Risk Management System for ERP Software Project

Muhammad Zaman Fakhar
National University of Sciences and Technology, Islamabad, Pakistan

Dr. Muhammad Abbas
National University of Sciences and Technology, Islamabad, Pakistan

Madiha Waris
National University of Sciences and Technology, Islamabad, Pakistan

***Abstract*—ERP systems are complex software systems that organizations use to manage their resources. From the beginning of ERP system life cycle to its end it faces lots of risks that have to be identified and appropriate measures should be taken to reduce or avoid these risks throughout project life cycle. The ERP system risk expands to all major risk dimensions majorly six which are 1) control & plan 2) Requirements 3) Team 4) Environment 5) User and 6) Complexity. All these risk affect the life cycle of the ERP projects. The aim of the research is to identify all these risks in ERP projects. In this paper a risk management system is proposed for ERP risks. The purpose of the risk management system is to handle all possible risks that are encountered in most ERP projects. The risk management system helps the project managers to find out most critical risks and their effects on the projects. The risk management system proposed is based on three risk management steps i.e. risk identification, risk reduction and risk control. The focus of this research is the identification of the critical risks in ERP projects.**

Keywords*—*Risk management system; ERP project risks; ERMS; Software risks; ERP risk management system (ERMS); Enterprise Sustainability Risk Management (ESRM); Risk Analysis Method (RAM)

I. Introduction

The evolution of the ERP software project introduced the need of risk management system to improve the project success rate. Different risks have been identified by the researchers but there is still a need for risk management system for ERP systems. A risk management system proposed in this paper helps the project manager to manage all possible risks in planned way and make decisions on the probability of the risk alarms. The system can identify risks and their effects on the project success. Tsai et al. in [1] had pointed six critical risk factors which are 1) control & plan 2) Requirements 3) Team 4) Environment 5) User and 6) Complexity. These factors directly affect the success of the ERP projects implementation. The most critical factors for ERP implementation success are 1) Goals are not clear 2) ERP lack in organization process 3) Organization changes lack 4) Users not ready to use ERP for their work assistance 5) Lack of knowledge for ERP projects and 6) Integration difficulties with other IT systems.

Wanqing and Yong proposed a risk management system for construction project that identifies major risk and the effects on the construction [2]. Following the same idea the aim of this research is to make a risk management system for ERP projects so that ERP projects can be completed successfully when working under the risk management system. Section 2 includes the literature review about different risk management techniques and a comparative analysis about these techniques. Section 3 illustrates proposed ERMS model. Section 4 describes the research methodology and states how data will be collected and managed to get results. Section 5 briefly explains the results and finding of the survey performed for staff risk levels and effects. The paper has been concluded in section 6.

II. Literature Review

Different authors have given their risk management models. The purpose of the literature review is to analyze different risk management models and find out the strengths and shortcomings. By analyzing the different models we will be able to find the best model available and its benefits and shortcomings. We will suggest if any necessary improvement can increase the effectiveness of the risk management model.

Deng and Bian stated that the risk is composed of origin, mode, way, receptor and consequence which interact with each other [3]. The author states that a risk management system includes three different areas to manage 1) Risk identification 2) Risk Evaluation and 3) Risk controlling. These have a complex interrelated relationship.

Risk identification is finding out the actual risk that can influence the software quality, plan or cost. Risk can be identified by expert observations, scenario analysis and risk tree analysis. Risk evaluation includes finding the level of risk that how much it can affect the system success. Risk controlling includes the steps taken to avoid or eliminate the risks that have been identified and evaluated. The controlling step is carried out by project managers mostly to reduce the risk effect on the software project.

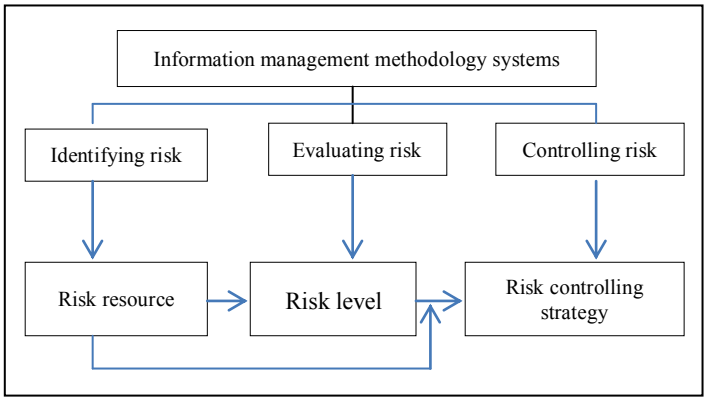

Fig. 1. Relative model for Risk Management Methodology System (derived from [3])

In Fig. 1the risk stages discussed by the authors are 1) decision stage risk 2) implementation stage risks and 3) application stage risk. The authors explained each stage risk management strategy. A two dimensional matrix mechanism

shown in Fig. 2 is proposed by the author for risk management system. Controlling risks at decision stage is more effective than controlling it in later stages. It will increase risk for later stages and it will be harder to handle them at later stages.

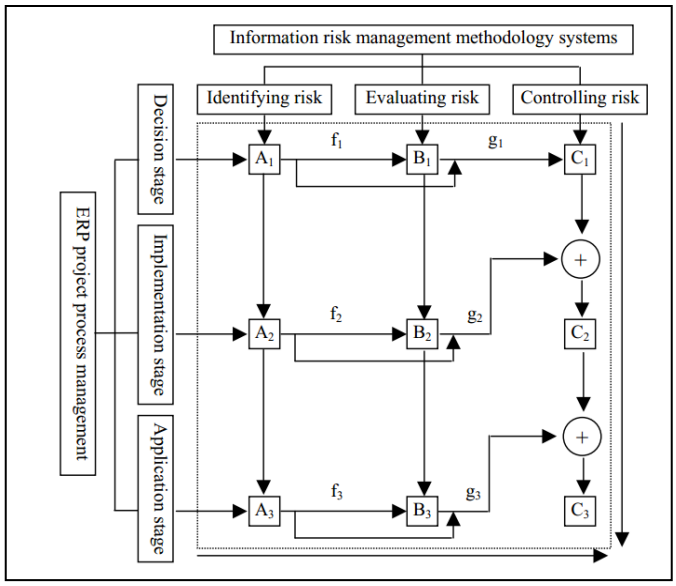

Fig. 2. Two-dimensional matrix mechanism model of manufacturing ERP project risk management (derived from [3])

Linda identified the risks in software projects and proposed a risk management system for risk handling [8]. The author stated that the risk management process shown in Fig. 3 starts with risk identification and prioritization of risks. Then a risk containment plan is made to reduce the effect of the risk and its probability to occur. The containment plan also includes contingency action that is taken if the risk turns to a problem and indicators which show when the risk is turning to problem. Actions are taken in the containments plan implementation to handle risk problems.

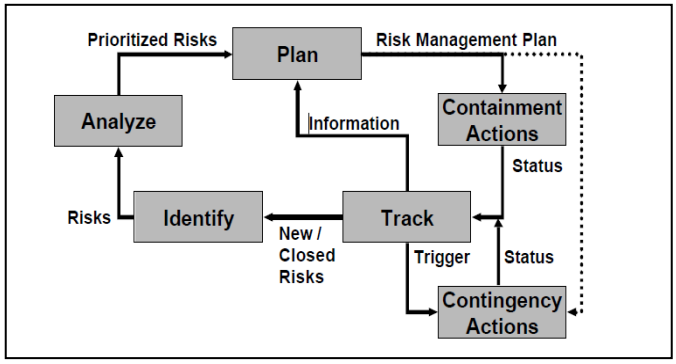

Fig. 3. Risk Management Process (derived from [8])

When the list of prioritized risks has been made the risk management plan is made to handle those risks for which few questions have to be answered. These questions can help for planning the risk management process. Fig. 4 illustrates the questions and techniques for risk handling.

Chen et al. identified five critical indicators based on risk management theory in ERP implementation namely system risk, implementation risk, change risk; organization risk and staff risk [4]. Based on these risk factors the authors proposed hypothesis that greater the ERP risk management factor, the greater will be the ERP implementation success.

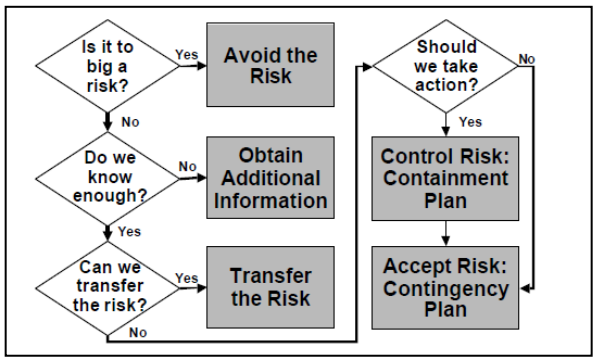

Fig. 4. Techniques for handling risks(derived from [8])

Deng and Bian conducted a questionnaire based survey to assess risk management perceptions for ERP implementation [3]. Items in questionnaire were drawn from literature review and interviews with executives and consultants were involved in ERP implementation in Xi'an. This questionnaire has been sent to 500 organization related to ERP and total 265 responses were received. Each respondent company had implemented ERP system. Regression analysis was used to validate research model of ERP implementation based on risk management by SPSS 11.0. Approximately 85 percent (R2 = 0.842) of the variance in ERP implementation success has been explained.

Results of the study showed that staff risk is the most critical factor which is positively correlated with the ERP implementation success. Implementation risk, organization risk and change risk are all positively correlated with the ERP implementation success. But system risk is correlated scarcely with the ERP implementation success.

Rabbi and Mannan analyzed different tools and techniques for risk management system [5]. A Software Engineering Institute (SEI) risk management paradigm has been used as a standard to analyze each technique available. Six techniques have been analyzed by them which are 1) Software Risk Evaluation (SRE) technique 2) Team Risk Management (TRM) technique 3) Soft risk model 4) ARMOR 5) Riskit Model and 6) CMM based software risk control optimization model. The authors highlighted the advantages and disadvantages of each technique in detail by comparing it with the SEI risk management paradigm.

The authors discussed that the SRE is a good example of the software risk management. Identification and analysis phase are conducted by personals. The major issue is that the requirements are given by the stakeholders and major risks are always evolved from the requirements phase. So lacking in stakeholders participation can cause major risk to evolve rapidly.

Rabbi and Mannan explained that in TRM it is assured that all the individuals are participating in the risk management process and requires coordination among the individuals [5]. Documentation is main focus in Softrisk techniques. The main

advantage of this technique is that risk magnitude and probability can be calculated easily. It finds out all the top risks and focuses on those risks. The authors elaborated that Riskit technique uses the risk graphs highlighting the different aspects of the risk. It is a combined approach from TRM and Softrisk as it emphasis on individual participation and highlights the most critical risk which is a feature of Softrisk technique. The authors stated that CMM and ARMOR are techniques based on heuristic knowledge and somewhat similar techniques.

Williams et al. argued that risk management is a continuous and systematic process [6]. Several elements have been listed in risk management paradigms shown in Fig. 5 which include 1) identify 2) analyze 3) plan 4) track 5) control and 6) communication. The steps occur in a sequential manner. The SEI risk management paradigm is shown in Fig. 5.

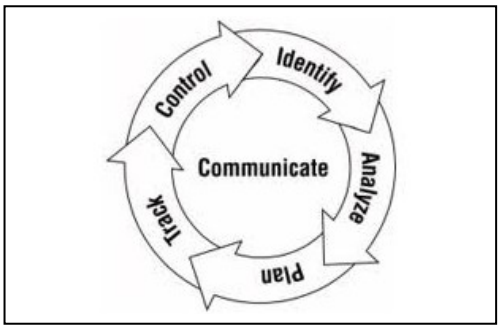

Fig. 5. SEI Risk Management paradigm (derived from [6])

Kwak and Stoddard in pointed out major obstacles in the project success which include people obstacles, process vs. project obstacles, human nature obstacle and the magnitude of challenges [7]. The authors suggested that if these obstacles are overcome by some risk management processes the project can be successful. The major lessons from the research are given which can help to make project successful. These lessons include various risk factors and the reasons for their negligence. The lessons learnt have been divided into two main categories:

1) Lesson learnt for Project Risk Management.

2) Lessons learnt for implementing project risk management tools and practices to software development projects.

These lessons are basically critical risk factors that are the reasons for major projects failures. These are overlooked when a risk management plan is made for the project and when actual implementation of the project is under process. Summarized lesson are listed in the Table I.

TABLE I. CONCEPTS ADAPTED FROM KWAK AND STODDARD (DERIVDED FROM [7])

Sr.	Lessons
1.	The greatest risk cause is mostly overlook.
2.	Inappropriate consideration to some risk as compared to others.
3.	Risk identification step is poorly done.
4.	Faster, better, cheaper as well as any other competitive initiatives, exacerbates risk.
5.	Documented risk management process is not followed properly.
6.	Risk Management Process must be evolved as the project is evolving.
7.	As the effort and size of the project increase the effort onrisk management should also be increased exponentially

B. Comparative Analysis

From the different risk management techniques discussed in literature review the risk management process appeared to be the best risk management system proposed by Linda [8] as it is useful and applicable in ERP projects. It focuses on all aspects of the risks and their management issues but there are still some difficulties in this model. Implementation of this model is quiet difficult in real time software development environments and it is a time consuming effort.

The risk management system by Deng and Bian [3] covers all areas of risk management and provides a solution of risk management systems for ERP projects but again implementing it in real time development environments is difficult due to its complexity. This two dimensional matrix system for risk management can be helpful for small projects which have less no of risks associated with them. With huge ERP projects it is not feasible to maintain matrixes containing large no of risks. This limitation of the model given by authors makes it limited for small projects. For ERP projects still a risk management system is needed which can handle large number of risks.

Rabbi and Mannan in [5] suggested risk management system which focuses on different tools for management of risks. The different techniques like TRM, Softrisk and Riskit can be helpful in risk management system but cannot be considered as complete risk management system. These tools and techniques described can be used in risk management system on some specific risk area not as a whole ERP risk management system. Similarly risks lessons given by Kwak and Stoddard [7] can be helpful in ERP risk management system that an organization can instruct the software developers to keep in mind the lessons while following the risk management system. The lessons given by Kwak and Stoddard focus on the critical risk factors that causes the project failure. In order to avoid these critical risk factors these lesson can be considered as risk management process help.

Yilmaz and Flouris [9] presented Enterprise Sustainability Risk Management (ESRM) for which they took Kwak and Stoddard [7]lesson as a base for making their ESRM model considering these lessons as critical risk factor in software development. Aloini et al. performed a comparative analysis on different risk management approaches in literature to find out critical risk factors and their impacts on the ERP projects success [10]. The authors further divided the literature review to address and analyze the different risks and their impact on different stages of the ERP projects. Focus had been on the importance of the risk management system throughout the life

cycle of ERP project and results were in the form of guidelines for managing risks.

III. ERP Risk Management System (ERMS Model)

The risk management system for ERP system covers all the risk areas that can influence the project success. The ERMS gives a complete solution to the risk handling and management of ERP projects. ERMS system includes all three risk management areas Identification, Reduction and Control in each step of the ERP projects. Considering any of the software lifecycle for ERP projects these three areas should be taken care of. As an example if we consider classic waterfall model, the three risks identification, reduction and control should be involved in each phase of it. If critical risk factors indicated by Chen et al. [4] are considered which are system risk, implementation risk, change risk, organization risk and staff risk then the three risk management areas should be involved to handle risks and their effects in each factor.

The basic structure of the risk management system for ERMS is shown in Fig. 6. The project phases comprise identification, reduction and control phases for risk handling. Each phase can be analyzed in detail and by using risk trees or interaction matrices each phase of risk handling can be done. If System risks are considered then all the risks related to system are identified first.

Then they are categorized to the level of their effect i.e. low, medium or high, and if there is a probability of the risk to occur then steps to reduce the risk are followed or its control mechanism is activated to reduce its effect on the project success.

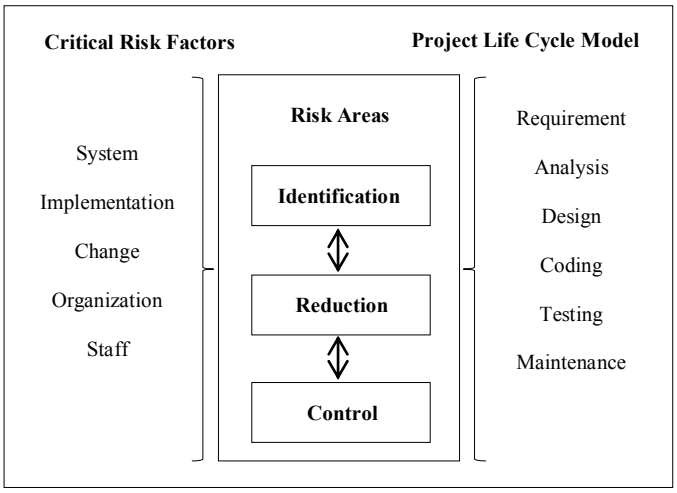

Fig. 6. ERMS Structure

The risk tree system or interaction matrices are best for risk management system as these can be used for comparative analysis. Other techniques can also be considered for managing these risks. Keeping in view this model comparing with other proposed models by other authors a comparative analysis will reveal the benefits of this model. The ERMS model proposed in this paper will ensure the project success. Each step of the ERP system undergoes the risk identification, reduction and control steps.

IV. Research Methodology

The aim of this research is to investigate a risk management system and its usefulness. For investigation this system a survey has been conducted. The survey has been performed by means of a questionnaire. The questionnaire was distributed among different software engineers in different companies. As Deng and Bian [3] stated that the staff risks are the most critical in the ERP projects implementation success so the survey that had been conducted is about staff risks. As the ERMS framework proposed above includes other areas of risk as well but the focus has been on staff risks. The explanation of the results with respect to staff risk has been done. This technique can be used with other risk areas as well for example system risks, organization risk and implementation risk. After identification of staff risks the next step is the analysis of the results gathered from the survey. After analysis of the results risk reduction or risk control steps can be taken to ensure project success. The focus of the survey is only on risk identification and analysis of the result. Risk reduction techniques and risk control techniques can be elaborated in future.

A. Collection of Data

Survey methodology has been used to collect data for staff risks levels and effects. Survey methodology has been used due to its advantages in such type of research in which a large amount of statistical data is needed. Surveys are inexpensive and useful in collecting data from large population. Surveys can be handled from dispersed location via emails, mail or telephone. More importantly surveys help to collect multiple variable data easily. The data for statistical analysis is collected through questionnaire based methodology. The reason why questionnaire is used for this survey is the ease of data collection among dispersed teams. Questionnaire based methodology helped to collect significant amount of data in short period of time. Standardized questions make measurement of facts more accurate and explain the definitions to the participants more precisely. As we have standard questions to ask from the software engineers so questionnaire is the best choice to conduct survey and collect useful data.

Data has been collected in two categories i.e. first as Staff risk level and second as Staff risk effects. Staff risk effect and staff risk level have been measured from the data collected by the questionnaire for each risk mentioned in the questionnaire. The results gathered form the survey serve as the basis for analysis of staff risk explaining which risks are most critical and which risks are less critical.

V. Survey Results

A. Risk Level Results

The questionnaire had been distributed among 30 software engineers working in different organizations. 11 engineers filled the survey and the results have been manipulated from their answers. The results have been put in graph to see them graphically. From the graph of risk levels few staff risks have occurred at high level and few staff risk have occurred at low level.

From 11 people who answered the survey questions said that staff leaving the organization due to over loading of work has most probability to occur. Among 11 people 5 rated that problem as high level risk. The 2nd major risk that had been given the high priority is staff leaving the company with valuable information. Among 11 people 6 graded this as a high level risk.

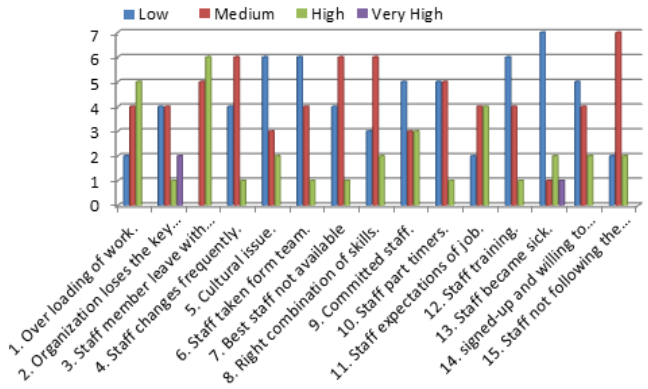

Fig. 7. Staff risks level

The staff members who are working more with the company have valuable information which company will lose when this staff member leaves the company. Medium level risks indicated in graph shown in Fig. 7 shows that staff changes frequently for which 6 people have voted out of 11. Other medium level risks include best staff not available, staff does not have right combination of skills and staff not following the risk management system. From Fig. 7 it can be seen that low level risks include cultural issues and among 11 people 6 rated this as a low level risk. The 2nd low level risk indicated in Fig. 7 is staff taken from team and among 11 people 6 ranked it a low level risk. Staff became ill for long time is also indicated as a low level risk in the Fig. 7. The result simulates the staff risk in three levels i.e. High, Medium and Low.

B. Risk Effects Results

The measurement of staff risk effect is to analyze which staff risk can be serious to the ERP project success. The purpose is to find out most critical risks to improve the project success rate. As shown in Fig. 8 one catastrophic risk is identified which are organization losses the key staff member for which 8 out of 11 people supported. The organization must not lose the key staff members in order to avoid project failure. From the graph results in Fig. 8 it can be seen that over loading of work on staff member is the most serious risk for which 8 people have supported out of 11.

The 2nd serious risk indicated is that staff is not committed for which 7 people out of 11 have supported. The 3rd serious risk indicated is staff become ill for a long time for which 7 people out of 11 have voted. Other serious risks indicated in graph in Fig. 8 are staff member leaving the company with valuable information, staff changes frequently, staff does not have right combination of skills, staff expectation about job and signed up and willing to work staff member and for all these risk 6 people out of 11 have graded.

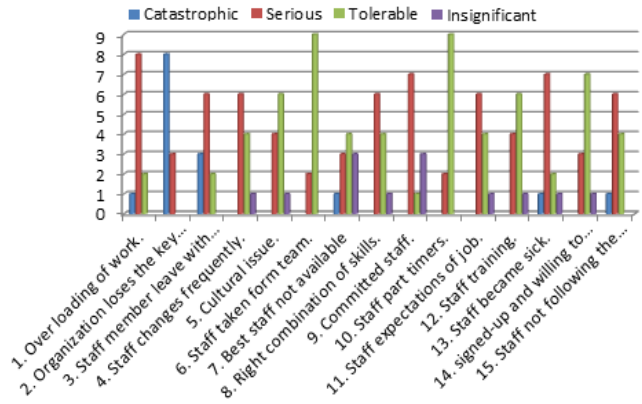

Fig. 8. Staff risks effects

Tolerable risk indicated in graph in Fig. 8 are staff taken from team for which 9 people out of 11 graded and the 2nd tolerable risk indicated is staff members part timers and 9 people out of 11 supported for this. As a result of the survey the staff risk has been categorized into three categories of effect i.e. Catastrophic, Serious and Tolerable.

Verville and Halingten highlighted the same issues in teams in their research that for ERP project success team management and team risk handling cannot be neglected [11]. For the success of ERP project implementation the authors removed the potential conflicts among the team members and resolved their issues. Only few people among all team members last longer with the projects which provide project memory and ensure the continuity of the project implementation.

C. Summarized StaffRisk Results

The major critical risks and less critical risks have been identified in above results and findings. Table II table summarizes the staff risk survey results. From the detail results of staff risk level and staff risk effects Table II is presented to give an overview of the results. The summarized results give a quick overview of the survey results.

The High to Low level risk and Catastrophic to Tolerable risks have been listed in Table II. Staff/team skills and experience risks are also identified by Iskanius [12]. According to Iskanius [12] company specific risk analysis method (RAM) results indicate that crucial risk factors are mostly dependent on personnel including project managers, team and top management due to lack of skills and experience.

D. Staff Risk Tree

The staff risks tree highlights the survey results to find out critical staff risks that can lead to project failure. Fig. 9 is devised for the summarized results of Table II. If any of the listed staff risk occurs it can lead to project failure.

TABLE II. STAFF RISKS SURVEY RESULTS

Sr.	Staff risk factor	Level	Effect
1.	Organization loses key staff member.	High	Catastrophic
2.	Employees work over loaded.	High	Serious
3.	Staff member leaves company with valuable knowledge.	High	Serious
4.	New staff member replacing previous.	High	Serious
5.	Staff members not having right skills for the project.	High	Serious
6.	Staff members not committed for the project.	High	Serious
7.	Staff member not following risk management system of the company.	High	Serious
8.	Staff member became sick.	Low	Serious
9.	Staff member taken from team for other projects due to multiple skill set.	Medium	Tolerable
10.	Some staff members working part time on the project.	Medium	Tolerable
11.	Cultural issue among staff members.	High	Tolerable
12.	Staff members have not received necessary training.	Medium	Tolerable

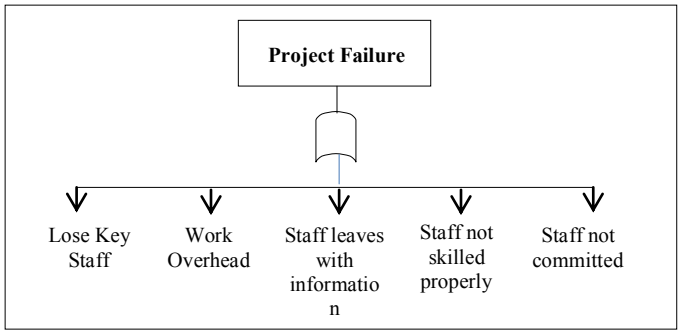

Fig. 9. Critical staff risks tree from survey results

E. Results Analysis

The results of the survey indicated major staff risks their effects and level of occurrences. The risk identification step is finished over here and now risk reduction parameters should be devised by the organization handling these risks. The risk reduction measure will be dependent on the organization polices about the staff risks. Risk control measure will also be taken by organization in light of organization policies. The aim of the survey had been achieved that staff risks identification and their levels and effects. This statistical analysis can help the organization to proceed for risk reduction and control steps. Risk control steps will be activated only when risk has been active or risk has occurred.

According to the proposed ERMS model the steps stated in the model will be performed for all the critical risk areas identified. If organizations are following software life cycle models then according to those models risk management system will be involved in each phase of the ERP projects. This will make the risk management more easy and significant because organizations will be able to find alarming risk that can cause the ERP project success if handled properly and projects failures occur otherwise.

VI. CONCLUSION

The purpose of this research was to present a model for risk management system which has been proposed as ERMS. ERMS will help the organizations to improve their risk management system and to deal with risk encountered in ERP projects. The survey of staff risk had proved the effectiveness of the ERMS and the results identified major staff risks, their level of occurrences and effects. Similarly other critical risks can also be identified in the same way staff risks have been identified. ERMS can be used in other software projects. It is a generic model for risk management system. Risk reduction and risk control can be elaborated in as an extension to this paper.

As both of risk reduction and risk control are complex activities to perform so a separate research is needed to explore these areas.

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