of the system that was developed. It looks at how the software developed scores on important parameters of software quality: reliability, maintainability, easiness to use, response time, meeting the requirements, user satisfaction etc. Process outcome measures refer to the "successfulness" of the development process of the project. The focus is on completing the project within budget, within schedule and the on the overall quality of the development process. Both aspects are important as the software delivered by the project may be of high quality but the project itself may have exceeded the time and cost projections. On the other hand, well managed projects which come in below cost and time budgets may deliver poor products.

Due to the difficulty in quantifying costs and benefits, measures based on perceptions have become particularly prominent in literature. Linda Wallace (1999) validated the second order factor model of risk through the establishment of co-alignment, a structural model of the relationship between risk and project outcome - both product and process outcome. The result of this research has established a tentative link between project risk and project outcome and shows that the level of risk associated with a project can have an impact on the ability of the project to be finished on time and within budget.

Jiang et. al. (2000) has independently done a study similar to the one described above and arrived at similar conclusions. He also found that software project risk can better be expressed as a second order factor model and that there is negative link between risk and project success. Based on her previous research, Wallace et al (2004) developed a model linking risk and project performance. This was guided by project management literature and socio technical theory. Six components of risk were extracted through principal component analysis and these six dimensions were further grouped under three dimensions namely social subsystem risk, technical subsystem risk and project management risk. The relationship of these second order dimensions of risk with product and process outcome of the project was studied through structural equation modeling.

Drawing from contingency research in Organizational theory and software project management literature, Barki et al (2001) developed an integrative contingency model of software project risk management. The central hypothesis in the model is that the outcome of the software project is influenced by the fit between the project risk and how the project is managed. The outcome measures used are cost overrun and quality of the final software delivered. The risk management practices studied is formal planning, internal integration and user participation. High risk score and the low risk score projects are separately analyzed. In each of these groups, sub groups scoring high and low on performance factors are separated. Thus the following four categories emerged: low risk high quality, low risk low quality, low risk high cost performance, high risk low cost performance. The ideal profiles for each risk category are calculated. The fit is measured as the deviation from the ideal profile. The deviations are seen to be negatively correlated with the performance supporting the contingency model.

Nidumolu's (1995) study was a leading effort in linking software project risk to project performance. His study linked synchronization mechanism and risk drivers to project performance. Two types of synchronization mechanisms were studied. Vertical coordination is the interaction through prescribed systems and procedures, and horizontal coordination is how they manage through mutual adjustments and interaction. A new research model was developed along the structural eventuality perspective in Organizational theory and risk based perception in software engineering. This model introduced enduring performance risk, i.e., the difficulty in estimating the performance related results in the later stages of the project, as a dominant variable clarifying the relationship between risk, management mechanisms and performance.

Na et al (2006) study is an extension of the Nidumolu (1995) study in Korea. They utilized measure development and analysis similar to the process described in the Nidumolu study. The study provides insights into managerial strategies to reduce the possibility of software project overruns.

Their findings reveal that both functional and system development risks are important predictors of software project performance.

Kirsch (1996) proposed to build an integrated contingency model of software project management linking project management practices to the characteristics of the project and attributes of the individuals involved. He hypothesized that the project characteristics directly affected project management practices while individual attributes may have both direct and moderating effects on such practices. These project management practices are, in turn, believed to affect project performance.

Walsh and Schneider (2002) had looked at software development risk from the agency theory point of view. He studied the causal relationship between team decisions and project success. According to him, team decisions are influenced by the agency effects (alignment between the interest of the member and that of the organization) as well as development ability of the member.

2.4. Observations from Literature Review

The researchers have adopted different approaches to developing checklists on risk and risk management. One approach has been to develop these checklists based primarily on their personal experience with software development projects. Boehm's top 10 is largely based on his experiences at TRW. The same was true with many studies in the 1980s and early 90s (e.g., Casher, 1984; McFarlan, 1982). Many of these checklists were criticized as they were not very systematic and coherent and lacked any theoretical basis (Ropponen and Lyytinen 1997; Schmidt et al. 1996).

Another approach adopted was to develop the checklist based on extensive literature review. The major work in this regard includes the literature from Software Engineering Institute. But many subsequent researchers have questioned the lack of empirical validation of these instruments developed. No steps were taken to contact practicing software project managers for input into the relative importance and accuracy of the identified risk factors. (Wallace, 1999)

The third approach was to elicit the list of risk factors from practicing managers. Many researchers have conducted surveys among the members of software projects (Moynihan, 1997, Jiang et. al. 2002). Many of these studies have been criticized for their limited focus on Software Project Development literature. They made no attempt to reconcile their findings with the literature in this area. This has limited their usefulness as a comprehensive practical tool for gauging project risk.

Linda Wallace (1999) study stands out as an attempt to develop a comprehensive measure of software development risk based on literature which is later validated with software professionals working in software projects. But she has focused only on in-house software development with USA companies most of which were non IT companies. Hence many of the non USA risk factors as well as risk factors specific to software development companies may not have been captured in her list.

Also, most of the previous research takes an isolated view of software project risk and risk management strategies. Very few studies have taken an integrated and comprehensive view of risk and risk mitigation strategies linked to project outcome. Arguments are largely based on anecdotal evidence or armchair theorizing. Empirical evidence on the relationship between risk and project outcome is rare and often fails to take into account various risk factors that may hinder success.

Linkages among software development risks, risk management strategies and various dimensions of system success are generally overlooked in IS literature. Yet, this is an important step for advancing our knowledge on project risks because it is very likely that different project risks may affect the various dimensions of system success differently. A particular control procedure or method may reduce only certain aspects of software development risk and not others. Linkages between risks and various dimensions of system success can help project managers to select the needed implementation strategies to achieve their desired project outcomes.

Most of the studies in these domains have been done in developed countries but have come out with generalized conclusions regarding the risk factors in software development projects. This has been acknowledged as a major limitation of the research on software development risk factors. Many researchers have argued with empirical evidence against this generalization across countries.

The most quoted international study on software risk factors by Schmidt et al. in 1996 study in the international world showed that there is no consensus on the top risk factors across countries. Mursu (2000) replicated the Delphi study of Schmidt in Nigeria. He found significant differences in the risk factors and their importance in Nigeria compared to what the original study showed. Similarly Na et al. (2006) found that models developed with data collected in USA do not apply to organizations in Korea where the IT capability is known to be lower than in the USA. Specifically, their study suggests that, unlike the Nidumolu (1995) study conducted in the USA, residual risk is not a significant predictor of subjective performance measures such as software project process and product performance

Many researchers acknowledge that cultural differences can impact work related values and play a significant role in the success or failure of projects (Hofstede, 1991). Joan Mann and James P. Johnson proposed a research model for risk associated with information systems projects in Thailand. His model is based on the premise that the Thai culture is likely to impact the propensity for risk to occur. A risk factor significant in one culture may not be significant in another.

Most of the previous studies focus on software professionals working in non IT companies. This has influenced many of the risk factors identified in the studies (e.g. factors such as lack of support from top management, lack of expertise available etc). Not many studies have been done focusing only on software development in software companies.

Also, most of the studies focus either on in-house projects or completely outsourced projects where the end user is well defined. The outsourced projects

covered in these studies are projects outsourced to IT companies in the same country. Multi-level outsourcing is also very popular. This will lead to project management issues such as lack of visibility about the final user, contractual problems, information asymmetry etc.

3. RESEARCH METHODOLOGY

3.1. Introduction

This chapter describes our research methodology and investigates the new trends in the field of open source software license selection. This chapter consists of following order:

3.2. Selection of Right Research Methodology

The selection of research method not only depends on the area of research but it also depends on the following factors such as research type which is acceptable to university, researcher sponsors and evaluators of research [23]. The selection of research method makes the same sense of the selection of open source software license. The selection of research method depends on the method, researcher and the circumstances of research [24]. In this framework, I consider myself as a researcher, research circumstances and research methodology.

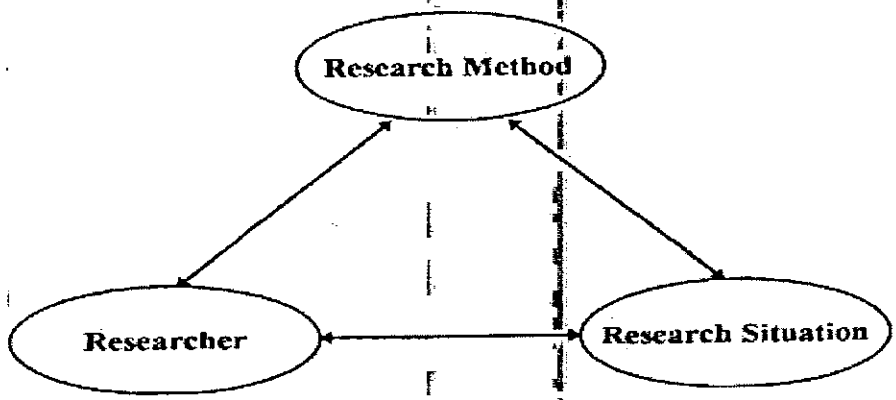


Figure 1 Research Methodology

3.2.1. Researcher

The first degree of researcher is in information technology from the Allama Iqbal Open University, Islamabad then he continued his studies and took in Master of Science (Software Engineering). The duration among in both degrees will be at least three and a half years. The researcher is going to explore the very important knowledge area.

3.2.2. Situation of Research

If anybody wants to understand the complete situation of research then, it is necessary to understand all the aspects of situation of research which are research area, admittance to population/sample, theory to support research and requirement for master's degree assessment.

This research wants to see the trends in Risk Management, Its management & Implementation. Therefore, the population of this research is those people, which have taken part in implementation of Risk management practices in Pakistani Software Houses. It is credible for researcher if the community respond.

The research study used social approach. It is used for eliciting and understanding the views of Risk Management Practices. The researcher interpreted the obtained results from the research. This research is related to adoption of open source software license in open source software community of the whole world.

The constraints of this research are the researcher's financial status, time duration of degree.

3.2.3. Research Method

Literature reported a number of research methods exist in the field of software engineering named mathematical model, controlled experiment, case study, action research, field experiment [25,26,27,29,30]. Experiment and phenomenal study are straightforward while case study and survey belongs to other category. Conceptual studies (interpretive) and experiment are opposite to each other in continuum approach [31]. The taxonomy of the research methodology is described below.

Objects	Modes of traditional approaches (observations)						Modes of newer approaches (interpretations)			
	Theorem proof	*Lab experiment*	*Field experiment*	*Case study*	*Survey*	*Futures research*	*Simulation*	*Subjective/ argumentative*	*Descriptive/ interpretative*	*Action Research*
Society	No	No	Possibly	Possibly	Yes	Yes	Possibly	Yes	Yes	Possibly
Organisation/ Group	No	Possibly (small groups)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual	No	Yes	Yes	Possibly	Possibly	Possibly	Yes	Yes	Yes	Possibly
Technology	Yes	Yes	Yes	No	Possibly	Yes	Yes	Possibly	Possibly	No
Methodology	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Theory										
building	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
testing	Yes	Yes	Yes	Yes	Possibly	No	Possibly	No	Possibly	Yes
extension	Possibly	Possibly	Possibly	Possibly	Possibly	No	No	No	Possibly	Possibly

Figure 2 Research Methods Taxonomy

The pictorial representation of approach is describes below:

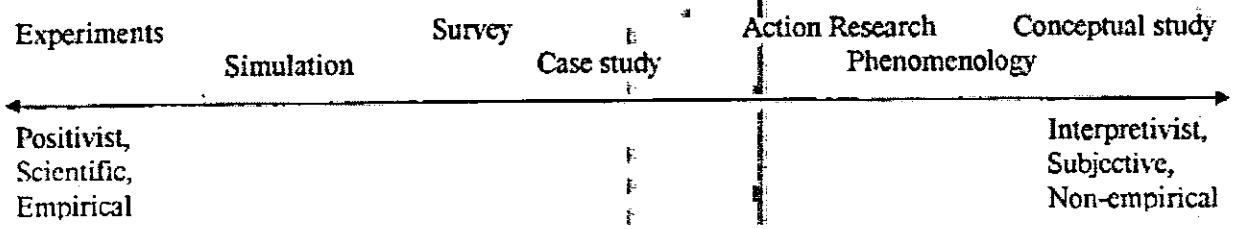


Figure 3 Pictorial representation of continuum approach

- **Conceptual study**

This method is on the right side of figure 8. It provides the subjective opinion about the area of research. This research method contains only thinking process but no experiment. It is opinion based methodology. There is no method of observation and measurement in it therefore it is hard to test hypothesis. It provides opportunity to critically analyze data and finds new dimensions. The subjective nature and necessity to link the conceptual environment to real environment is the major weakness of this research methodology.

- **Proof of Theorem**

  This research method is on the left side of the figure 8. Its level of control is the supreme. Its measurement is accurate. The accuracy of results is its strength. The inability to present organizational, cultural and contextual issues in form of equation is its major weakness.

- **Experiment**

  This method provides the exact relationship between two variables into a controlled environment. Quantitative techniques provide statement. In this technique behavior of dependent variable is observed after manipulating the independent variable.

- **Field Experiment**

  This research method is hybrid of subjective and objective elements. It has less degree of control. In this method, research is conducted in organization's own setting on human instead of laboratory. In this method, the effect of independent variable on dependent variable is observed. Its weakness is that the level of control on environment cannot be attained.

- **Case Study**

  In this method, a phenomenon is investigated with its normal setting depending on evidence from various sources .i.e. observation, archival record, interview and questionnaire. Such questions are answered through this method .i.e. why this decision was taken? How was it implemented? What types of results were achieved?

  The boundaries of this method are not defined and no mechanism of controlled environment is existed. This method is implemented in real world, therefore various and difficult types of situation can be studied. Its weakness is the lack of control and high cost.

- **Phenomenology**

  It is defined as "It is the methodological study of consciousness in order to understand the essence of experience". It is a method of obtaining meaning of structure, which provides supposition and sense about the subject and author. It tells us about thing rather than their functionality. Its

strength is that it provides understanding about the situation. It is not suitable if anybody wants to use statistical inference.

- **Action Research**

This method solves practical problem and increase knowledge simultaneously. In this approach link between theory and practice is exist. It takes its problem from the practitioner's perceptions in a specific context. It specifies the research according to the local circumstances. The data gather in this approach from action, which is imposed by the actor. It is a realistic approach in which terms and conditions are taken from real world. It is difficult to take control on all circumstances of this research method.

- **Survey**

A survey is a systematic method for collecting data from a population of interest. It has a tendency to quantitative in nature and is intended to gather information from a sample of the population, so that the results are representative of the population within a certain amount of faults. The purpose of a survey is to obtain quantitative information, usually using a structured questionnaire and standardized

Advantages of Surveys

- The surveys are relatively cheap (especially internal investigations).
- Research into the most useful features of a large population. No other method of observation provides this general possibility.
- They can be administered by e-mail, e-mail or telephone from remote locations.
- As a consequence, very large samples possible, so the results are statistically significant, although the multivariate analysis.
- Questions can be fou nd on many a topic, create flexibility in the analysis.
- There is flexibility in the planning phase to determine how things will be administered face to face, by telephone, as a group, whether oral or written examination or by electronic means.

- The standardized questions accurately measured by the application of uniform definitions for the participants.
- Standardization ensures that similar data can be collected and interpreted relative groups (between groups).

Disadvantages of Surveys

- A methodology based on standardization requires researchers to question general enough to be the least suitable for all respondents, may be missing, which is best adapted to a large number of respondents to develop.
- Surveys are inflexible because they remain in the original study design (tool and administration tool), while data collection requires the same thing.
- The researcher must ensure that a substantial number will respond to the selected sample.
- It may be difficult for participants to recall information or the truth about a controversial topic to say.
- In terms of direct observation, survey study (except for some approximations interview), in contrast to the rare "context" to be treated.

3.3. Steps in Conduction a Survey

a) Clarify Purpose

Why Conduct a Survey?

Who are the stakeholders?

Who is the population of Interest?

What Issued need to be explored?

b) Assess Resource

What external resources will you need?

Which in-house resources can you make use off?

c) Decide on Methods

Select the methods which is most appropriate

d) Write Questionnaire

Decide on what question to ask?

Set the types of response format

Set the layout of questionnaire

e) Pilot Test Revise Questionnaire

Pilot Test the questionnaire

Revise the questionnaire

f) Prepare Sample

Decide on the sample design

Identify sources of samples

g) Train Interviewers

h) Collection Data

i) Process Data

Code the data

Data enters the information

j) Analyze the result

k) Interpret and Disseminate Results

l) Take Action

3.4. My Research Methodology

The aim of the research is to explore the area and describe the reason, problem and give their explanation [26]. Exploratory research tries to find out the happening of event through qualitative techniques but it doesn't necessary. The descriptive research is related to the events or persons through qualitative and quantitative techniques. Explanatory research provides the reason of events and problems by qualitative and quantitative techniques [26, 30, 33]. The scenario of adoption of research methodology is based on the research situation, researcher background and the possible available research method [26, 33].

3.5. Research Design

The design of this research for exploration of motivation factors of selection of open source software license contains on following sub parts: research strategy, unit of analysis, data collection and data analysis.

3.5.1. Research strategy

To adopt the research strategy, researcher needs to intent the inquiry and research question(s). Literature reported that there are three types of investigation techniques which are explanatory, exploratory and descriptive [30, 33]. In point of view of Robson survey is appropriate for descriptive techniques; case studies are for exploratory techniques and experiments for explanatory techniques but Yin stated that each type of technique can be used for any research strategy. These all three techniques provide guideline in adoption of appropriate research methodology as shown in table 3 [34].

	Experiment	Simulation	Survey	Case study	Action Research	Phenom. Study	Conceptual Study
Exploratory	No	Yes	Maybe	Yes	Yes	Yes	Yes
Descriptive	No	No	Yes	Yes	Yes	Yes	No
Explanatory	Yes	No	Maybe	Maybe	No	Maybe	No

The research strategy depends on the questions which may be of these types "what, why, how, who and where" [30,33]. Yin provided instruction about archival analysis, survey, experiment, case study which are given below in table 4.

Strategy	Form of research question	Requires control over behavioural events?	Focuses on contemporary events?
Experiment	how, why	yes	yes
Survey	who, what, where, how many, how much	no	yes
Archival analysis	who, what, where, how many, how much	no	Yes/no
History	how, why	no	no
Case study	how, why	no	yes

3.5.2. Unit of Analysis

Project managers usually know the development activities of open source software. They also have right to choose the open source software license. This research focuses the motivation factors of a project manager due to which he adopted open source software license. Therefore, this

research only focuses the open source software community both at national level and at international level.

3.5.3. Data Collection

The relevant data is gathered about the selection of license of open source software from those personals, whose background is from open source software community through questionnaire. The sample is huge in number and scattered in all over the world therefore e-mail is the best way collect data or observe the behavior through attained responses. The questionnaire was sent more than 650 persons.

3.5.4. Data Analysis

The statistical analyses are applied through survey tool on the attained data. A variety of issues are found through the responses of questionnaire. The results of survey are interpreted and globally announced trough general/conference publications.

3.6. Initial Questionnaire Design

The Initial Questionnaire has four main sections:

Section 1: Characteristics of the respondents, such as their experience with CMMI, Qualification details & employment details (Current & Past).

Section 2: Actual Questionnaire about the CMMI based organizations those are using risk management techniques with few open ended questions to explore more about the techniques in used by Pakistani software industry.

Section 3 and 4: Characteristics about the using and not using of Risk Management Methodology.

4. RESULT AND ANALYSIS

Table 1 Key Aggregate Statistics on Response

Key Aggregate Statistics On Responses	
Total Number of Software Companies Surveyed	33
Companies at CMMI Level 5:	04
Companies at CMMI Level 4:	09
Companies at CMMI Level 3:	23
Companies at CMMI Level 2:	19
Companies working on Offshore Development:	12
Companies working on In-house Development:	18
Companies working on Both:	25
Companies of Age (1-4 Yrs):	17
Companies of Age (4-7 Yrs):	25
Companies of Age (7-Above Yrs):	13
Project Based Companies:	20
Product Based Companies:	04
Hybrid Companies:	31
Total Number of Software Practitioners Contacted	90
Total Number of Software Practitioners Responded	55
Total Number of Questions in Questionnaire	48
Mandatory Questions:	40
Optional Questions:	08

Response Rate Vs CMMI-Levels

According to the feedback from the respondents, it has been observed that nearly 70% of respondents are associated with the Software Companies having CMMI-Level 2 and Level 3 which therefore can be considered as the largest population among all the CMMI implemented Organizations. Statistics show that it is difficult or time taking activity for the organizations to climb up to higher levels of CMMI. In total 33 companies were surveyed and out of these 55 responses was observed, according to the results there are about 19 focal person from the companies those are currently at Level 2 of CMMI, 23 responses have been recorded from the focal persons of companies at Level 3 same as 9 from the Level 4 & 4 responses from the Level 5 organization.

Table 2 CMM Levels

	Percent	Frequency
Level 2	34.5	19
Level 3	41.8	23
Level 4	16.4	9
Level 5	7.3	4

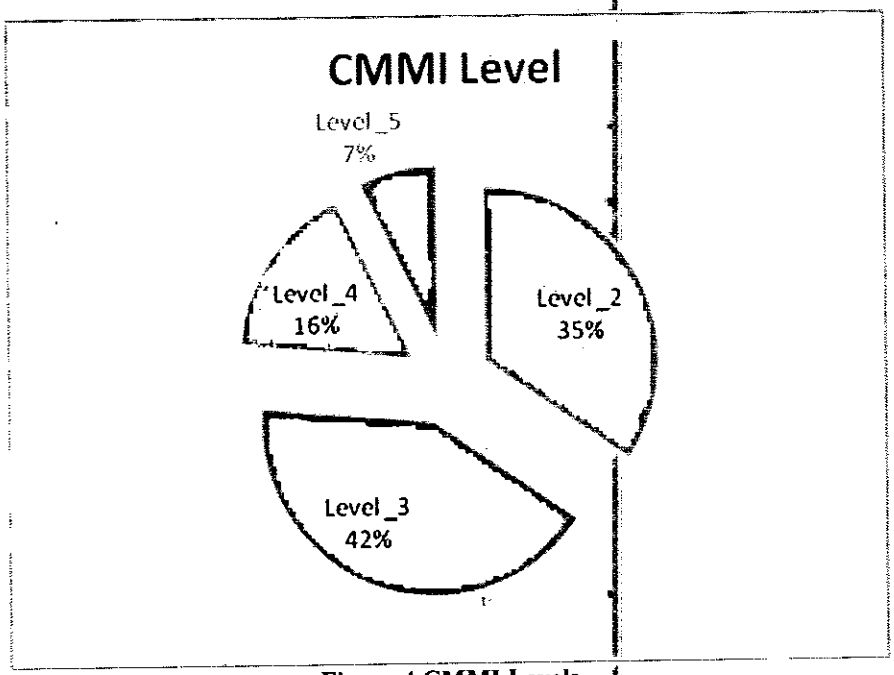


Figure 4 CMMI Levels

Three types of organization were observed during the study these organizations were categorized as Project Based, Product Based & Hybrid Companies. With respect to the specialization there annual revenues are recorded for the last five years.

Table 3 Organization Type and Annual Revenue Cross Tabulation

		Annual Revenue in Million Dollars ($)? [Year 2006]			
		<50	50 ~ 99	100 ~ 249	Total
Organization Type	Project Based	43.2%	26.7%	0.0%	23.3%
	Product Based	8.1%	0.0%	0.0%	2.7%
	Hybrid Company	48.6%	73.3%	100.0%	74.0%
Total		100.0%	100.0%	100.0%	100.0%

		Annual Revenue in Million Dollars ($)? [Year 2007]			
		<50	50 ~ 99	100 ~ 249	Total
Organization Type	Project Based	44.8%	30.0%	20.0%	31.6%
	Product Based	10.3%	0.0%	0.0%	3.4%
	Hybrid Company	44.8%	70.0%	80.0%	64.9%
Total		100.0%	100.0%	100.0%	100.0%

		Annual Revenue in Million Dollars ($)? [Year 2008]			
		<50	50 ~ 99	100 ~ 249	Total
Organization Type	Project Based	47.4%	45.5%	7.7%	33.5%
	Product Based	5.3%	9.1%	0.0%	4.8%
	Hybrid Company	47.4%	45.5%	92.3%	61.7%
Total		100.0%	100.0%	100.0%	100.0%

		Annual Revenue in Million Dollars ($)? [Year 2009]			
		<50	50 ~ 99	100 ~ 249	Total
Organization Type	Project Based	60.0%	44.4%	11.8%	38.7%
	Product Based	10.0%	3.7%	5.9%	6.5%
	Hybrid Company	30.0%	51.9%	82.4%	54.7%
Total		100.0%	100.0%	100.0%	100.0%

		Annual Revenue in Million Dollars ($)? [Year 2010]			
		<50	50 ~ 99	100 ~ 249	Total
Organization Type	Project Based	66.7%	45.5%	17.4%	43.2%
	Product Based	11.1%	4.5%	4.3%	6.7%
	Hybrid Company	22.2%	50.0%	78.3%	50.2%
Total		100.0%	100.0%	100.0%	100.0%

Annual Revenue Yearly Comparison of Project based, Product Based & Hybrid Companies

Table shows the percentage values of Project based organizations annual revenue in terms of percentages. The line graph shows that the average annual revenue increase with the passage of time & lies in between 40% ~ 70% for those organizations generating less than 50 Million dollars whereas Product based organizations have comparatively uneven trend for the year 2008 both in the ranges of the companies those are generating revenues less than 50 million dollars & for those generating average annual revenue more than 50 million dollars but less than 100 million dollars.

As compare to those hybrid companies have some sort of different type of trend their annual revenue between 100 ~ 249 million dollars are much enough in the early 2006 but it goes down after passing years all the ranges that are recorded for the hybrid companies are gradually decreasing after passing years.

Table 4 Project Based Annual Revenue Comparison

		<50	50 ~ 99	100 ~ 249
Project Based	2006	43.2%	26.7%	0.0%
	2007	44.8%	30.0%	0.0%
	2008	47.4%	45.5%	7.7%
	2009	60.0%	44.4%	11.8%
	2010	66.7%	45.5%	17.4%

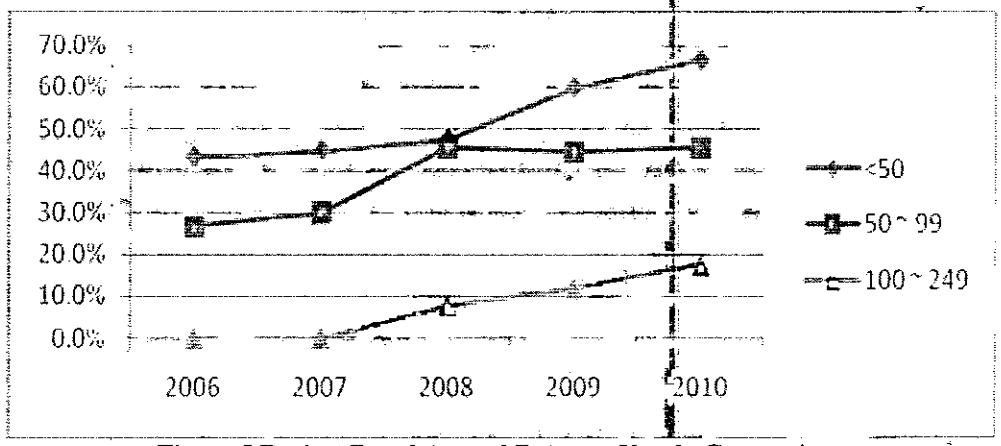


Figure 5 Project Based Annual Revenue Yearly Comparison

Table 5 Product Based Annual Revenue Comparison

		<50	50 ~ 99	100 ~ 249
Product Based	2006	8.1%	0.0%	0.0%
	2007	10.3%	0.0%	0.0%
	2008	5.3%	9.1%	0.0%
	2009	10.0%	3.7%	5.9%
	2010	11.1%	4.5%	4.3%

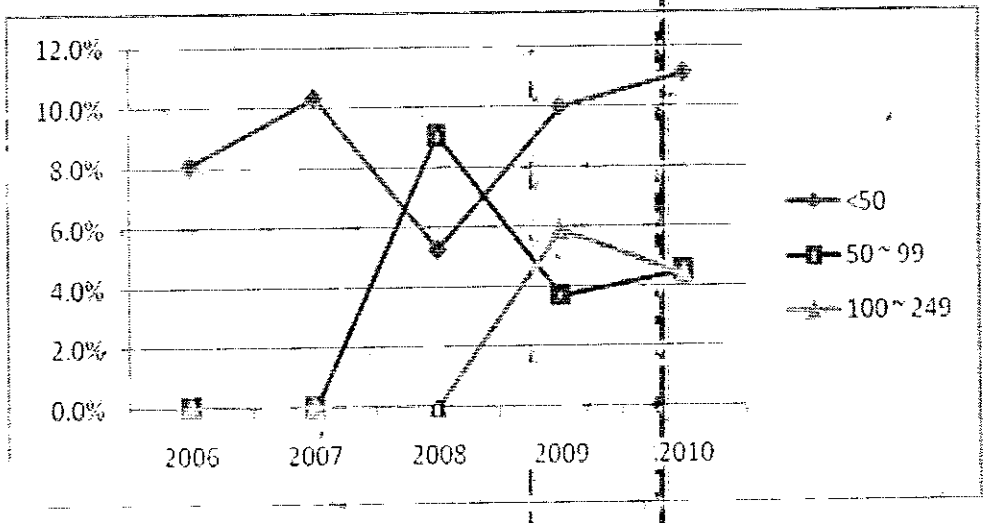


Figure 6 Product Based Annual Revenue Yearly Comparison

Table 6 Hybrid Companies Annual Revenue Comparison

		<50	50 ~ 99	100 ~ 249
Hybrid Companies	2006	48.6%	73.3%	100.0%
	2007	44.8%	70.0%	80.0%
	2008	47.4%	45.5%	92.3%
	2009	30.0%	51.9%	82.4%
	2010	22.2%	50.0%	78.3%

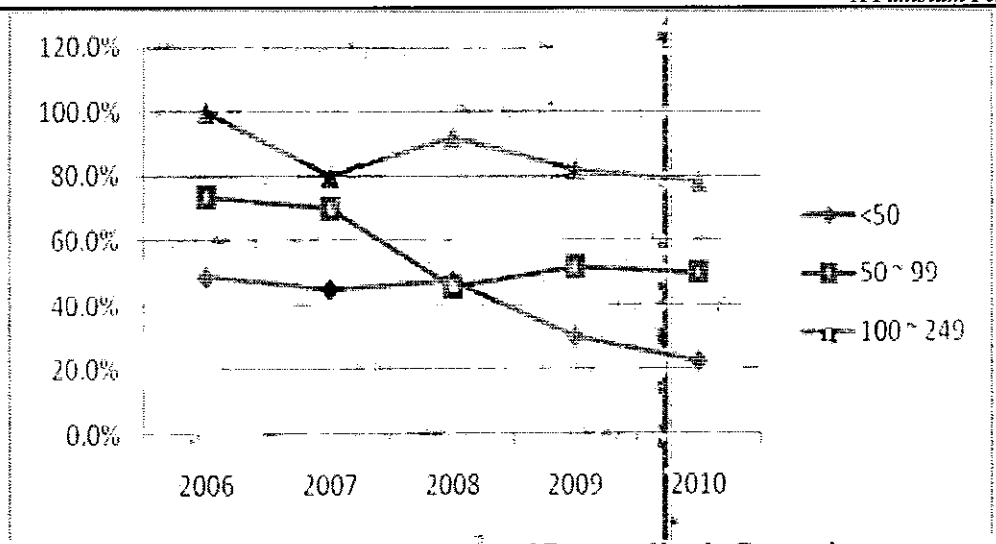


Figure 7 Hybrid Companies Annual Revenue Yearly Comparison

Type of Application Development

Application development with respect to the organization type was recorded and the analysis shows that Project Based Organization shows much more concerns in the business application rather than Engineering applications, System Software's & Web Application whereas Product Based organization shows average concerns both in Business & Web Application, same is the scenario with the Hybrid companies they have much more concerns in the Business & Web Applications.

Table 7 Type of Application Development

	Business Application	Engineering Application	System Software	Web Application
Project Based	16	10	5	6
Product Based	4	2	1	4
Hybrid	24	20	7	24

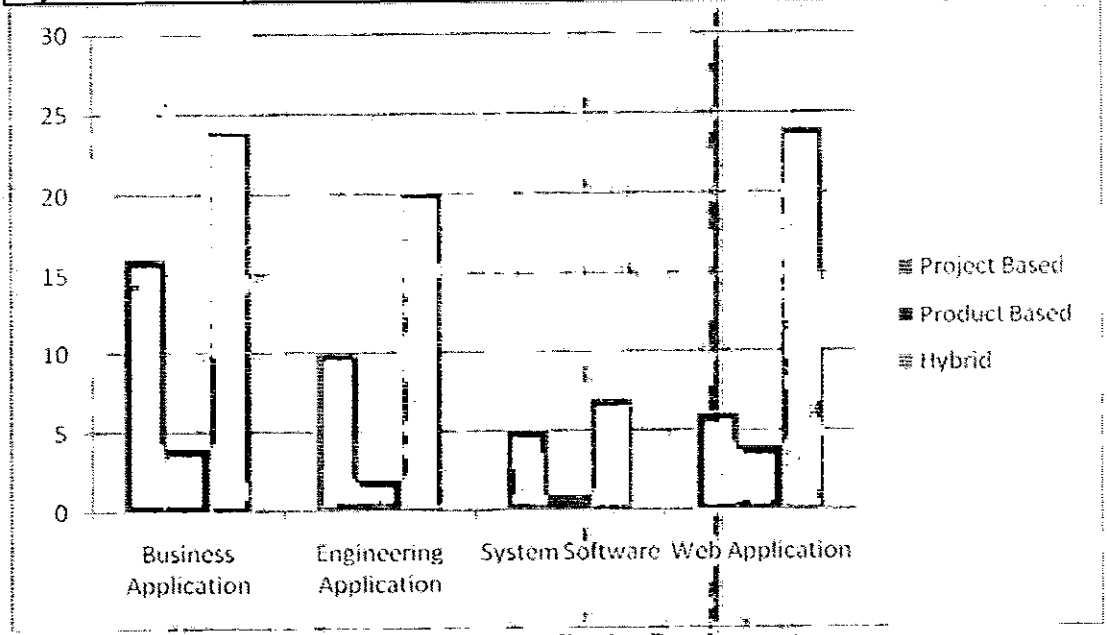


Figure 8 Type of Application Development

Risk Management Activity

Risk management activity was recorded in the survey from the participants having focus when they perform the Risk Management activities in their software development houses and out of 55 responses 23 responses was recorded from the organization that they perform the Risk management activity at the beginning of each stage that acquire about 42% of the total samples.

Table 8 Risk Management Activity

	Frequency	Percentage
At the beginning of the project	18	32.73
At the beginning of the each stage	23	41.82
On the weekly basis	6	10.91
Throughout the project	4	7.27
Other	4	7.27
	55	100

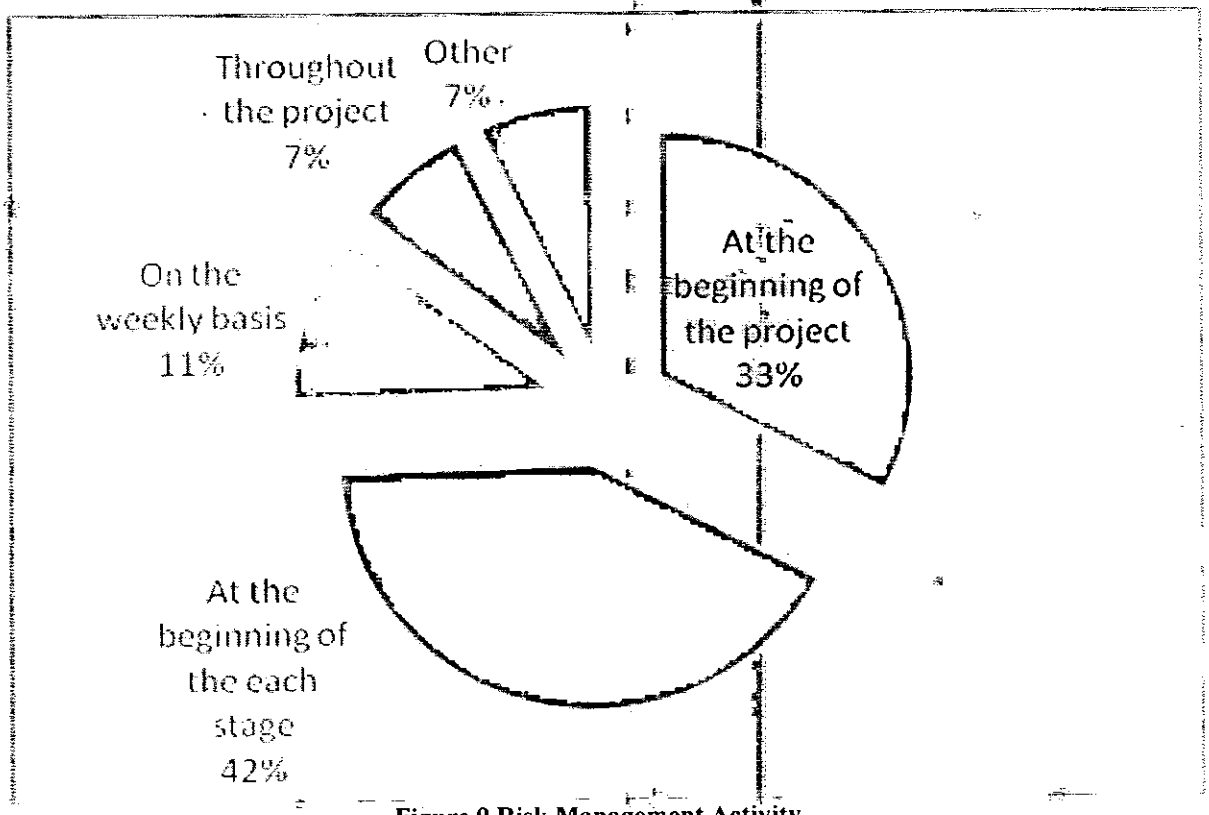


Figure 9 Risk Management Activity

Risk Management Process

Risk management Process was recorded in the survey from the participants having focused what they think about the Risk Management Process either it is a part of Project management, Business Management or Risk management is driving project Management. Out of 55 respondents 40 responses were in favor of Risk Management part of project Management that acquires about 73% of the total samples.

Table 9 Risk Management Process

	Frequency	Percentage
Risk Management part of Project Management	40	72.73
Risk Management part of Business Management	8	14.55
Risk Management driving Project Management	4	7.27
Other	3	5.45
	55	100

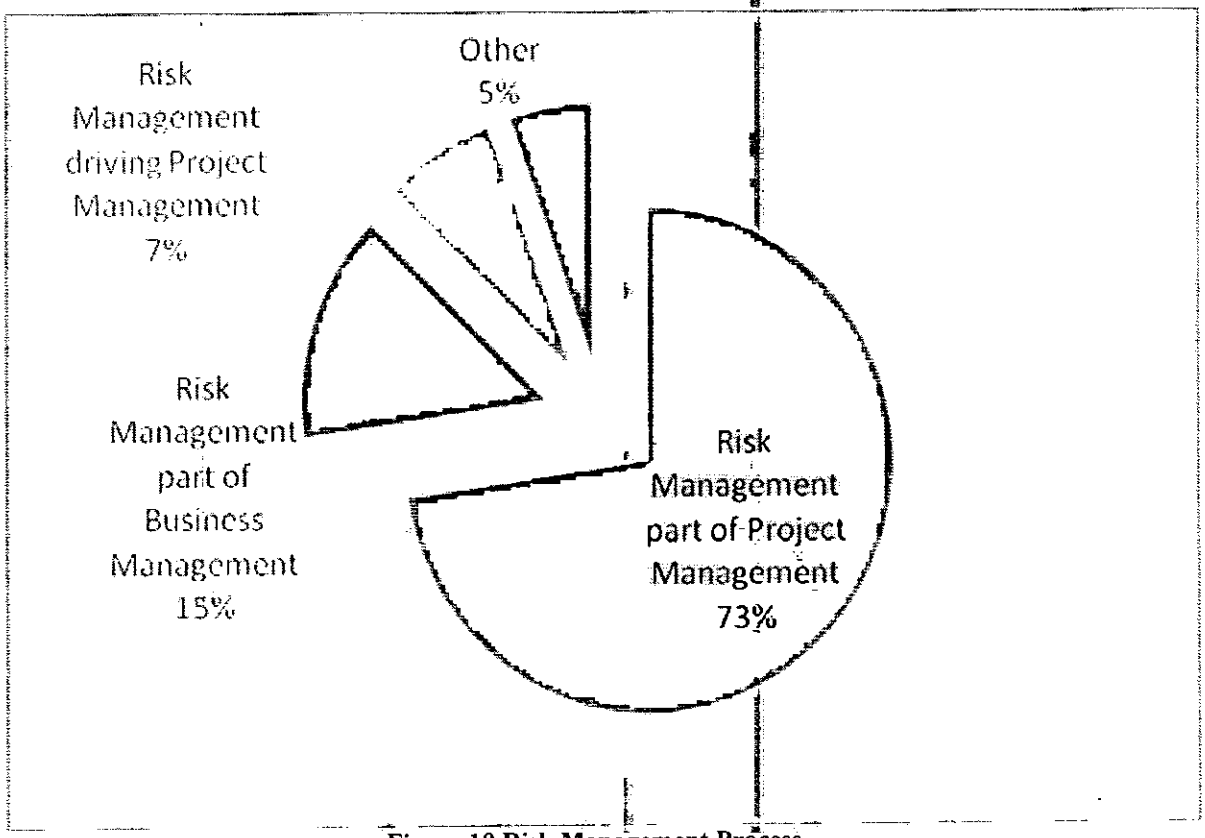


Figure 10 Risk Management Process

Risk Identification Methods

Risk Identification methods was recorded in the survey from the participants having focused about the most commonly used methodology while identifying Risks and out of 55 respondents 18 responses were in favor of Past Experiences that acquires about 33% of the total samples.

Table 10 Risk Identification Methods

	Frequency	Percentage
Common Sense	8	14.55
Past Experience	18	32.73
Historical Data	9	16.36
Analogies to other cases	11	20.00
Tools and Aids	5	9.09
Independent Assessors	1	1.82
Other	3	5.45
	55	100.00

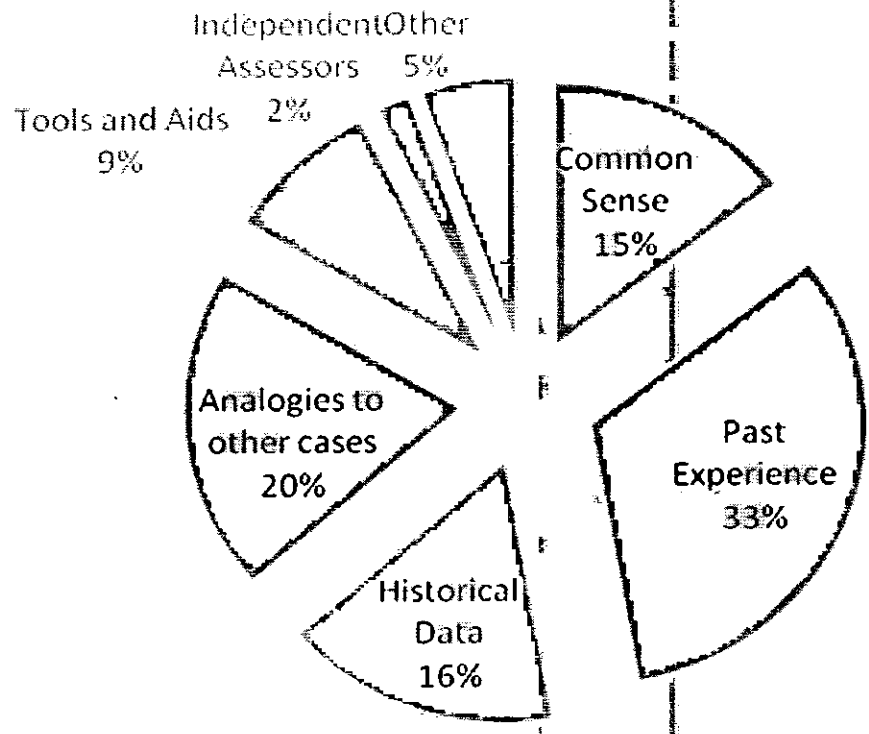


Figure 11 Risk Identification Methods

Risk Identification Tools

Risk Identification Tools are questioned in the questionnaire how the software practitioners identify Risk like they used checklist, questionnaire, interviews, brainstorming or any other methodology. In out of 55 responses 25 responses are in favor of brainstorming that is about 46% of the total samples.

Table 11 Risk Identification Tools

	Frequency	Percentage
Check List	12	21.82
Questionnaires	10	18.18
Interviews	6	10.91
Brainstorming	25	45.45
Other	2	3.64
	55	100.00

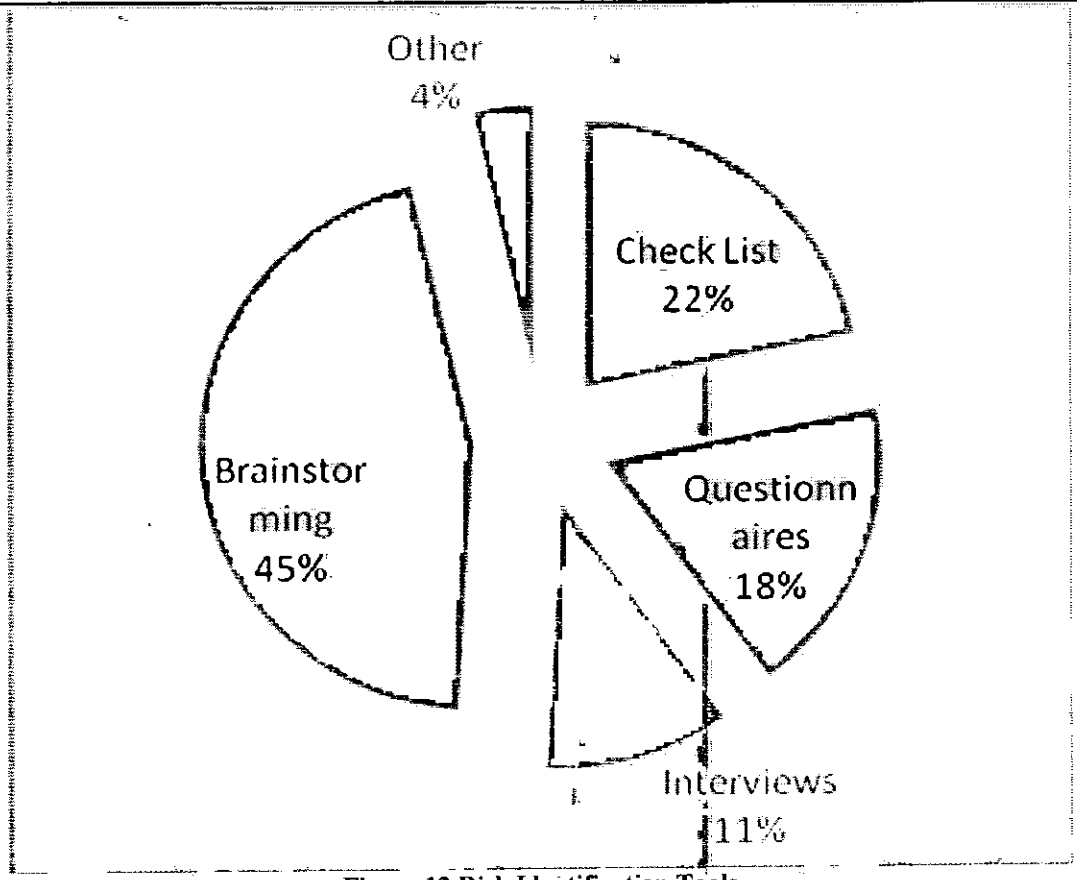


Figure 12 Risk Identification Tools

Major Concerns for Documentation

While documenting the Risk factors major concerns were questioned in the questionnaire and out of 55 responses from the respondents majorly key concerns were focused and answered by the software practitioners that are about 46% of the total samples.

Table 12 Major Concerns for Documentation

	Frequency	Percentage
Key Objectives	8	14.55
Constraints	3	5.45
Critical Success Factors	10	18.18
Key Concerns	25	45.45
Assumptions	7	12.73
Other	2	3.64
Total	55	100.00

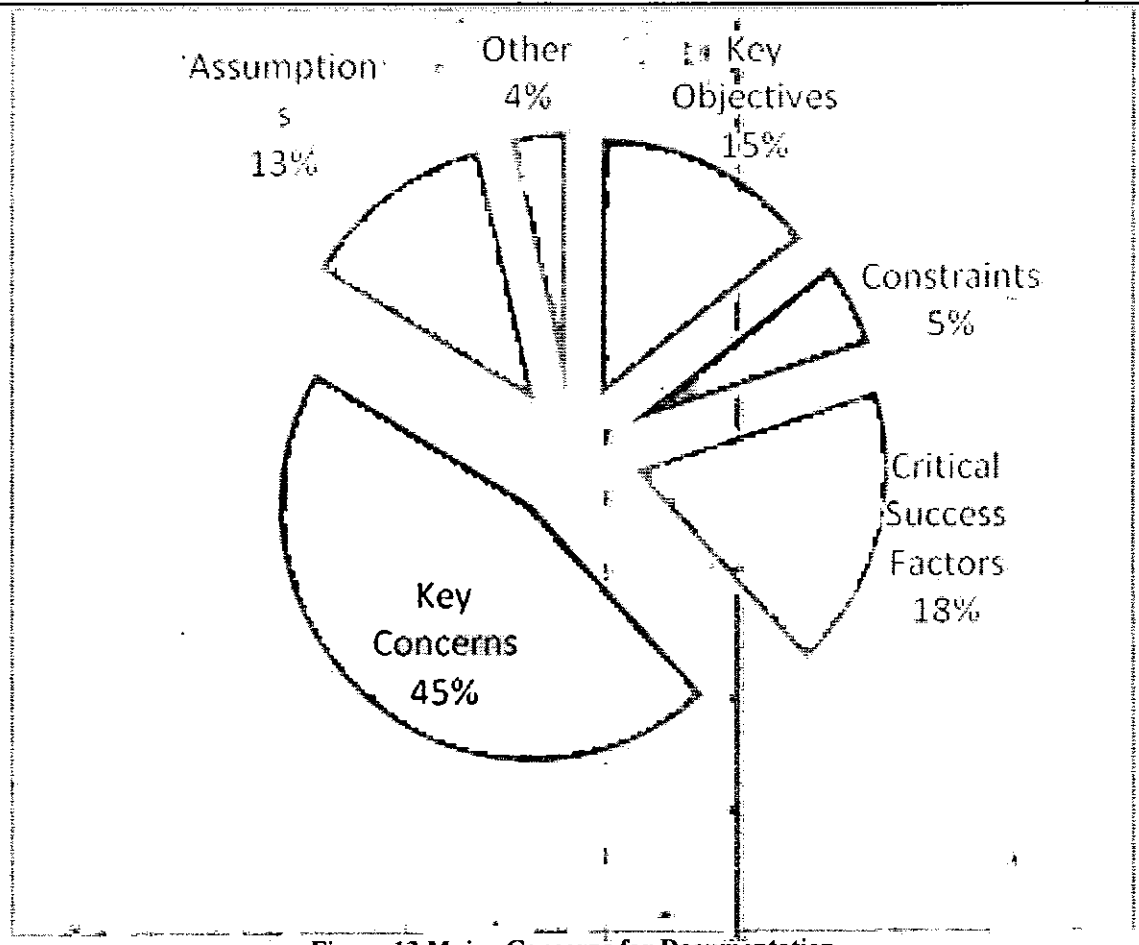


Figure 13 Major Concerns for Documentation

Opinion Consulted During Identification of Risk

In an opinion consulted during identification of Risk likert scale was used in the questionnaire with the reply from the respondents was recorded in line of Never, seldom, Occasionally, Often and Always.

Table 13 Opinion Consulted During Identification of Risk

		Never	Seldom	occasionally	often	always
Senior Manager	Project Based	8	8	1	2	1
	Product Based	2	1	1	0	0
	Hybrid Companies	13	14	1	2	1

		Never	Seldom	occasionally	often	always
Project Manager	Project Based	3	9	3	2	3
	Product Based	1	1	1	1	0
	Hybrid Companies	6	15	8	0	2

		Never	Seldom	occasionally	often	always
Development Team	Project Based	2	7	7	2	2
	Product Based	1	0	1	0	2
	Hybrid Companies	2	13	12	2	2

		Never	Seldom	occasionally	often	always
End Users	Project Based	2	7	7	1	3
	Product Based	1	2	0	1	0
	Hybrid Companies	9	7	10	4	1

Average Values

	Senior Manager	Project Manager	Development Team	End Users
Project Based	16	12	9	9
Product Based	3	2	1	3
Hybrid Companies	27	21	15	16

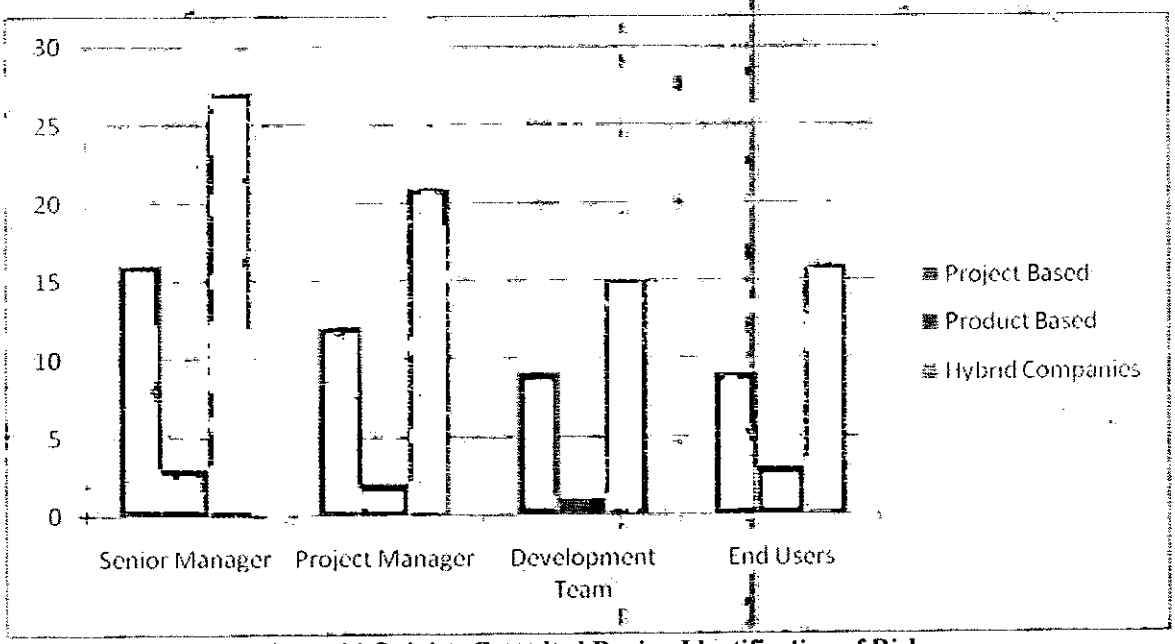


Figure 14 Opinion Consulted During Identification of Risk

The graph shows the values of Senior Manager, Project Manager, Development Team and End Users against the Project Based, Product Based & Hybrid Companies. As the graph shows Senior Manager was never or Seldom consulted while building opinion during Identification of Risk instead of this Development Team was consulted often.

Opinion Consulted During Assessment of Risk

In an opinion consulted during assessment of Risk likert scale was used in the questionnaire with the reply from the respondents was recorded in line of Never, seldom, Occasionally, Often and Always.

Table 14 Opinion Consulted During Assessment of Risk

		Never	Seldom	occasionally	often	always
Senior Manager	Project	5	10	2	2	1
	Product	1	2	1	0	0
	Hybrid	3	13	10	2	1

		Never	Seldom	occasionally	often	always
Project Manager	**Project**	3	10	4	0	3
	Product	1	0	1	1	1
	Hybrid	2	7	15	3	2

		Never	Seldom	occasionally	often	always
Development Team	**Project**	3	5	8	2	1
	Product	1	0	3	0	0
	Hybrid	2	11	5	9	0

		Never	Seldom	occasionally	often	always
End Users	**Project**	1	2	7	6	2
	Product	1	0	0	1	2
	Hybrid	7	4	10	4	3

The values of Senior Manager, Project Manager, Development Team and End Users against the Project Based, Product Based & Hybrid Companies has been recorded. As the graph shows Senior Manager was never or Seldom consulted while building opinion during assessment of Risk instead of this End User is more often consulted in the Project Based Organisation and Project Manager in Hybrid Companies whereas responses of Product Based organistation remains same against Porject Manager, Development Team & End Users.

Average Values

	Senior Manager	Project Manager	Development Team	End Users
Project Based	15	13	8	3
Product Based	3	1	1	1
Hybrid Companies	16	9	13	11

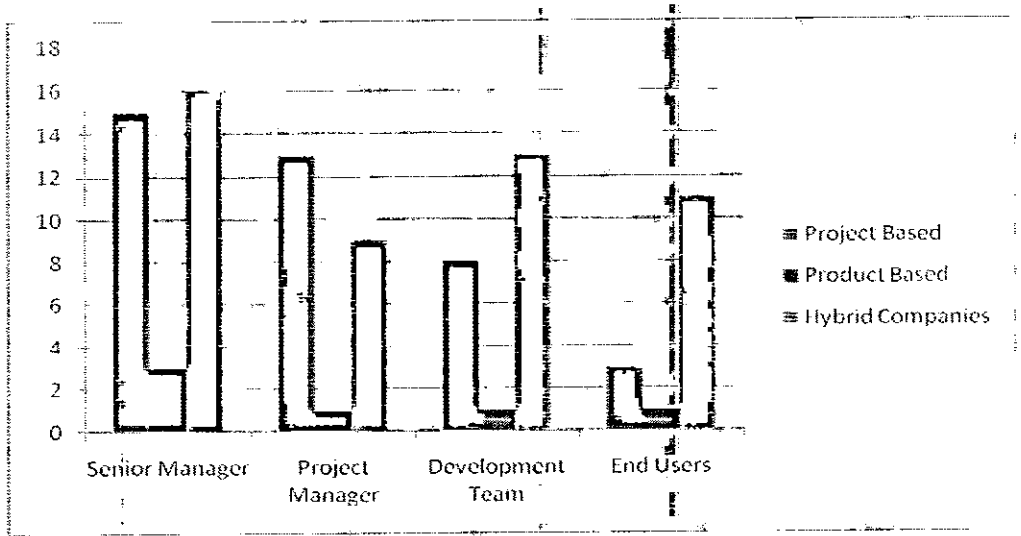


Figure 15 Opinion Consulted During Assessment of Risk

Disagreement among Participants

While Considering Disagreement among participants likert scale was used in the questionnaire with the reply from the respondents was recorded in line of Never, seldom, Occasionally, Often and Always.

Table 15 Disagreement among Participants

		Never	Seldom	occasionally	often	always
Senior Manager	Project	6	10	4	0	0
	Product	1	2	1	0	0
	Hybrid	9	12	6	3	1

		Never	Seldom	occasionally	often	always
Project Manager	Project	2	9	6	3	0
	Product	1	1	1	1	0
	Hybrid	2	12	15	1	1

		Never	Seldom	occasionally	often	always
Development Team	Project	1	5	10	3	1
	Product	1	0	1	2	0
	Hybrid	2	13	11	3	2

		Never	Seldom	occasionally	often	always
End Users	Project	2	4	7	6	1
	Product	1	0	1	2	0
	Hybrid	4	5	16	3	3

The values of Senior Manager, Project Manager, Development Team and End Users against the Project Based, Product Based & Hybrid Companies has been recorded.As the graph shows that the Senior Manager was never consulted in both Project Based Organisations as well as Hybrid Companies whereas End Users .

Average Values

	Senior Manager	Project Manager	Development Team	End Users
Project Based	16	11	6	6
Product Based	3	2	1	1
Hybrid Companies	21	14	15	9

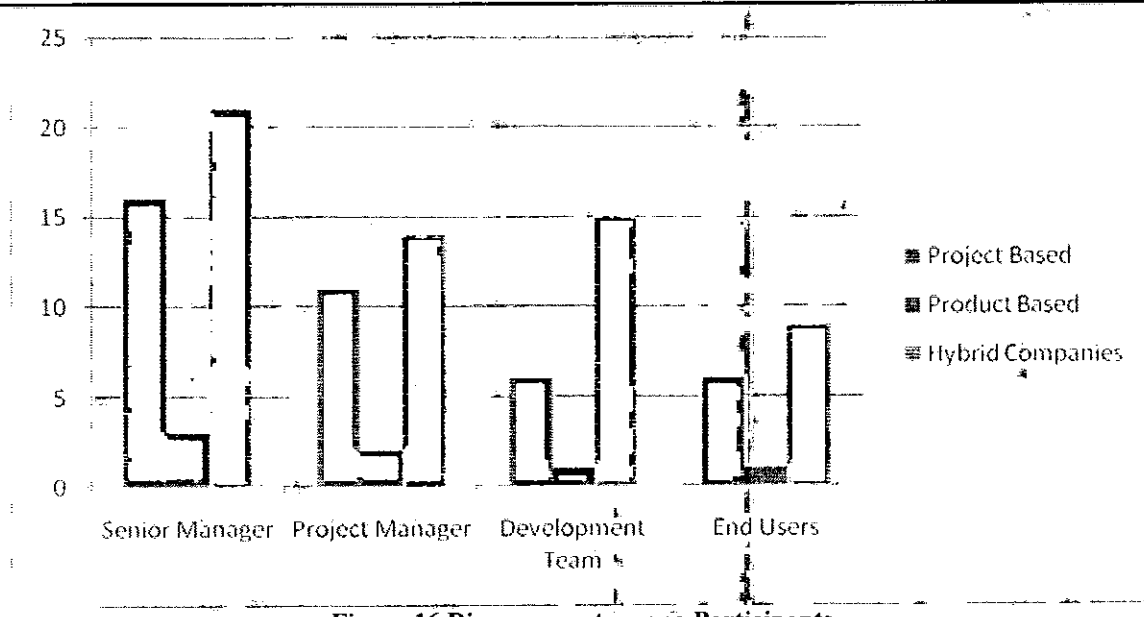


Figure 16 Disagreement among Participants

Discussion Initiatives

While recording about the who raises issues or discussion initiatives likert scale was used in the questionnaire with the reply from the respondents was recorded in line of Never, seldom, Occasionally, Often and Always.

Table 16 Discussion Initiatives

		Never	Seldom	occasionally	often	always
Senior Manager	Project	6	8	4	1	1
	Product	1	2	1	0	0
	Hybrid	7	18	2	4	0

		Never	Seldom	occasionally	often	always
Project Manager	Project	2	10	4	3	1
	Product	1	0	2	0	1
	Hybrid	4	9	15	2	1

		Never	Seldom	occasionally	often	always
Development Team	Project	2	4	9	3	2
	Product	1	1	0	1	1
	Hybrid	5	12	8	5	1

		Never	Seldom	occasionally	often	always
End Users	Project	2	4	8	3	3
	Product	1	0	2	1	0
	Hybrid	7	4	9	8	3

The values of Senior Manager, Project Manager, Development Team and End Users against the Project Based, Product Based & Hybrid Companies has been

recorded.As the graph shows that the Senior Manager was never been amoung initiators who raises issues in hybrid companies whereas Project Manager and End Users are amoung those who raises issues in Prduct Based Organisation & Hybrid Companies respectively & Product Based Organisations Development Team are amoung those who raises issues or take initiatives in discussion.

Average Values

	Senior Manager	Project Manager	Development Team	End Users
Project Based	14	12	6	6
Product Based	3	1	2	1
Hybrid Companies	25	13	17	11

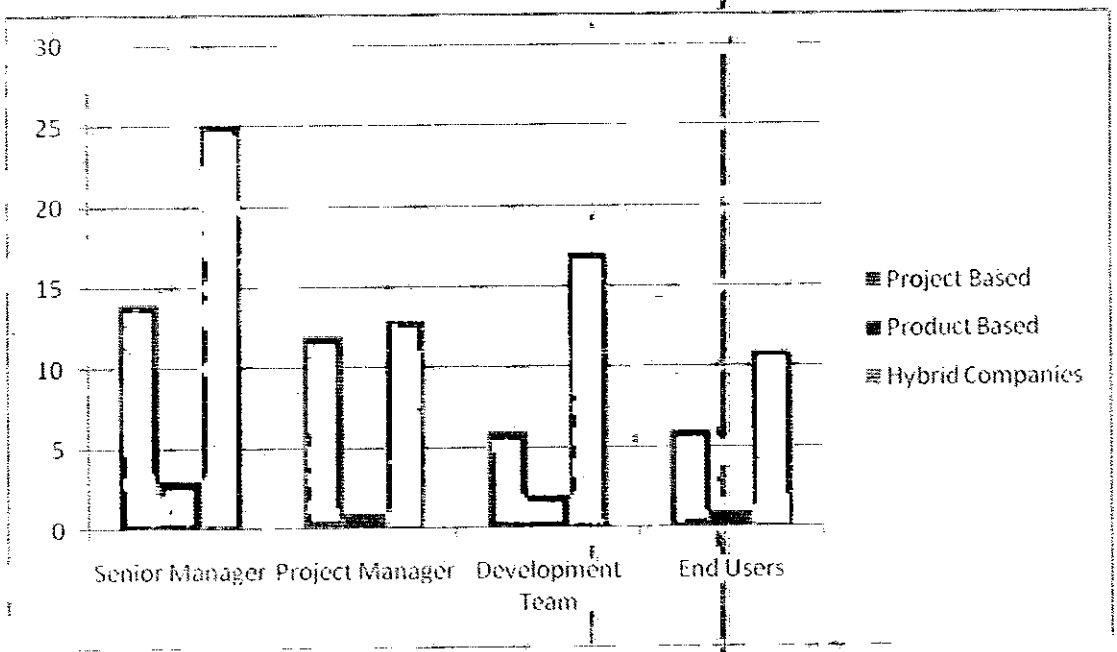


Figure 17 Discussion Initiatives

Disagreement Resolved

While documenting about the disagreement resolved factors were questioned in the questionnaire and out of 55 responses from the respondents majorly focused on expert option and about 29 responses was recorded by the software practitioners that are about 53% of the total samples.

Table 17 Disagreement Resolved

	Frequency	Percent
Majority	12	21.8
Consensus	8	14.5
Expert Option	29	52.7
Arbitration at High Level	4	7.3
On the Instruction from higher level	2	3.6
Total	55	100.0

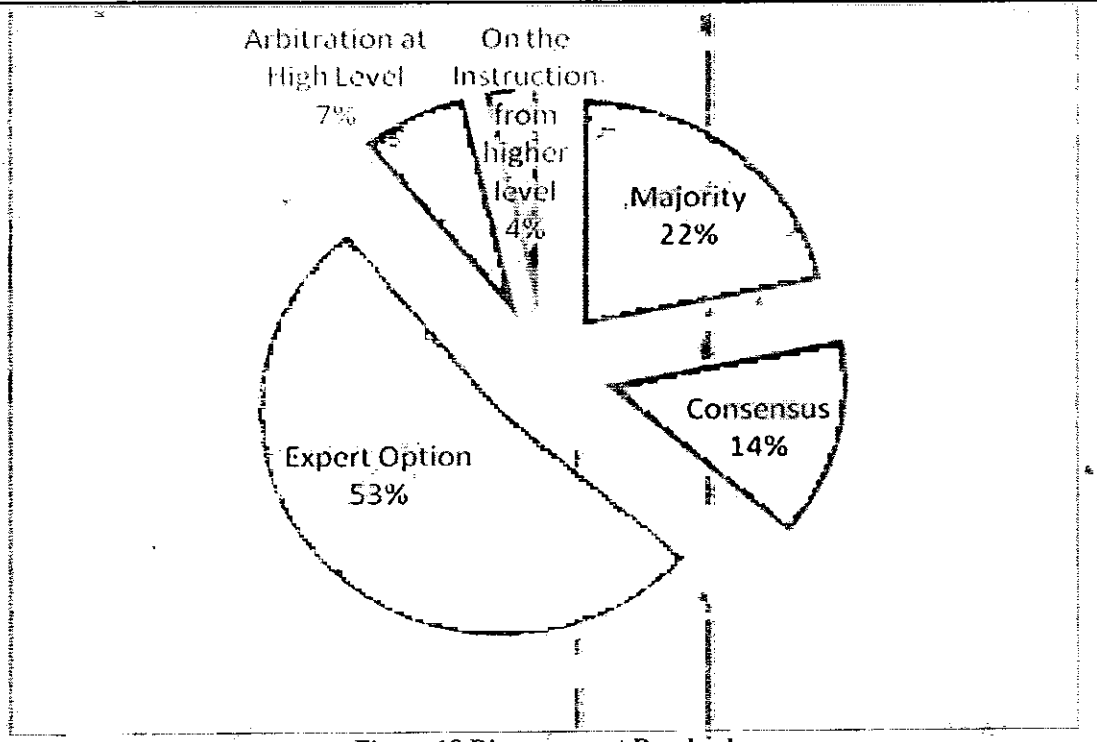


Figure 18 Disagreement Resolved

Comparison on Technical, Financial, Hiring & Job Assignments

Comparison on Technical matters, Financials matters, Hiring of new personal & Job assignment with in development team was questioned in the questionnaire & feed back against the Senior Manager, Project Manager, Development Team and End Users was recorded. In total there were about 55 responses was recorded.

Table 18 Comparison on Technical, Financial, Hiring & Job Assignments

Organization Type * Who choose the final course of action-taken on technical matters?

		Who choose the final course of action-taken on technical matters?				
		Senior Manager	Project Manager	Development Team	End Users	Total
Organization Type	Project Based	10	9	1	0	20
	Product Based	3	1	0	0	4
	Hybrid Company	21	8	2	0	31
Total		34	18	3	0	55

Organization Type * Who choose the final course of action-taken on financial matters?

		Who choose the final course of action-taken on financial matters?				
		Senior Manager	Project Manager	Development Team	End Users	Total
Organization Type	Project Based	13	6	1	0	20
	Product Based	4	0	0	0	4
	Hybrid Company	21	5	2	3	31
Total		38	11	3	3	55

Organization Type * Who authorize the hiring of new personnel for project teams?

		Who authorize the hiring of new personnel for project teams?				
		Senior Manager	Project Manager	Development Team	End Users	Total
Organization Type	Project Based	10	8	1	1	20
	Product Based	2	2	0	0	4
	Hybrid Company	11	18	1	1	31
Total		23	28	2	2	55

Organization Type * Who changes the job assignment within the development team?

		Who changes the job assignment within the development team?				
		Senior Manager	Project Manager	Development Team	End Users	Total
Organization Type	Project Based	3	16	1	0	20
	Product Based	1	3	0	0	4
	Hybrid Company	2	27	1	1	31
Total		6	46	2	1	55

Below mentioned table is about the factor analysis about the Project Based Organizations with respect to Technical Matters, Financial Matters, and Hiring of the New Personnel within the Project Team & Job Assignments within the Development Teams. The results shows that in project Based organizations Technical & Financial Matters are taken by Project Manager, Product Based Organization mostly the matters and involvement in discussion and disagreements has been resolved by the Senior Manager whereas the same results has been recorded in the hybrid companies.

		Senior Manager	Project Manager	Development Team	End Users
Project Based	Technical	29.41	50.00	33.33	0.00
	Financial	34.21	54.55	33.33	0.00
	Hiring	43.48	28.57	50.00	50.00
	Job Assignment	50.00	34.78	50.00	0.00

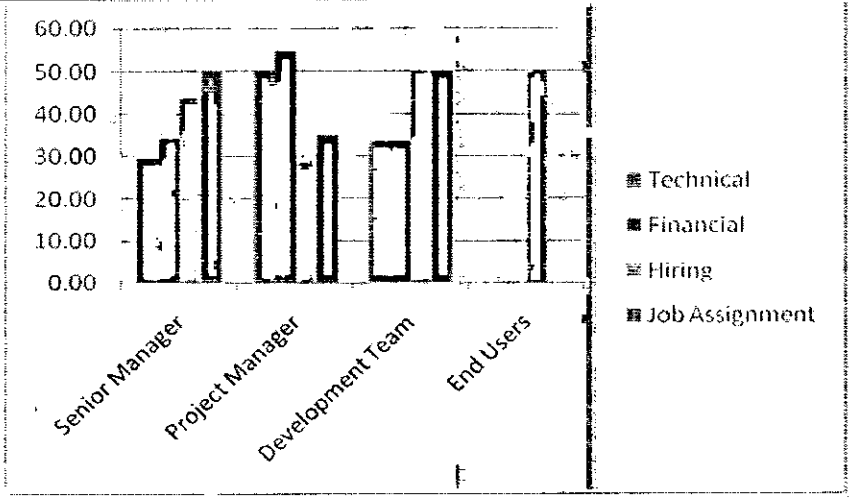


Figure 19 Project Based Comparisons

		Senior Manager	Project Manager	Development Team	End Users
Product Based	Technical	8.82	5.56	0.00	0.00
	Financial	10.53	0.00	0.00	0.00
	Hiring	8.70	7.14	0.00	0.00
	Job Assignment	16.67	6.52	0.00	0.00

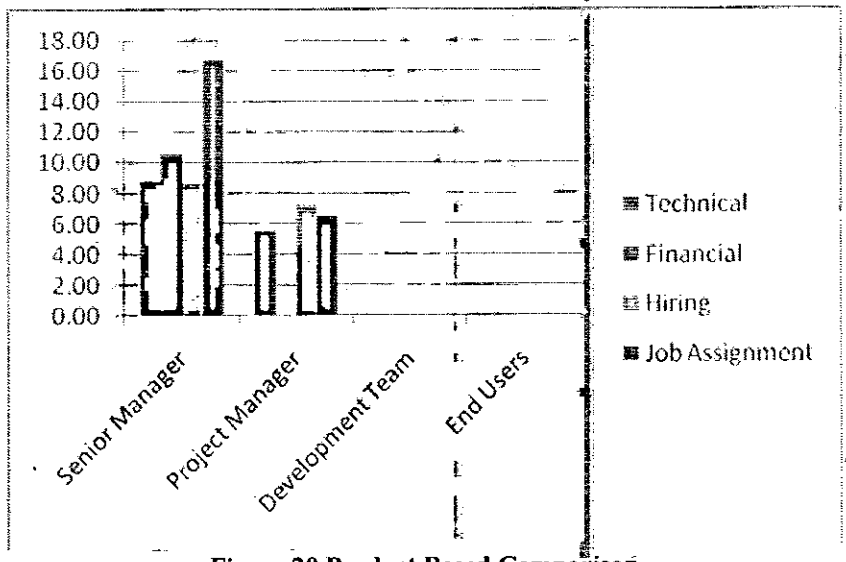


Figure 20 Product Based Comparison

		Senior Manager	Project Manager	Development Team	End Users
Hybrid Companies	Technical	61.76	44.44	66.67	0.00
	Financial	55.26	45.45	66.67	100.00
	Hiring	47.83	64.29	50.00	50.00
	Job Assignment	33.33	58.70	50.00	100.00

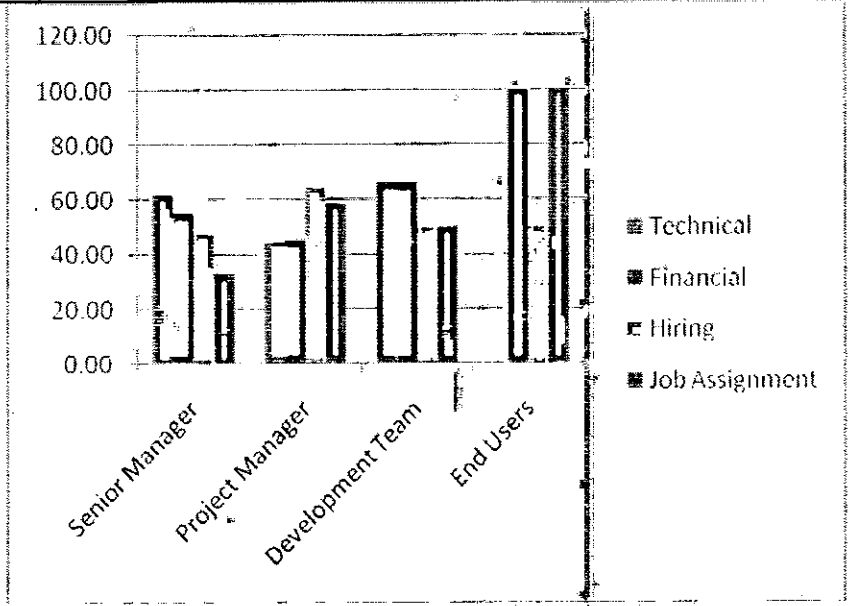


Figure 21 Hybrid Companies Comparison

Influence on Decision during Risk Management Process

In recording the factors about the influence on Decision during Risk Management Process amoung Senior Manager, Project Manager, Development

Team and End Users. Likert scale was used to records the results amoug the participant with the factors very little, some, fair, much and a lot.

Table 19 Influence on Decision during Risk Management Process

How much influence do you think the following have over the decision made during the Risk management process?[Senior Manager]

		How much influence do you think the following have over the decision made during the Risk management process?[Senior Manager]					
		Very Little	Some	Fair	Much	Alot	Total
Organization Type	Project Based	7	8	2	0	3	20
	Product Based	2	1	0	0	1	4
	Hybrid Company	14	10	5	1	1	31
	Total	23	19	7	1	5	55

How much influence do you think the following have over the decision made during the Risk management process?[Project Manager]

		How much influence do you think the following have over the decision made during the Risk management process?[Project Manager]					
		Very Little	Some	Fair	Much	Alot	Total
Organization Type	Project Based	1	8	6	4	1	20
	Product Based	1	1	0	2	0	4
	Hybrid Company	6	13	10	1	1	31
	Total	8	22	16	7	2	55

How much influence do you think the following have over the decision made during the Risk management process?[Development Team]

		How much influence do you think the following have over the decision made during the Risk management process?[Development Team]					
		Very Little	Some	Fair	Much	Alot	Total
Organization Type	Project Based	2	2	13	1	2	20
	Product Based	1	0	2	1	0	4
	Hybrid Company	2	8	13	7	1	31
	Total	5	10	28	9	3	55

How much influence do you think the following have over the decision made during the Risk management process?[End Users]

		How much influence do you think the following have over the decision made during the Risk management process?[End Users]					
		Very Little	Some	Fair	Much	Alot	Total
Organization Type	Project Based	3	6	4	5	2	20
	Product Based	1	0	0	2	1	4
	Hybrid Company	6	9	11	4	1	31
	Total	10	15	15	11	4	55

The average values table shows the Project Based organizations, Product Based Organizations & Hybrid companies date with the comparison of figures among senior manager, project manager, development team & end users. The results shows that the senior manager has very little impact in the Hybrid companies and Development Team has very high impact in the Project Based

organizations the same results is for the Product based organizations & Project Based Organization.

Average Values

	Senior Manager	Project Manager	Development Team	End Users
Project Based	15	9	4	9
Product Based	3	2	1	1
Hybrid Companies	24	19	10	15

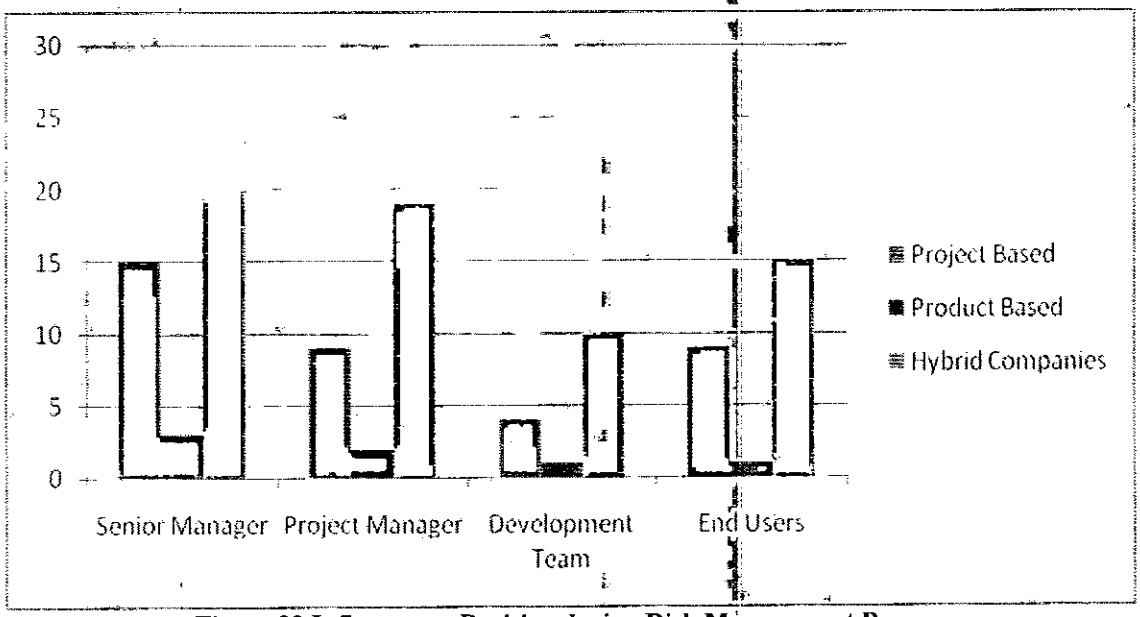


Figure 22 Influence on Decision during Risk Management Process

Percentage of Total Project Time over an Average Project

Results in percentages of the total project time over an average project estimated is spent on within the Project Based Organizations, Product Based Organization & Hybrid companies in context of Identification, Assessment and Planning & Control.

Table 20 Percentage of Total Project Time over an Average Project

What percentage of the total project time over an average project do you estimate is spent on?

		What percentage of the total project time over an average project do you estimate is spent on?[Identification]					
		<2%	2 ~ 5 %	6 ~10 %	11~20%	>20%	Total
Organization Type	Project Based	2	12	4	1	1	20
	Product Based	2	1	1	0	0	4
	Hybrid Company	4	11	11	2	3	31
Total		8	24	16	3	4	55

What percentage of the total project time over an average project do you estimate is spent on?

		What percentage of the total project time over an average project do you estimate is spent on?[Assessment]					
		<2%	2 ~ 5 %	6 ~10 %	11~20%	>20%	Total
Organization Type	Project Based	1	6	11	2	0	20
	Product Based	1	1	2	0	0	4
	Hybrid Company	3	6	18	3	1	31
Total		5	13	31	5	1	55

What percentage of the total project time over an average project do you estimate is spent on?

		What percentage of the total project time over an average project do you estimate is spent on?[Planning & Control]					
		<2%	2 ~ 5 %	6 ~10 %	11~20%	>20%	Total
Organization Type	Project Based	3	3	9	4	1	20
	Product Based	1	1	2	0	0	4
	Hybrid Company	3	9	9	6	4	31
Total		7	13	20	10	5	55

In Project Based organizations average percentages is 2 ~ 5 % for the identification of Risk, 6 ~ 10% us for assessment & the same percentages for Planning & control.

		<2%	2 ~ 5 %	6 ~10 %	11~20%	>20%
Project Based	Identification	2	12	4	1	1
	Assessment	1	6	11	2	0
	Planning & Control	3	3	9	4	1

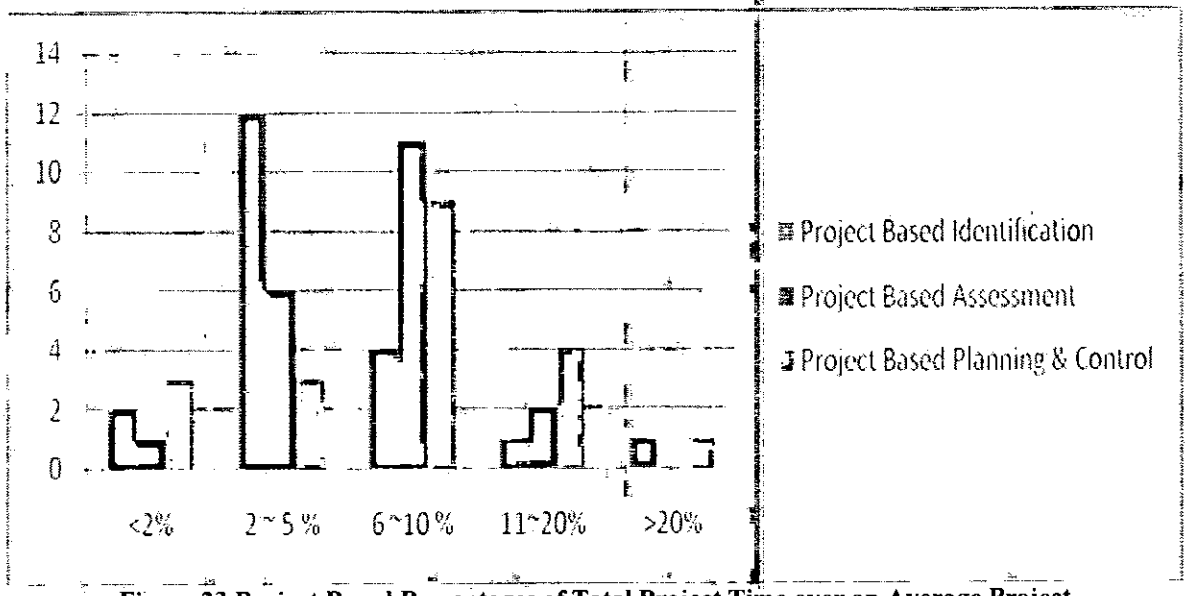


Figure 23 Project Based Percentages of Total Project Time over an Average Project

In Product Based organizations average percentages is less than 2% for the identification of Risk, 6 ~ 10% us for assessment & the same percentages for Planning & control.

		<2%	2 ~ 5 %	6 ~10 %	11~20%	>20%
Product Based	Identification	2	1	1	0	0
	Assessment	1	1	2	0	0
	Planning & Control	1	1	2	0	0

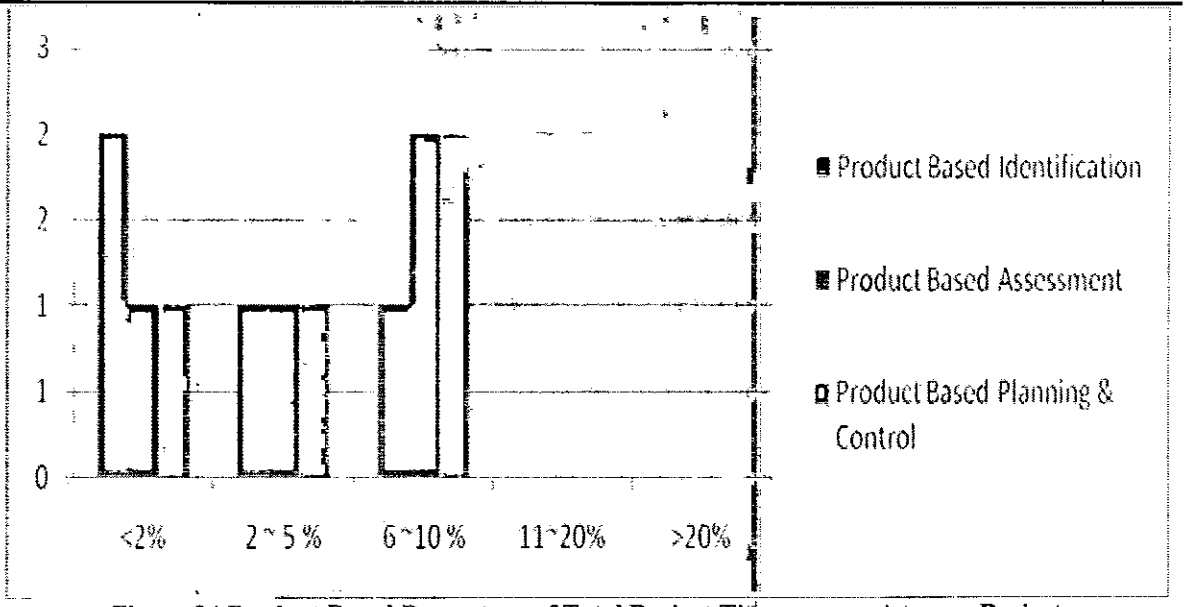


Figure 24 Product Based Percentage of Total Project Time over an Average Project

In Hybrid Companies average percentages is 2 ~ 10% for the identification of Risk, 6 ~ 10% us for assessment & 2 ~ 10% for Planning & control.

		<2%	2 ~ 5 %	6 ~10 %	11~20%	>20%
Hybrid Companies	Identification	4	11	11	2	3
	Assessment	3	6	18	3	1
	Planning & Control	3	9	9	6	4

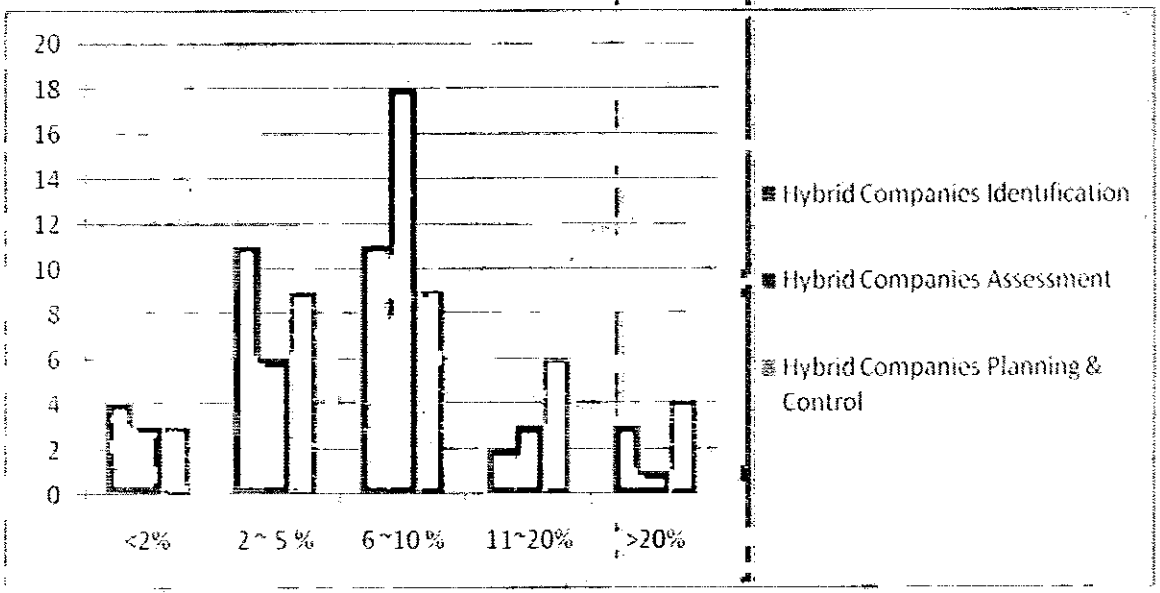


Figure 25 Hybrid Companies Percentages of Total Project Time over an Average Project

Project Budget over an Average Project

Results in percentages of the total project budget over an average project estimated is spent on within the Project Based Organizations, Product Based Organization & Hybrid companies in context of Identification, Assessment and Planning & Control.

Table 21 Project Budget over an Average Project

What percentage of the project budget over an average project do you estimate is spent on?

		What percentage of the project budget over an average project do you estimate is spent on?[Assessment]					Total
		<2%	2 ~ 5 %	6 ~10 %	11~20%	>20%	
Organization Type	Project Based	6	8	6	0	0	20
	Product Based	2	1	1	0	0	4
	Hybrid Company	2	17	11	1	0	31
	Total	10	26	18	1	0	55

What percentage of the project budget over an average project do you estimate is spent on?

		What percentage of the project budget over an average project do you estimate is spent on?[Assessment]					Total
		<2%	2 ~ 5 %	6 ~10 %	11~20%	>20%	
Organization Type	Project Based	2	4	13	1	0	20
	Product Based	2	1	1	0	0	4
	Hybrid Company	4	4	21	1	1	31
	Total	8	9	35	2	1	55

What percentage of the project budget over an average project do you estimate is spent on?

		What percentage of the project budget over an average project do you estimate is spent on?[Planning & Control]					Total
		<2%	2 ~ 5 %	6 ~10 %	11~20%	>20%	
Organization Type	Project Based	3	4	10	1	2	20
	Product Based	1	1	2	0	0	4
	Hybrid Company	6	9	7	7	2	31
	Total	10	14	19	8	4	55

In Project Based organizations average percentages is 2 ~ 5 % for the identification of Risk, 6 ~ 10% us for assessment & the same percentages for Planning & control is spent on Project budget over an average project.

		<2%	2 ~ 5 %	6 ~10 %	11~20%	>20%
Project Based	**Identification**	6	8	6	0	0
	Assessment	2	4	13	1	0
	Planning & Control	3	4	10	1	2

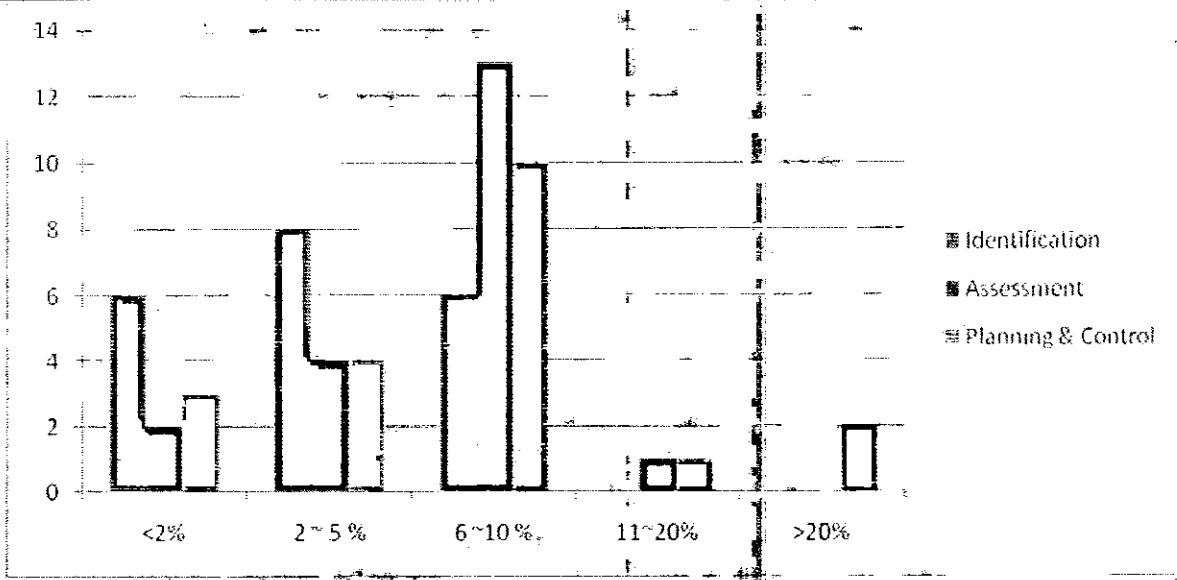


Figure 26 Project Based Project Budget over an Average Project

In Product Based organizations less than 2% for the identification of Risk and Assessment of Risk, 6 ~ 10% for Planning & control is spent on Project budget over an average project.

		<2%	2 ~ 5 %	6 ~10 %	11~20%	>20%
Product Based	**Identification**	2	1	1	0	0
	Assessment	2	1	1	0	0
	Planning & Control	1	1	2	0	0

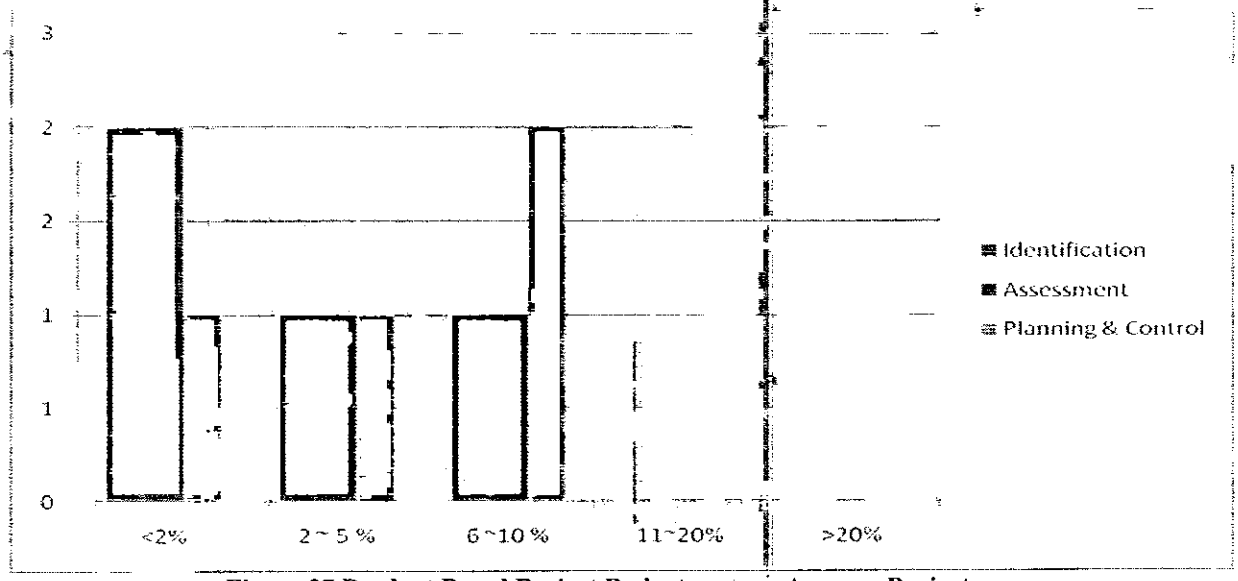


Figure 27 Product Based Project Budget over an Average Project

In Hybrid Companies average percentages is 2 ~ 5 % for the identification of Risk, 6 ~ 10% us for assessment & 2 ~ 5 % for Planning & control is spent on Project budget over an average project.

		<2%	2 ~ 5 %	6 ~10 %	11~20%	>20%
Hybrid Companies	**Identification**	2	17	11	1	0
	Assessment	4	4	21	1	1
	Planning & Control	6	9	7	7	2

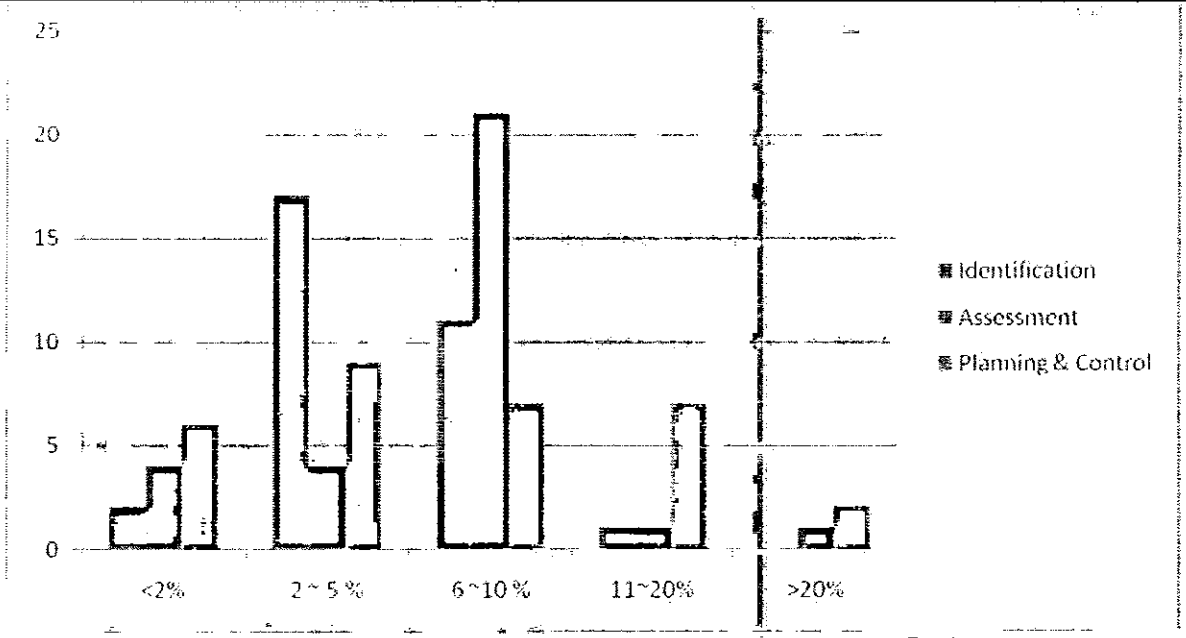


Figure 28 Hybrid Companies Project Budget over an Average Project

Table 22 Summary of Software Project Risks & Risk Factors in during Software Development.

Year	Author	Software Risks	Risk Factors	Research Area
2006	Wen-Hing Han et al.	27	6	Common
2004	Wallace & Keil	10	0	Common
2004	Wallace et al.	27	6	Common
2003	Mursu et al.	10	0	Common
2003	Carney et al.	21	4	COTS
2003	Addison	28	10	E-Commerce
2002	Murthi	12	0	Common
2001	Houston et al.	29	0	Common
2001	Schmidt et al.	33	14	Common
2000	Clue et al.	55	4	Common
2000	Sumner	19	6	ERP
1993	Barki et al.	35	5	Common
1991	Boehm	10	0	Common
1981	McFarlan	54	3	Common

Major Risk Factors

Table 23 Software risks considered in this study

Risk Factors	ID	Software Project Risk	Representative References
User Management	U1	Lack of user participation	[20,4]
	U2	Users not committed the project	
	U3	Lack of cooperation from users	
	U4	Users have negative attitude towards the project	
	U5	Conflict between users	
Requirement Engineering	R1	Rapidly changing system requirements	[4,13,16,20]
	R2	Incomplete & unclear system requirements	
	R3	Incorrect system requirements	
	R4	System requirements not adequately identified	
	R5	Conflicting system requirements	
	R6	Ineffective requirements change management process	
Team Management	T1	Frequent conflict between development team member	[20]
	T2	Frequent turnover within the project team	
	T3	Inadequately trained development team members	
	T4	Team members are inexperienced	
	T5	Team members not familiar with the task	
Technology	Tech 1	Large number of links to other systems required	[16,34]
	Tech 2	Project involves the use of new technology	
	Tech 3	Technology incompetence	
	Tech 4	Immature technology	
Staffing	Staf 1	Insufficient/inappropriate staffing	[13,16,34]
	Staf 2	Staffing volatility	
	Staf 3	Excessive use of outside consultants	
	Staf 4	Lack of available skilled personnel	
Sponsorship/ Ownership	Spons1	Failure to get project plan approval from all parties	[34,35,36]
	Spons2	Conflict between user departments	
	Spons3	Failure to gain user commitment	
	Spons4	Lack of top management commitment to the project	
Scheduling	Sch 1	"Preemption" of project by higher priority project	[1,13,36]
	Sch 2	Artificial deadlines	
Planning	P1	Lack of project planning	[3, 20,36]
	P2	Inadequate planning	
Development Process	DP1	Lack of effective development process/methodology	[35,36]
	DP2	Trying new development method/technology during important project	
Project Management	PM1	Lack of effective project management skills	[34,36]
	PM2	Lack of effective project management methodology	
	PM3	Poor or nonexistent control	
	PM4	Choosing the wrong development strategy	
	PM5	Poor risk management	
	PM6	Not managing change properly	
	PM7	Improper definition of roles and responsibilities	

Risk Factors	ID	Software Project Risk	Representative References
Relationship Management	RM1	Managing multiple relationships with stakeholders	[13,16,35,36]
	RM2	Lack of cooperation from users	
	RM3	Lack of appropriate experience of the user representatives	
	RM4	Growing sophistication of users leads to higher expectations	
	RM5	Lack of cooperation from users	
	RM6	Failure to identify all stakeholders	
	RM7	Failure to manage end-user expectations	
Funding	Fun1	Underfunding of development	[13,34,36]
	Fun2	Underfunding of maintenance	
	Fun3	Bad estimation	
Scope	Scope1	Unclear/misunderstood scope/objectives	[16,34,35]
	Scope2	Changing scope/objectives	
	Scope3	Scope creep	
	Scope4	Project not based on sound business case	
	Scope5	Number of organizational units involved	
External Dependencies	ED1	External dependencies not met	[34,35,36]
	ED2	Multi-vendor projects complicate dependencies	
	ED3	Lack of control over consultants, vendors, and subcontractors	
Product	Prod1	Lack of clear product vision	[10,20,36]
	Prod2	Lack of agreement on product requirements	
Corporate Environment	CE1	Unstable corporate environment	[13,16,34,35]
	CE2	Change in ownership or senior management	
	CE3	Projects that are intended to fail	
	CE4	Mismatch between company culture and required business process changes needed for new system	
	CE5	A climate of change in the business and organizational environment that creates instability in the project	

Risk Factors with Measurement Items

Table 24 Description of risk factors & no. of Measurement items

Risk Factors	No. of Measurement items	Description
User Management	5	User risks refer to define that issues which are associated with the project sponsor, customer & user. Like, lack of user participations, corporation, & involvements.
Requirement Management	5	Requirement risk factor is a major factor that can impact project performance. Unusable, unclear, incorrect, ambiguous, inadequate or rapidly changing requirements may increase the problems or risks associated with a software development project.
Team Management	5	Team risk refers issues associated with the project team members that can increase the uncertainty of a projects outcome, like, insufficient knowledge among team members cooperation, motivation & communication issues.
Technology	4	Insufficient understanding of the technology that is chosen.
Staffing	4	Changes in staffing levels or personnel, key personnel resources unavailability.
Sponsorship/ Ownership	5	Lack of mandate for the PM to execute the project plan. Lack of trust or poor relationships with the owners of the system.
Scheduling	2	Poor management of resource consumption and needs. Poor timing.
Planning	2	No interest or inadequate skills to plan the project.
Development Process	2	Inappropriate or lacking process approach.
Organizational Environment	3	Organizational Environment risk factor can impact Lack of IT & Top Management support for the project, Organizational management changing during project etc.
Product	2	Product risks factor refer to define that issues which are associated with Lack of agreement on product requirements.
Project Management	7	Inefficient or very poor management strategy and execution.
Relationship Management	7	Lack of trust and inadequate user involvement. Unclear roles and expectations among users or other stakeholders.
Funding	3	badly estimated or very little resources for SD.
Scope	5	Unclear, changing, or partial understanding of the system scope and mission.
External Dependencies	3	Poor management or control over dependencies with external agents.
Corporate Environment	5	Changes in the political, business environment or poor alignment of system with the organizational environment.

Confirmatory Factor Analysis Model

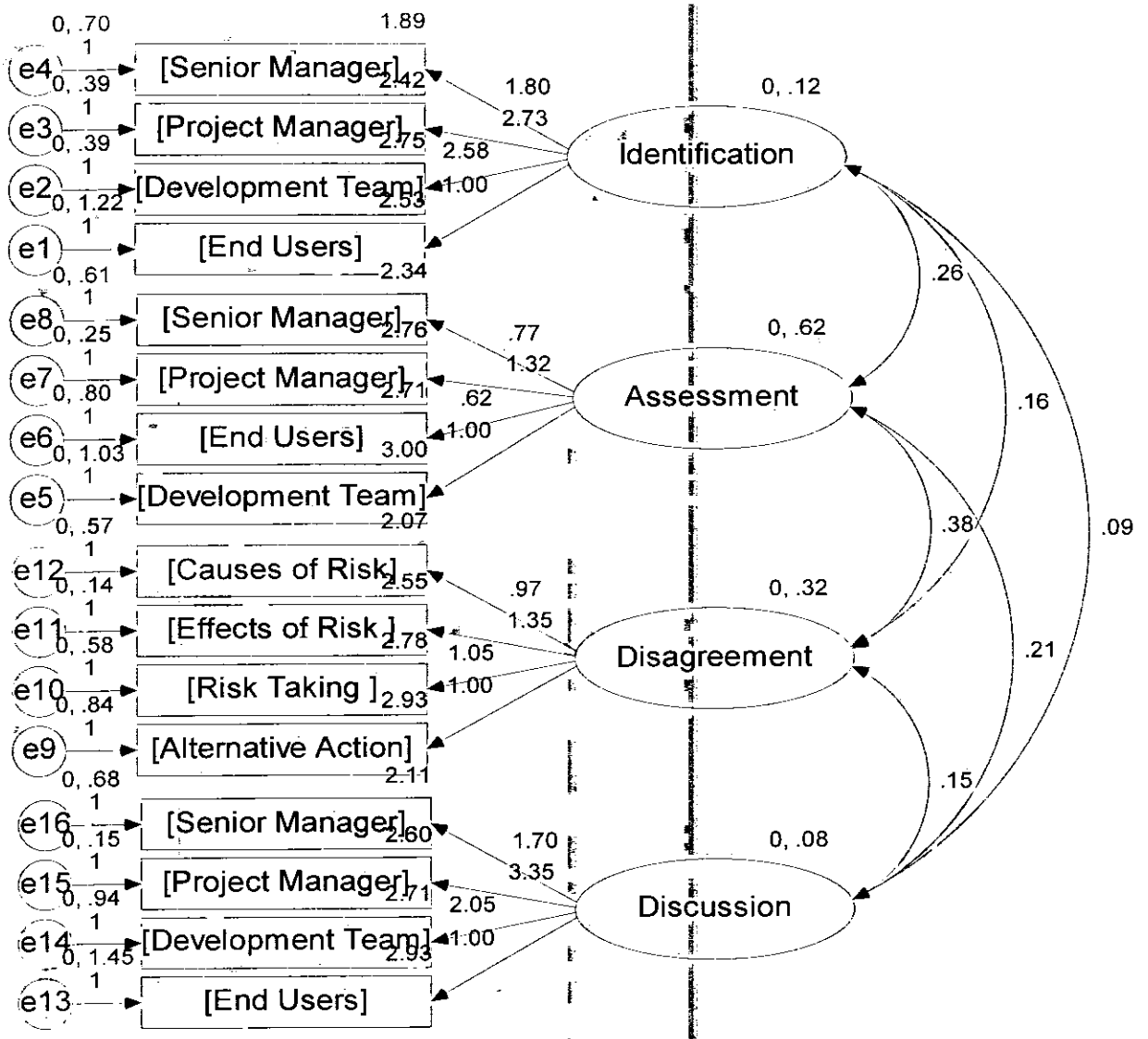


Figure 29 Confirmatory Factors Analysis Model

1 Parameter summary (Group number 1)

	Weights	Covariance	Variances	Means	Intercepts	Total
Fixed	20	0	0	0	0	20
Labeled	0	0	0	0	0	0
Unlabeled	12	8	20	0	16	56
Total	32	8	20	0	16	76

2 Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
Opinion_for_Risk_identify_EU	<---	Identification	1.000				
Opinion_for_Risk_identify_DT	<---	Identification	2.548	1.183	2.153	.031	par_1
Opinion_for_Risk_identify_PM	<---	Identification	2.685	1.245	2.158	.031	par_2
Opinion_for_Risk_identify_SM	<---	Identification	1.760	.869	2.026	.043	par_3
Opinion_for_RiskAssessment_EU	<---	Assessment	1.000				

			Estimate	S.E.	C.R.	P	Label
Opinion_for_RiskAssessment_DT	<---	Assessment	.610	.203	2.999	.003	par_4
Opinion_for_RiskAssessment_PM	<---	Assessment	1.310	.272	4.816	***	par_5
Opinion_for_RiskAssessment_SM	<---	Assessment	.747	.202	3.695	***	par_6
Participant_Disagreement_Alt_Action	<---	Disagreement	1.000				
Participant_Disagreement_RiskTaking	<---	Disagreement	1.075	.344	3.125	.002	par_7
Participant_Disagreement_effect	<---	Disagreement	1.395	.359	3.889	***	par_8
Participant_Disagreement_Causes	<---	Disagreement	1.050	.334	3.148	.002	par_9
Initiate_Discussion_EU	<---	Discussion	1.000				
Initiate_Discussion_DT	<---	Discussion	2.028	1.284	1.580	.114	par_10
Initiate_Discussion_PM	<---	Discussion	3.275	1.937	1.691	.091	par_11
Initiate_Discussion_SM	<---	Discussion	1.650	1.052	1.569	.117	par_12

3 Intercepts: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
Opinion_for_Risk_identify_EU	2.527	.158	16.042	***	par_21
Opinion_for_Risk_identify_DT	2.745	.147	18.639	***	par_22
Opinion_for_Risk_identify_PM	2.418	.153	15.821	***	par_23
Opinion_for_Risk_identify_SM	1.891	.141	13.377	***	par_24
Opinion_for_RiskAssessment_EU	3.004	.180	16.659	***	par_25
Opinion_for_RiskAssessment_DT	2.711	.144	18.822	***	par_26
Opinion_for_RiskAssessment_PM	2.756	.158	17.466	***	par_27
Opinion_for_RiskAssessment_SM	2.340	.136	17.241	***	par_28
Participant_Disagreement_Alt_Action	2.927	.146	19.987	***	par_29
Participant_Disagreement_RiskTaking	2.782	.132	21.150	***	par_30
Participant_Disagreement_effect	2.545	.116	22.034	***	par_31
Participant_Disagreement_Causes	2.073	.127	16.354	***	par_32
Initiate_Discussion_EU	2.927	.168	17.436	***	par_33
Initiate_Discussion_DT	2.709	.153	17.729	***	par_34
Initiate_Discussion_PM	2.600	.136	19.071	***	par_35
Initiate_Discussion_SM	2.109	.129	16.363	***	par_36

4 CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	54	338.387	98	.000	3.453
Saturated model	152	.000	0		
Independence model	16	708.534	136	.000	5.210

5 Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.522	.337	.606	.417	.580
Saturated model	1.000		1.000		1.000

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Independence model	.000	.000	.000	.000	.000

6 Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.721	.376	.418
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

7 NCP

Model	NCP	LO 90	HI 90
Default model	240.387	188.176	300.193
Saturated model	.000	.000	.000
Independence model	572.534	492.996	659.588

8 FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	6.266	4.452	3.485	5.559
Saturated model	.000	.000	.000	.000
Independence model	13.121	10.602	9.130	12.215

9 RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.213	.189	.238	.000
Independence model	.279	.259	.300	.000

10 AIC

Model	AIC	BCC	BIC	CAIC
Default model	446.387	496.008		
Saturated model	304.000	443.676		
Independence model	740.534	755.237		

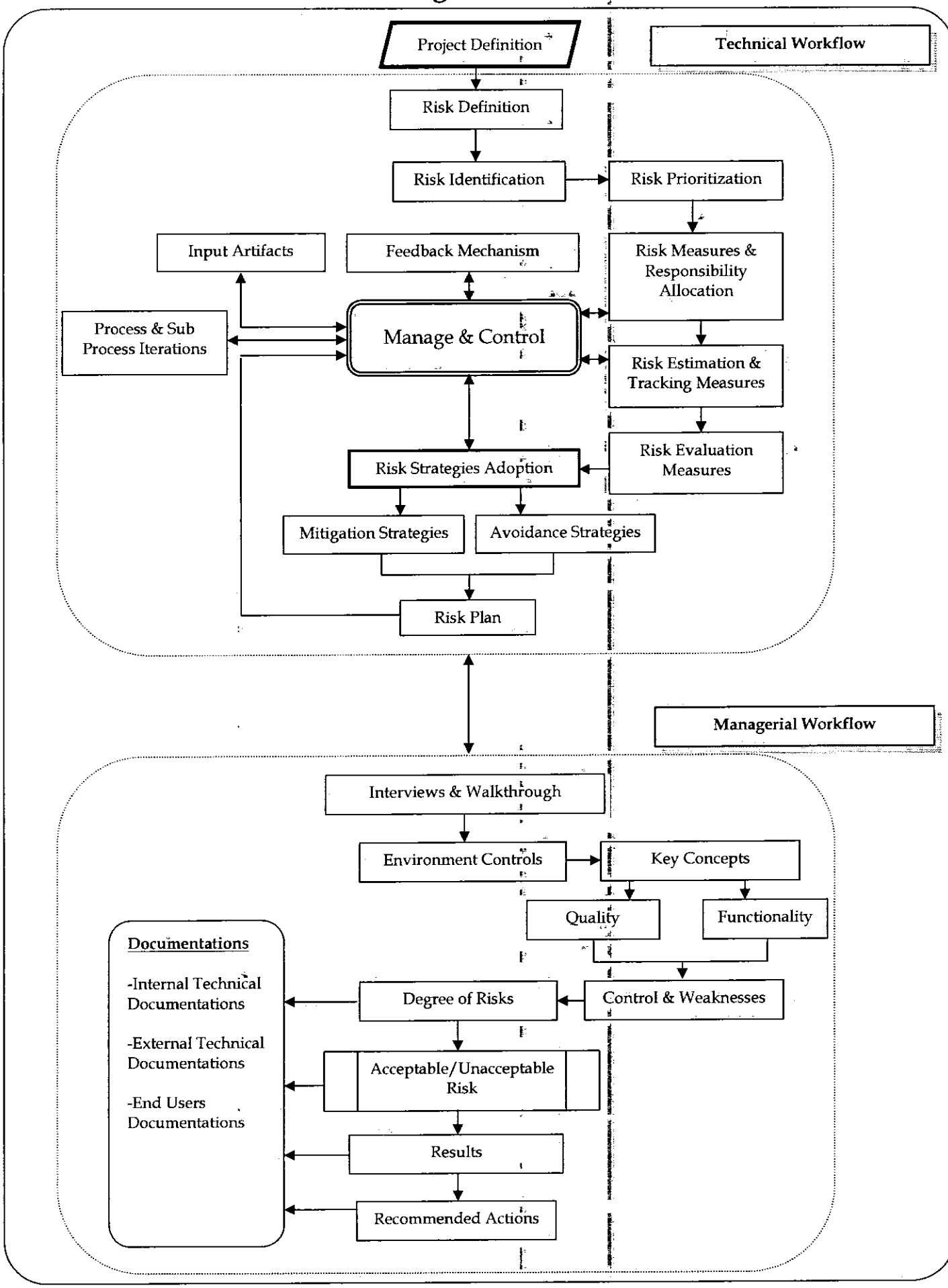
11 ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	8.266	7.300	9.374	9.185
Saturated model	5.630	5.630	5.630	8.216
Independence model	13.714	12.241	15.326	13.986

12 HOELTER

Model	HOELTER .05	HOELTER .01
Default model	20	22
Independence model	13	14

Risk Management Workflow



The propose Risk Management workflow is designed to work parallel in context of Technical perspectives as well as managerial perspectives. Phases in this workflow are generalized from the expert opinion from the personnel working in the leading software houses of Pakistan. In their view organizations are implementing Risk Management Practices in an isolated manner where some focus on Technical perspectives whereas some of them are focusing on Managerial perspectives and they resolved their issues making consensus on the major issues. As the statistics shows that the Risk management activity is normally done in the beginning of each stage and most of them consider that the Risk management is the part of Project management and this Project management is the managerial activity whereas the Risk management techniques mostly studied in the literature showed in below mentioned table do not focus on managerial factors. Rare techniques are focusing on the Managerial Factors.

Table below shows the comparison of different techniques mentioned in the literature with the Top 10 identified Risk Management factors by the experts working in the software industry of Pakistan. Most common techniques that are found in the literature are either implementing the Technical factors or the managerial factors but none of them are focusing in implementing techniques in both perspectives technical as well as managerial perspectives. Our proposed workflow model is designed by the opinion of experts in the software industry of Pakistan keeping in view the Technical perspectives as well as Managerial Perspectives.

International software industry is working in an heterogeneous environment where mostly the matters are taken up in their respective environment and a huge amount in budget is available for Risk assessment whereas in local industry mostly the Risk assessment is done through past experience as the result received from the survey in local industry of Pakistan.

Same is the scenario while we have concluded the result in amos software using confirmatory factors analysis and covariance's among different factors are relatively far away from one another and there is no any relationship reflecting

among each factor like identification, assessment, disagreement & discussion in all three phases there values are not rational with one another.

Table 25 Techniques & Factor Comparison

		Technical Factors				Managerial Factors					
		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10
		Development Process	Requirement Engineering	External Dependencies	Technology	Project Management	Scheduling	Planning	Corporate Environment	Scope Management	Technical & Managerial
	Tailoring Process to skill mix		✔		✔	✔					
	Key Personnel Agreements					✔	✔	✔			
	Walkthrough						✔	✔		✔	
	Team Building					✔			✔	✔	
	Outside Reviews			✔	✔						
	Multisource cost & Schedule			✔			✔				
	Estimation Incremental Development	✔	✔		✔	✔					
	Software Reuses	✔	✔	✔	✔						
	Benchmarking	✔	✔	✔	✔						
	Compatibility	✔	✔	✔	✔						
	Prototyping & Analysis				✔			✔		✔	
	Reference Checking		✔								
	Inceptions	✔	✔	✔		✔					
	Cost Benefit Analysis								✔	✔	
	User Surveys						✔	✔		✔	
	Requirements scrubbing		✔			✔					
	Technical Analysis	✔		✔	✔	✔					
	Tuning	✔	✔								
	simulation	✔	✔			✔			✔		
	Instrumentation	✔			✔		✔	✔			
	Modeling	✔	✔	✔		✔					
	Re-engineering	✔	✔	✔	✔						
	Code Analysis	✔		✔	✔						

5. CONCLUSIONS

This research provide helpful information regarding Improvements in Risk Management Investigation & management within software houses in context of Pakistani Software Houses to enhance the effectiveness of software risk management practices and lays the foundation for the inception of Risk suggestion.

As the result shows that the Pakistani environment is different from International and also Technical perspectives are different from the Managerial perspectives and mostly while implementing Risk management practices these perspectives are normally ignored and managers normally implement what they think it better.

Our model helps the local software industry as well as the international software industry to cater the most commonly used factors and help the manager to adopt the factors among the best. In light of the data provided from the software practitioners a workflow model is also proposed.

5.1. Future Work

- Implementation of model in the future as case study.
- Model fine grain form can be extracted
- Task description at every phase of the workflow model.
- Testing of model in different scenario with different perspective.

5.2. Benefits of the Research:

The main uses of my research are given below.

1. Reduced overall project and portfolio risk in requirement engineering.
2. Better management of project risks in requirement engineering.
3. Improved solution delivery efficiency.
4. Increased success rate.
5. Savings on both development and maintenance costs.
6. Better control over scope, budget, schedule and quality.
7. Increased predictability over delivery schedules.
8. Increased user satisfaction and better quality projects.
9. Reduction of risks associated with non-compliance.
10. Organizational alignment through effective planning and estimation.

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