Innovative approach to risk analysis and management of sugar industries in Punjab

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Abstract

Process industries are full of risks especially in sugar industries there are several type of risks causes of failure to achieve desired results. Risk in sugar sector involved at decision making of management, resource manipulation, quality control, engineering constraints, health and safety, process control etc. The best way to manage and tackle these risks a comprehensive risk management approach should be adopted. Project management practices provide the way to handle these types of risks. It provides many risk management approaches to manage these. Risk analysis, as the core part of the risk management process enable the experts to quantify and analyze the risks which can affect the outcome and cause of performance threat for sugar sector in term of low productivity.

Risk identification is very essential for sugar sector. It includes the identification of particular risks in each category and then finds the impact on outcome. Purpose of this research is to identify and find the impact on outcome associated with sugar industry in Punjab .Risk disturbing the performance will be identified by literature review and consulting with experts. Then a structured questionnaire is designed on bases of survey and distributed. Make analysis of data and try to provide the guide lines for effective risk management in sugar sector.

Key word: - Risk, Risk identification, Risk analysis, Risk management

CHAPTER 1: INTRODUCTION

1.1. Introduction

Project management is the discipline of carefully projecting or planning, organizing, motivating and controlling resources to achieve specific goals and meet specific success criteria. In so many areas of our lives, we use project management without even realizing we are. Whether it's brushing your teeth or building a skyscraper, we all use project management every day. Initiating, planning, executing, monitoring/controlling and closing out every project requires some knowledge and expertise of what you are doing and will be more likely to get completed with a trained project manager and project team

Looking for a way to stay ahead of the pack in today's competitive global economy, companies are turning to project management to consistently deliver business results. And more companies are clearly seeing the payoff from investing time, money and resources to build organizational project management expertise: lower costs, greater efficiencies, improved customer and stakeholder satisfaction, and greater competitive advantage (*McKinsey & Co., January 2010).* Many business projects involve large-scale planning that affects every department or aspect of a business. Implementing the project may mean dealing with human resources, budgetary and supply constraints. Accredited project managers are skilled in project management techniques specific to dealing with one-time projects. They can create plans to manage interdependence and address resource conflict. Organizations that use project management to monitor and control processes and schedules can more effectively complete their projects on time and on budget (*Sarita Harbour, Demand Media 2012).*

Risk analysis and management is the critical part of project management. Risk is the quality of a system that relates to the possibility of different outcomes. *Schuyler (2001)* Risk is an event having the impact on organization's objectives and may affect the performance of organization in term of low productivity, poor quality, and increase in budget. *(Akintoye and Macleod, 1997).*An uncertain event or condition which an organization may face in future having greater than 0% and less than 100%probability rate and may have affect on one or more than one objectives i.e. cost, time, quality scope etc but the important thing in addition that the impact of this future event must be unplanned and unexpected. *(Chia, 2006).*

Risk management is defined as a controlling approach for predicted risks to be faced in an investment or a project *(Dikemen et al, 2004)*. In project risk management, strategy is to reduce the probability and impact of a threat and increase the probability and impact of an opportunity (*Schuyler, 2001)*. Evidence has defined risk management as a stepwise procedure consisting of risk identification, risk classification, risk analysis, and risk response tasks *(Flagnan and Norman, 1993)*. Risk analysis is defined by *(Loosemore et al. 2006)*: the process of evaluating identified risks and opportunities to discover their magnitude, whether they merit a response, and how responses should be prioritized in the light of limited resources.

Risk management practice is not in formally used in Pakistan. *(Ahmad et al, 2009)*. A recent study to investigate the adoption of risk management practice in industry of Pakistan results that the majority of management are not practicing the formal risk management so the reason that majority of projects suffers from risk causes resulting in less productivity, cost overrun, poor quality *(Farooqui et al.2007)*.so the main reasons to conduct this research are

- To identify the risks involved in sugar industry
- Analysis and management of those risk
- Qualitative analysis of these risks and to prioritize risk according to the impact on project performance in perspective of time, cost, quality.

1.2. Problem Background

In this globalized world the project management is essential part of an organization/industry to achieve the desired results or goal. "Project management is a complete field of knowledge which provide various methods and procedures to control and manage the projects in engineering, construction and process industries" *(Dariad I. Cleland 2006)*.

Poor risk analysis and wrong management approach is the reason that most of our industries/project suffers with loss and unable to give desired result. Sugar industry is also one of them. It's one of the most important industries of our country and suffers with loss and many other issues since last many years' leads directly to high production cost. So it's important to identify the risks and their impact on outcome in term of cost, time and quality as those risk must be considered in future for smooth running.

1.3. Problem statement

Risk and risk management are multidimensional constructs whose sub dimensions need to be studied and analysed. The literature review has identified a major gap in research with respect to these. This research tries to plug some gapes in research in Punjab context. Following problems have been addressed in this study

- What are the major risks associated with sugar sector?
- What are the critical risks in term of time, cost, and quality?
- What are the risk management approaches most effective for those risk factors?

1.4. Significance of research

In past years there are many articles and features those have been published are related to sugar industry but none of them try to discuss about risk identification and analysis for sugar sector. Most of the authors discuss related to raw material production, rates problem between industry and former, payment issues between both parties and some time the behaviours of both parties.

In this study I applied the risk analysis and management model described in **3.1**. This is not ever used for sugar sector. No major study is held on this topic before in Pakistan so there is need of such an innovative approach in this regards in order to generalize the risk and finding the analysis. So it is the first attempt to cover the topic.

1.5. Purpose of Research

The purpose of the research is to identify the risk, Risk analysis and risk management in sugar sector of Punjab. To attain the said purpose following are the key points for this study

- Study the extent and nature of risk
- Risk analysis
- Sort out the critical risks

1.6. Research hypothesis

After literature review I have formulated following hypothesis about risk

- Risk has a significant impact on project/organization objectives
- Risk analysis and management has a significant relationship with risk
- Risk analysis and management has a significant impact on project/organization objectives

1.7. Research Questions

Following question are addressed in this study

- Define the risk categories
- Define the accepted risk in each category
- Impact of each and every risk in term of time, cost and quality
- What are the critical risks in each category?
- What is the ranking of risk in term of impact on time cost and quality?
- What is the ranking of risk in term of overall effect on outcome?

2. CHAPTER 2 LETRATURE REVIEW

Pakistan is an agricultural country and sugarcane is one of the important and valuable agricultural products of it. This is used by the all sugar sector of Pakistan as a primary raw material source. At the time sugar industry is the second largest agro based sector of Pakistan which provide the sugar products as well as playing important role in power generation (Bul-e-shah packages Lahore is working on the biggest power plant 42MW in which the wastage of sugar mills (Bagasse) will be used to generate power). In Pakistan the future of sugar sector is mainly attributed to the production efficiency because of higher cost of production; increase in the imports and due to declining competitiveness of the domestic sugar industry. Productive efficiency can be improved by the adoption and development of new production technologies and approaches but at present due to the limited income and dealing on credit with grower of sugarcane its difficult at this time, but the efficiency of industry, process productivity & overall performance can be improved by adopting by the latest available technology and management techniques practised and considering the risks and mange them.

Measures of productivity, its growth and sources for the sugar industry of Pakistan play a significant role for policy development. Productivity growth can be decomposed into three components:

"Technical change, scale effects, and changes in the degree of technical efficiency *[Coelli, et al. (2005)]."*

Technical change means progress in technology not only physically in the form of improved machinery but also innovations in the knowledge base. Regarding scale effects, it relate to economies in production. If there exists increasing economies of scale it indicates that the production of additional outputs will require a less than proportional increase in inputs. Improvements in the degree of technical efficiency arise from situations where resources can be used more efficiently by applying practices from the present stock of knowledge or by using the latest management approaches to get best results by best utilizing the available resources in scheduled time with minimum cost.

Since last many year sugar industry has been facing a situation quite similar to the Textile industry stemming out of unchecked growth of the sector because of project sanctioning on political grounds without any consideration of raw material availability and

market size and also by creating management monopoly. The political interference and market hacking playing a vital role in destroying the industry. This crisis has affected the three factors of production, raw material suppliers, employees and owners equally. The problem is more intense for the newer units, which have a lower crushing capacity and higher associated financial costs so may have to face more issues regarding equipment, resources, process. In this case there are more chances of risks that can effect. Safety, environmental and many other external risks/issues may contribute in their failure. So to survive the best management approach should be there. Better approach should be there to find the involved risks in each category and how to manage them is the important thing for consideration in term of get desired outcome. Due to political interference involves incompetent management are running the industries and if there are some of competent persons with latest management techniques to resolve and mange those associated risks they have no chance to prove them so having no chance to grow up the industry in current scenario.

Sugar industry in Pakistan has now entered into an era of export orientation as it has been exporting it for the last two years. But this year this looks doubtful as there is a shortfall expected in the sugar production. There are many reasons for this short fall like poor management, wrong approaches toward work, old technology, poor utilisation of resources etc. Pakistan may become an importer again and this trend will continue for some time until the policy makers put our sugar industry on the right track. They should adopt the latest management techniques. They should plan what to do and how to do. The policy makers should consider the whole scenario from to get raw material till the outcome. Consider the problems and associated risk involved from raw material to process. They should also consider the latest project management approaches and latest engineering techniques to minimize the risk to increase the productivity. A restructuring of the sugar industry in this manner may prevent the constant decline in this industry and to put it back on the track of growth and profitability.

A well established sugar industry may contribute in overall economy of the country. Rather than this in our country establishing a new sugar industry in under developed ruler areas it's a sign of prosperity for that area. As a sugar mill comes with new communications system, roads, colonies, schools, hospitals, electricity and the most important thing the opportunities of trade and employment for every and each cadre of society. Mean

Unemployment can also be sort out. But it's all happen when we run the industry with best available technology, resources and management with the energetic and ambitious people.

2.1. Literature analysis & Motivation for current research

Sugar industry is suffering with loss and having no healthy growth since last many years also having high production cost. Causes may include but not limited to

- ✓ Raw material problem
- ✓ Old machinery
- ✓ Poor management approaches
- ✓ No innovation in knowledge area
- ✓ Low technical efficiency
- ✓ Poor resource utilization
- ✓ political interference

Proposed Solutions for all those problems are

- ✓ Best management techniques
- ✓ Good risk analysis management
- ✓ Usage of latest technology
- ✓ Update in knowledge areas
- ✓ Latest machinery

Risk and risk analysis & management have a lot of impact on project objectives. Most of previous researchers take the isolated view of sugar sector in term of raw material issues and political interference. Risk and risk analysis & management have a vide impact of project objectives and unfortunately no major studies on these constructs are reported from Pakistan in context with sugar sector. The motivation of this study is derived from these limitations.

2.2. Importance of risk, risk analysis and risk management

Risk is defined as the uncertain event or condition that if occurs having a positive or negative effect on one or more than one objectives i.e. scope, time, cost or quality etc (PMBOK 5th addition). Risk has the origin in the uncertainty present during execution. PMBOK categorised it in two ways. The known risks those have been identified and been analysed during planning which make it possible for to plan response for them and if unable to manage proactively we can assigned contingency reserves for them. The second one unknown threats which can't be managed so may be handled via management reserves (PMBOK 5th addition).

To be successful the organization should identified the risks at planning level and should be committed the better risk management approach and address the risk management throughout the life cycle. Moving ahead without risk identification, analysis and management is leads towards more problems arising from unplanned risks (PMBOK 5th addition).PMBOK risk management includes the following process

- Plan risk management
- Identify risks
- Perform qualitative risk analysis
- Perform quantitative analysis
- Plan risk response
- Control risk

(Mubeen .S 2007) defines that Risk is an unwanted but probable event that can have the positive or negative impact on one or more than one objective of organization. He also categorised the various types of risks i.e. technological, financial, Enviourmental, natural etc. he console the risk analysis in two ways i.e. qualitative and quantitative.

In his research he observed the risk by the barometer of probability and impact scale by using the formula to find the risk number

$$RN = P \times I \qquad \text{(Eq. 1)}$$

Where P = Probability of occurrence

I = Impact of particular risk

He used the following approach to make the risk analysis process (Mannan 2009).

- Risk management planning
- Risk classification
- Risk identification
- Risk frequency and impact
- Risk analysis and ranking
- Risk register
- Risk mitigation
- Risk monitoring

In his research he drafted the risk register and highlighted the critical risks having the impact on cost & time. He recommended that risk base planning, estimating and controlling increase the chances of success for the organisations.

A research by (Jamil et al 2008) they said that risk identification is important for all the organisations because it plays the important role in the success of organizations. They claim that risk management is very much important for to ensure the way to get objectives and organisations should adopt the pro active approach towards this. They use the logic that risk management is a sequenced process of identifying, analysing the risk and then responding them throughout the life cycle (Wang et al 2004).

They started their research from identification of risk from literature review and drafted a questionnaire and ask the respondent to identify these risk significant on a 0-4 likert point scale where 0=not important and 4=extremely important. Then usy the formula to find the relative importance index RII

$$RII = \sum W/AxN \qquad \text{(Eq. 2)}$$

W= weightage given to each factor by respondents form 0 – 4

A = highest weightage

N = Total number of respondents

They concluded that identification of risk is much important for organisations and recommended that risk identification should be as early as possible because risk management provides the assistance to management for better decision making.

(Hassan. A 2013) claimed that none of project/process is without risk. He also claimed that risk management involves maximizing the probability and consequence of positive risks and minimizing for negative threats. Researchers identified the risks by literature review and interviewing from field experts and then evaluate the risks up to four levels i.e. Low, Medium, High, Very high and find the risk factor by using following formula

$$RF = nS + mC + qB \quad \text{(Eq. 3)}$$

Where: S = schedule, C = Scope, B = budget, m,n,q = variables.

He concluded that the risk management is the most demanding and important for stack holders to achieve targets. He also recommended that risk management concept should be injected in students mind and professionals also included in course at university level to give exposure to students.

(Muhammad. R & Aslam. A 2012) make analysis that every project/ process are full of risks and the way to tackle these risks most effectively can be done by adopting a comprehensive risk management approach. Risk management being a core integrant of risk management process allows the stack holders and professionals to quantify and analysis the risk those can impose the potential damage on the outcome or objectives of project/organisations in term of cost, time, quality, safety etc. Researcher included the comments that risk management approach at formal level is not been adopted in Pakistan (Ahmad et al 2009). His research has following objectives

- Identify the critical risks
- Quantify & analysis
- Recommend risk analysis guidelines

They designed the questionnaire through identifying the risks via literature review and sort out them as per their criticality by finding the relative importance index of each risk by using the relation advised by (Gosh and Jintanapakanont 2004).

$$RII = \sum (aX) * 100/5 \quad \text{(Eq. 4)}$$

Where a represents the constant shows the weightage given to each response from 1(least important) to 5(most important). And X = n/N, where n is frequency and N = total number of responses

By this research they concluded that awareness of stack holders about the destructive threats can affect the overall performance in term of cost, time etc they also apply this on real time bridge project to defend their findings.

Hamdy et al 2014 described that great efforts are been needed to identify and manage these risks. They highlighted the top risk categories and identified the possible risks in each category by literature review and experts opinion. They defined the risk as the chance of something happen which may have the impact on project objectives, may be in positive or negative. They claimed that risk management is necessary for the organisation for to minimizing the loss and increasing the profitability.

Researchers classified the risks according to their nature i.e. physical, economical, logistic, design, political, operational etc. They worked with following objectives

- Identification risks
- Examining risk perception
- Identifying risk probabilities
- Classifying the risks types regarding their resource (external/internal)
- Suggesting strategy for managing those risk

They sort out the list of risks by interviewing of professionals and brief literature review. And formed a questionnaire by considering three variables i.e. risk factor R. Probability P, Impact I and using following relation

$$R = P \times I \qquad \text{(Eq. 5)}$$

Allow the respondent to judge the probability and impact at five levels from very low to high. The "very high" took a value of 0.9 and the "high" "Moderate", "low", "very low", took values of 0.7, 0.5, 0.3 and 0.1 respectively.

They concluded that Egyptian projects are been suffered with new probabilities of risk resulted from political and economical variables. They identified the possible risk for stack holders for better decision making. In addition they also suggest the response strategies.

Considering the risk management as an important term they suggest that the risk identification should be at initial stage and they also insist on improving the role of universities to develop the risk related knowledge among professionals and newly graduate engineers.

2.3. Conclusion

From the brief study of literature review the result is derived that in new era of global world the update knowledge in management is very necessary for the organizations for their improvements and to get the better results in term of their targets.PMI provides the good management techniques for getting the objectives in good manners. Risk is also considered as the most important that may have the bad impact on results if we unable to handle them id good way. That's the reason the scholars and researchers consider the risk management at very high level and insist on to prioritize them and use best management techniques to reduce their negative impact on objectives.

Considering the current situation of sugar sector and the results of this described by the Raheman et all 2009 the need of such a study is required for this sector to enhance the overall productivity.

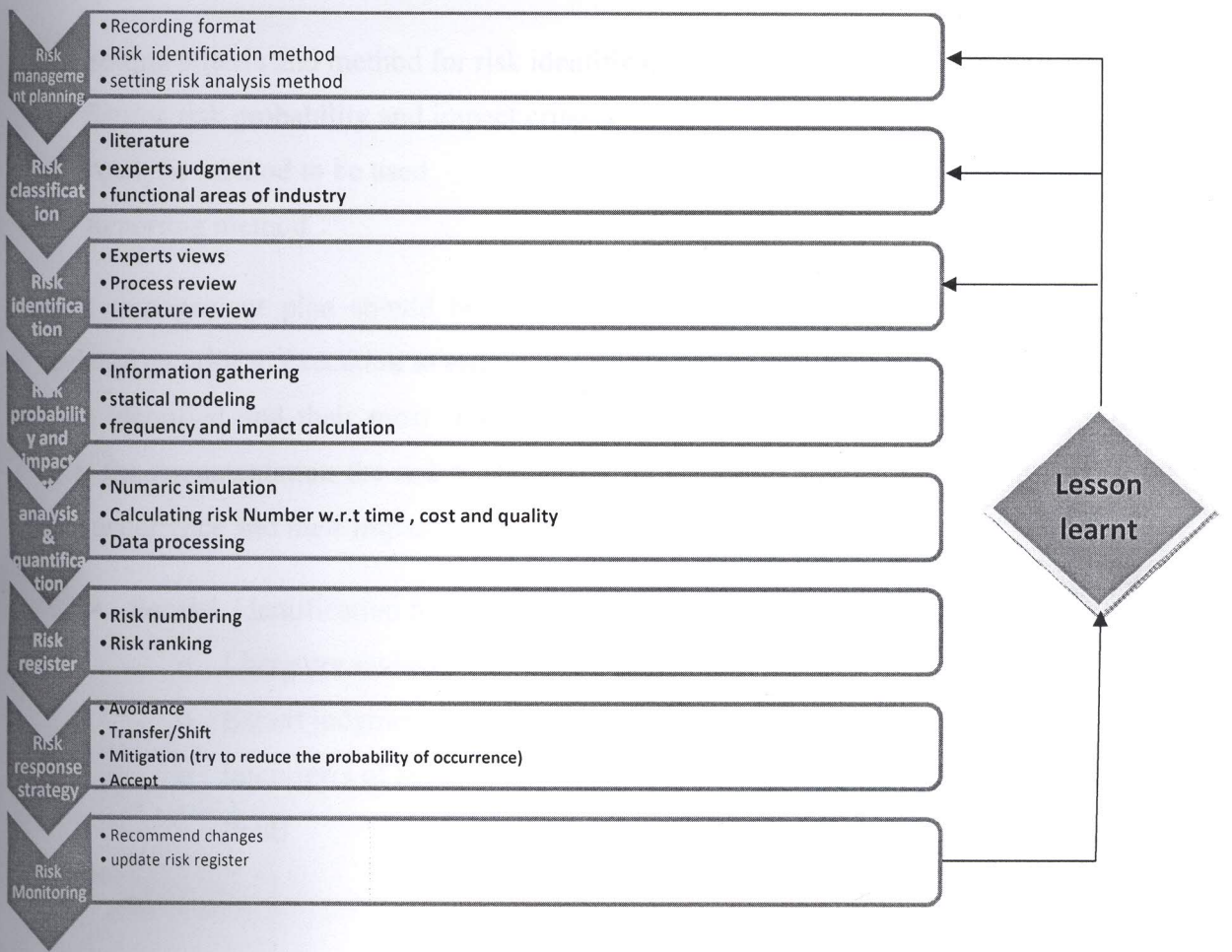
3. Chapter 3 Research methodology

3.1. Research model

For this research a comprehensive model is used developed by (Mannan. A and Mubin. S 2009) which based on survey type methodology to identify access and analyze the risk associated with sugar industry and also proposed the best suitable risk response and management strategies by considering the critical risk into account. More ever importance has been considered in this research for giving three dimensional risk assessment and quantification.

Research model

Fig: 1



Through a review based research this model provides a way forward for to identification of risks by brief literature review and by getting information gathering from process owners in sugar sector in Punjab. Expert's opinion was also there to finalize the

identification process. This model developed by the (Mannan. A, Mubin. S 2008) talks about the limitation of PMI and by using the instrument of probability and impact scale get the value each risk from the experience of process owners and lesson learnt of sugar industry and average of that information is analysed and quantified and then integrated in risk register also providing the suitable risk response strategy.

Following steps are required to perform the risk analysis process as per model developed by PMI (Manaan 2009) (Pakistan management institute)

3.1.1. Risk management planning

PMI approach of risk analysis and management is get going with the appropriate planning which includes detailed risk management planning. In this phase a course of action is proposed for risk analysis. This process includes

- Setting criteria and method for risk identification
- Setting risk probability and impact criteria
- Analysis method to be used
- Reporting method

Risk management plan should be documented as early before the work starts and is undertaken prior to execution to ensure that all the risk categories and their related risk has been identified and their most suitable and practical assessment has been made. Right after the documentation the risk management process busy in monitoring and control the risk occurrence and their impact.

- For risk identification following method was used
  - Literature review
  - Expert judgment
  - Interviews of process owners (Departmental heads and workers working in field)

- The selected risk probability and impact criteria is as in table

Table: 1

Standard values of frequency of occurrence and impact factor			
Frequency of occurrence	Frequency Value	Level of risk impact	Impact factor Value
Very high	0.9	Very high	0.9
High	0.7	High	0.7
Moderate	0.5	Moderate	0.5
Low	0.3	Low	0.3
Very low	0.1	Very low	0.1

- Risk analysis method is discussed in detail below

3.1.2. Risk classification

In context of sugar industry the risk are classified in following 8 areas by considering the field reality and structure of sugar industries

1. Management
2. Engineering
3. Health and safety
4. Process
5. Procurement
6. HR
7. Financial
8. External

3.1.3. Risk identification

After classification it's necessary to identify the risks, which is an important part for any organization (Mubin 2008). Fig 1 shows the complete road map and method used for identification and analysis process for sugar industry. It shows the necessary components of analysis process and steps involved. It's apparent from the diagram that after completing each analysis cycle, lesson learnt or conclusion should be noted and addressing in manner for future consideration to carry out the process in good way. There are lot of methods which may

use in single or with combination of others to identify the risk which may include but not limited to

- Individual/department representative
- Lesson learnt
- Process study
- Interviews
- Literature study
- Questionnaire meetings
- Experts judgment

In this research information gathering technique is used in combination with some others. Firstly identify the all possible risk from brief literature review articles, research papers and reports from internet. After finalizing the list of risks from all sources then sorted out them as per their defined categories.

From brief literature review and by the help of process owners and experts judgment total 59 risks were identified associated with management, engineering, financial, procurement, HR, and safety with following break up as in table 2

Table 2

S. No	Risk Category	No of questions
1	Management	7
2	Engineering	11
3	Financial	5
3	Health and safety	7
4	Risks during process	7
5	External risks	7
6	Procurement	7
7	HR related risks	10
	total	61

The list of associated risks in all these categories is as following table

Table 3

Risk category	Risk Description
Management	1) Poor planning
	2) Influence from higher management
	3) Lack of coordination among departments
	4) Poor supervision and site management
	5) Sub contractor issues
	6) Poor documentation
	7) Lack of decision making
Engineering	1) Insufficient engineers & workers
	2) Unavailability of machinery (for production)
	3) Defective tools and equipment
	4) Poor awareness about tool usage
	5) Poor process design(Production process)
	6) Operating and using machines without permission
	7) Machinery breakdown
	8) Less Labour and equipment productivity
	9) Equipment/Technology availability
	10) Poor equipment management & planning
	11) Replacing imported parts with local
Financial	1) Unavailability of funds
	2) Hike in material price(Raw)
	3) Financial delay(Payments)
	4) Economic disaster
	5) Shortage of running finance

Health and safety	1) Fire and explosion
	2) Hazard atmosphere
	3) Excessive noise
	4) Poor lighting on work place
	5) Not using safety equipment
	6) Third party damage
	7) Accidents
Risks during process	1) Complicated machinery
	2) Complicated process flow
	3) Poor process guide lines
	4) Poor material management & planning
	5) Increase material wastage
	6) Defective work
	7) Poor quality control
External risks	1) Delay in approval from higher management
	2) Political instability
	3) Third party/vender delay
	4) Unavailability of equipment/spare parts
	5) Unavailability of raw material
	6) Suppliers/subcontractors poor performance
	7) Transport strike
Procurement	1) Failure to identify potential sources
	2) Understatement of the need
	3) Insufficient funding
	4) Dispute with supplier
	5) No response from known quality suppliers
	6) Delay by suppliers
	7) Selecting an inappropriate supplier

HR related risks	1) Labour availability 2) Resource performance 3) Human error in process 4) Conflict among departments/team 5) Over stress burden on workers 6) Untrained workers 7) Out sourcing 8) Poor trainings 9) Labour disputes 10) Shortage/unavailability of skilled workers/engineers

3.1.4. Risk frequency and impact factor

It has been observed that using standard criteria can't be selected to find all the aspects of risk in term of cost, time and quality etc in an organization by using standard PMI (Project management institute) approach. PMI (Project management institute) also didn't provide the facility to find the separate of risk by considering the cost, time scope & quality instead of this it leads to identify a common impact factor or related risk (Mubin. S, Mannan. A 2013)

For this research the probability of risk occurrence and the impact factor is divided up to five levels which provide the easy facility to respondents to select the frequency as per their experience. Table shows the all five levels for probability and their assigned values.

Table 4

Level	value
Very high	.9
High	.7
Moderate	.5
Low	.3
Very low	.1

"Very low" to "very high" with base level "moderate" helps the respondents to choose the probability level for each risk. Same the opinion judgment scale to convert the opinion in to numbers is used by (Hamdy, A 2013) in their research.

Same like to find the impact of each risk in respective category the five level choice is given to the respondent provide them the opportunity to assign the value for impact of each risk in term of time, cost & quality. Some time possibility is there that a risk has a less impact on cost which causes the reduction of impact factor but the same risk may have a significant impact on time which is ignored while we are using the PMI (project management institute) approach (Mubin. S, Mannan. A 2013)

By considering the three different aspects of risk impact in term of cost, time & quality the experience of professional and departmental concerns can also help in judgment but the factor of biasness, personal conclusions & experience may also affect the overall process of risk analysis. This is one of the limitations for this research.

After getting the risk number in term of objectives i.e. time, cost, quality entered all in the table. Average of all is also derived and listed in table. This way of presentation helps the stakeholders if they want to know the three dimensional critical risk by considering time, cost & quality separately or overall.

3.1.5. Risk analysis and quantification

Several theories are there for risk analysis and quantification different numerous formulas exist for risk analysis. But perhaps the formula widely used and accepted for this purpose needs the following information

- Probability/frequency of risk occurrence
- Impact of each risk on objectives

For to quantify the risk, calculated risk like hood based on risk frequency is multiplied with the impact of that risk on objectives equal to the risk number (RN)

Risk number (RN) = Risk like hood (frequency/probability) x Impact

$$RN = P \times I \qquad \text{(Eq. 6)}$$

After the process of identification o& assessment of risk through the route discussed above the overall impact of particular risk on organization's objectives is analysed and quantified. Following practice is adopted for this purpose

- Result from risk analysis in term of probability and impact will be entered in risk register as per their position
- To get the critical risk number for particular factor i.e. cost, time, quality frequency of each & every risk will be multiplied with the impact on each factor. There all RNs can be used to sort out the critical risks in term of organization's objectives in term of cost, time quality. For example if someone need to know the critical risks impacting cost he can consult with the (RN c) column in register

Mathematical expressions for this are as under

$(RN)^{cost}$= probability of risk x Impact on cost (Eq. 7)

$(RN)^{time}$= probability of risk x Impact on time (Eq. 8)

$(RN)^{quality}$ = probability of risk x Impact on quality (Eq. 9)

Average $(RN)^{avg} = (RN)^{cost} + (RN)^{time} + (RN)^{quality}$ /3 (Eq. 10)

Limitation: for this research only considering $(RN)^{cost}$ &$(RN)^{time}$. $(RN)^{quality}$ Is not computed and considered as zero so taking the average of $(RN)^{cost}$ & $(RN)^{time}$ only. Because the quality standards may be different in each industry.

3.1.6. Risk register

After analysis all the risks are recorded in risk register. Where separate columns are been added for different RNs i.e. related to cost, time, quality. Risk with highest RN will be considered as the most critical one in respective category. However average risk number also added in separate column and ranked which may required specially for decision making.

Ranking mechanism for different risk will be in tabular form where they are sorted out as per there criticality. Risk with highest $(RN)^{cost}$ is ranked at number 1 and considered as the most critical risk with respect to Cost. Remaining risks are added in respective column as per there risk number. If a GM or CEO of the organization need to know the list of risks as per their

criticality in term of cost then the $(RN)^{cost}$ column is there to help him and same the procedure may be adopted while considering the time related risks. A separate column $(RN)^{time}$ is there in risk register to show up the critical risk in term of time and provide assistance to management if they need to know the time related critical risk in organization. Another column of average RN will be added which can be used if overall impact of risk is need to be checked.

3.1.7. Risk response

This process leads to the plan/strategy for better management of risk in most economical, suitable & acceptable way. Specially while considering the critical risk it's most important that to be very careful and diligence should be given while choosing the response strategy for them. There are many risk management strategies to handle the different type of risks i.e. critical, normal, non critical depends upon the nature of risk. Following four strategies are there for this purpose

- Avoidance
- Transfer/Shift
- Mitigation (try to reduce the probability of occurrence)
- Accept

The purpose of these responses is to minimize/regulate the overall negative impact on objectives at minimum cost and acceptable way.

All selected risks which have been identified and analysed, their handling strategies are proposed in risk register next to each risk. This may help the management for quick decision making and handling them in better manner.

3.1.8. Risk monitoring

Analysis of risk and their management is a live ongoing process for the organizations. It's the fact that each risk needs a appropriate strategy to be ended and during monitoring if new risk arise in the process may noted in the risk register for future consideration. Risk monitoring is the continuous process and provide a way for further improvement in risk analysis process and also contribute for more risk identification and provide improvement & further possibilities to handle & manage the risk based on lesson learnt & continuous improvement approach.

3.2. Research hypothesis

After literature review following hypothesis about risk was formulated

1. Risk has a significant impact on project/organization objectives
2. Risk analysis and management has a significant relationship with risk
3. Risk analysis and management has a significant impact on project/organization objectives

3.3. Research methodology

To conduct this research a structured questionnaire is used to get data from professionals in industry. The first part is the information of respondent. Proposed template is as under

Table 5:

Questionnaire for risk analysis	
Name of respondent	
Organisation	
Designation	
Years of experience	

Respondent information

On second page guidelines were given to respondent about to fill the questionnaire. The value for risk frequency and impact on cost, time, and quality will be analysing on five stages levels from

options
Very high
High
Moderate
Low
Very low

The questionnaire was presented as

Table 6

<table>
<tr><td colspan="3">Risk name</td></tr>
<tr><td>Risk frequency</td><td colspan="2">Impact on time & cost</td></tr>
<tr><td rowspan="2">o o o o o
V.Low Low Moderate High V.High</td><td>o o o o o
V.Low Low Moderate High V.High</td><td>Time</td></tr>
<tr><td>o o o o o
V.Low Low Moderate High V.High</td><td>cost</td></tr>
</table>

Questionnaire design

By using of this format probability and impact of risk on three aspects is judged through experience of managers, concerned engineers and owners. The element of biasness and personal judgment were the limitation of the study (sajjid mubeen 2008)

The detailed questionnaire is in APPENDEX

3.4. Population

Sugar industries in Punjab were taken as the basic unit for this study and the professionals working in these units like Owners, Managers, engineers, department heads etc. are considered as the population for this study.

3.5. Sampling

To get data questionnaires were distributed to the sugar mills also visited the head offices in Lahore. The returned numbers of questionnaires filled by owners, departmental heads, Engineers from different sugar mills are as in following table

Table 7: Sugar mill list

S. NO	Name of sugar mill	No of samples received
1	Chishtia sugar mill Sargoda	7
2	Colony sugar mill Phalia	10
3	Makka sugar mill Kasur	11
4	HAQ bahoo sugar mill jhang	13
5	Al-Moize sugar mill Mianwali	9
6	Chuhdary sugar mill Gogra	8
7	Shah taj sugar mill Mandi Bahaudin	11
8	Itfaq sugar mills Sahiwal	5
9	Sugar mill association office Lahore	3
	Total	**77**

Total numbers of 77 responses are received and then make analysis of it by using MS Excel

3.6. Data source

Major source of data is primary as collected from the industry professionals based in Punjab

3.7. Instruments

Well designed and pre tested questionnaire is used as instrument for this study. To fill the questionnaires used following three tool

- Visits
- Email
- Phone calls

3.8. Data analysis tool

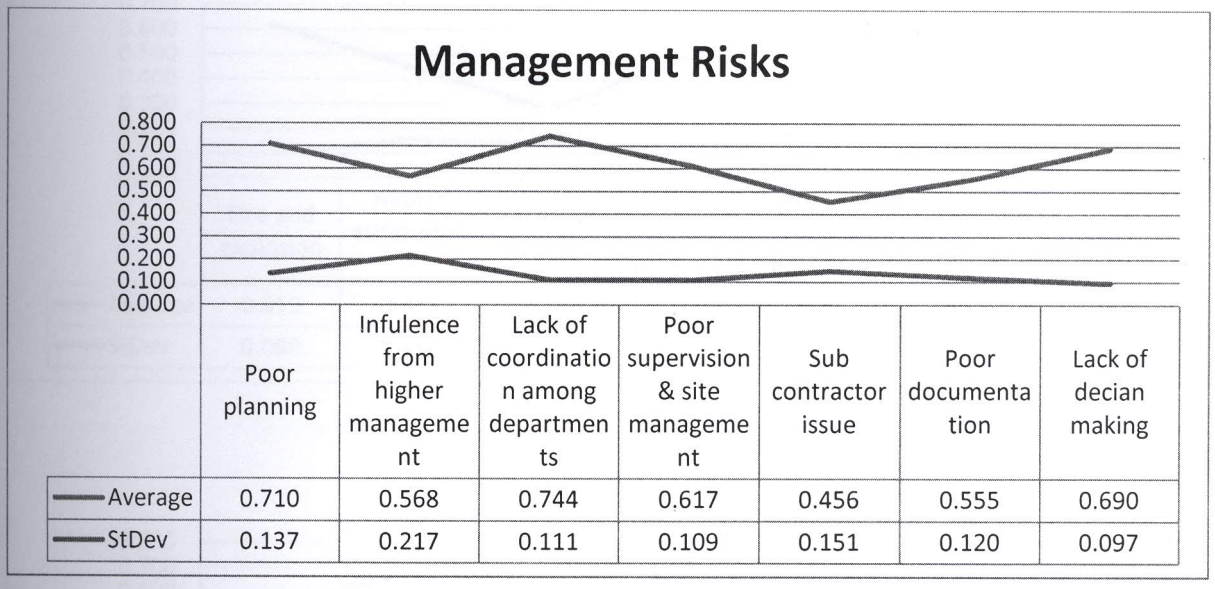
To make data analysis I used Microsoft excel

4. Data analysis and conclusion

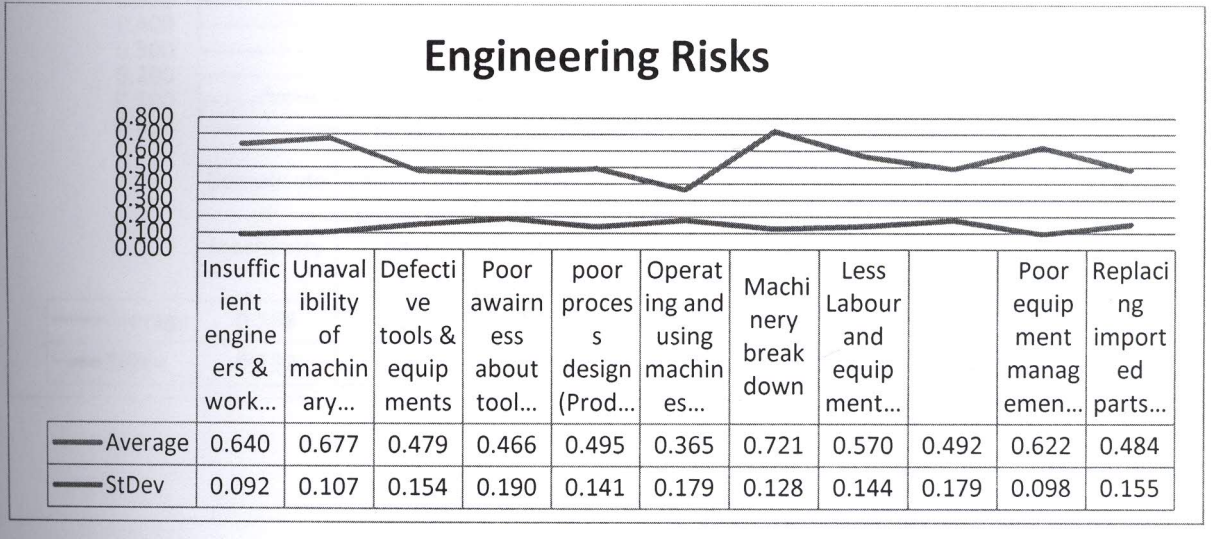
After the analysis of gathered data on MS excel find the average of probability and impact (cost, Time) and also find the standard deviation for each risk. Standard deviation is a number used to tell how measurements for a group are spread out from the average (mean), or expected value. A low standard deviation means that most of the numbers are very close to the average. A high standard deviation means that the numbers are spread out.

In under graphs shows the average/mean and the standard deviation for every risk in each category

4.1. Probability of risk happening

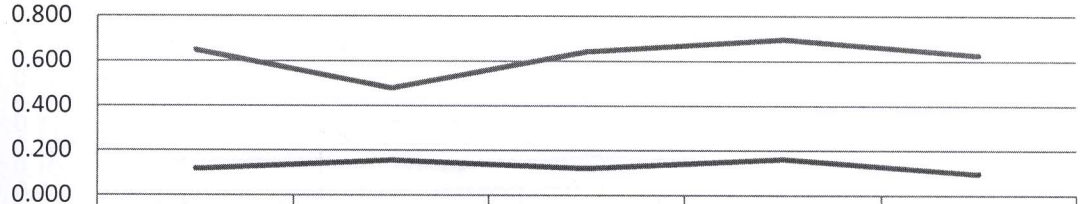


	Poor planning	Infulence from higher management	Lack of coordination among departments	Poor supervision & site management	Sub contractor issue	Poor documentation	Lack of decian making
Average	0.710	0.568	0.744	0.617	0.456	0.555	0.690
StDev	0.137	0.217	0.111	0.109	0.151	0.120	0.097



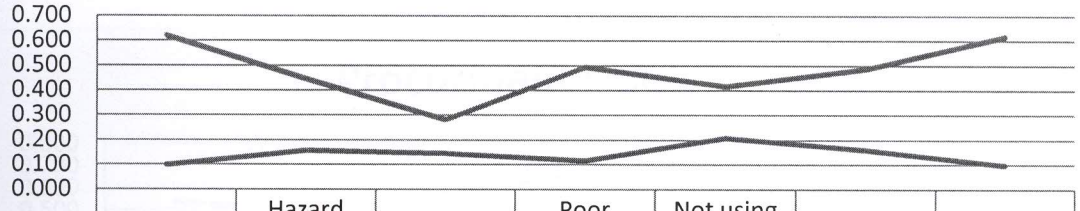
	Insufficient engineers & work...	Unavality of machinary...	Defective tools & equipments	Poor awairness about tool...	poor process design (Prod...	Operating and using machines...	Machinery break down	Less Labour and equipment...		Poor equipment managemen...	Replacing imported parts...
Average	0.640	0.677	0.479	0.466	0.495	0.365	0.721	0.570	0.492	0.622	0.484
StDev	0.092	0.107	0.154	0.190	0.141	0.179	0.128	0.144	0.179	0.098	0.155

Financial risks



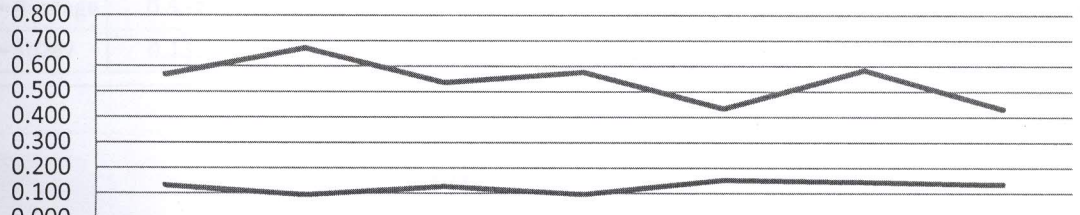
	Unavailability of funds	Hike in material price	Financial delay	Economic disaster	Shortage of running finance
Average	0.648	0.479	0.643	0.697	0.627
StDev	0.119	0.158	0.121	0.164	0.097

H & S risks



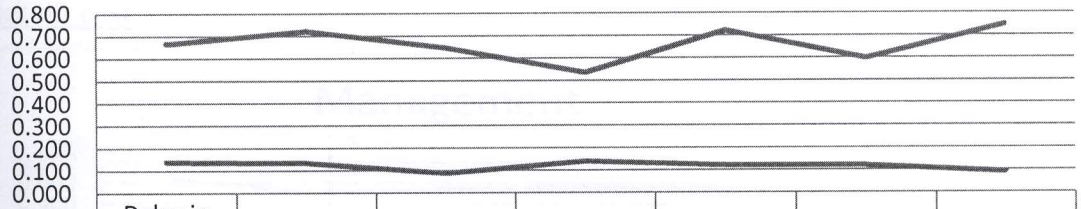
	Fire and explosion	Hazard atmospher e	Excessive noise	Poor lighting on work place	Not using safety equipment	Third party damage	Accidents
Average	0.619	0.445	0.282	0.495	0.417	0.487	0.617
StDev	0.099	0.158	0.146	0.117	0.209	0.160	0.099

Process risks



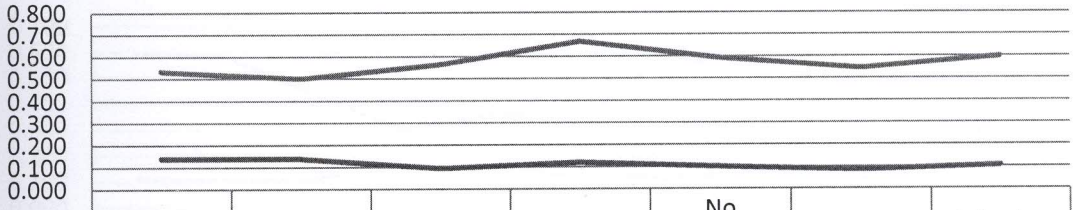
	Complicate d machinery	Complicate d process flow	Poor process guide lines	Poor material manageme nt & planning	Increase material wastage	Defective work	Poor quality control
Average	0.568	0.671	0.536	0.578	0.435	0.586	0.432
StDev	0.132	0.096	0.129	0.098	0.154	0.147	0.136

External risks



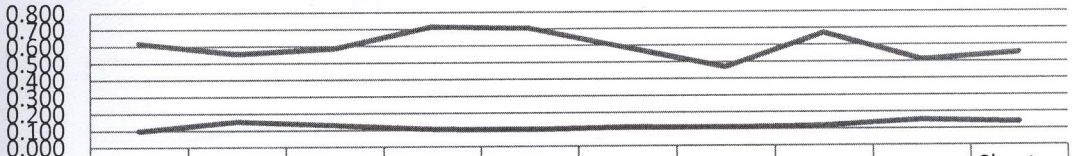
	Delay in approval from higher management	Political instability	Third party/vender delay	Unavailability of equipment	Unavailability of raw material	Suppliers/subcontractors poor performance	Transport strike
Average	0.666	0.723	0.648	0.536	0.723	0.599	0.747
StDev	0.139	0.134	0.088	0.140	0.121	0.120	0.091

Procurment risks



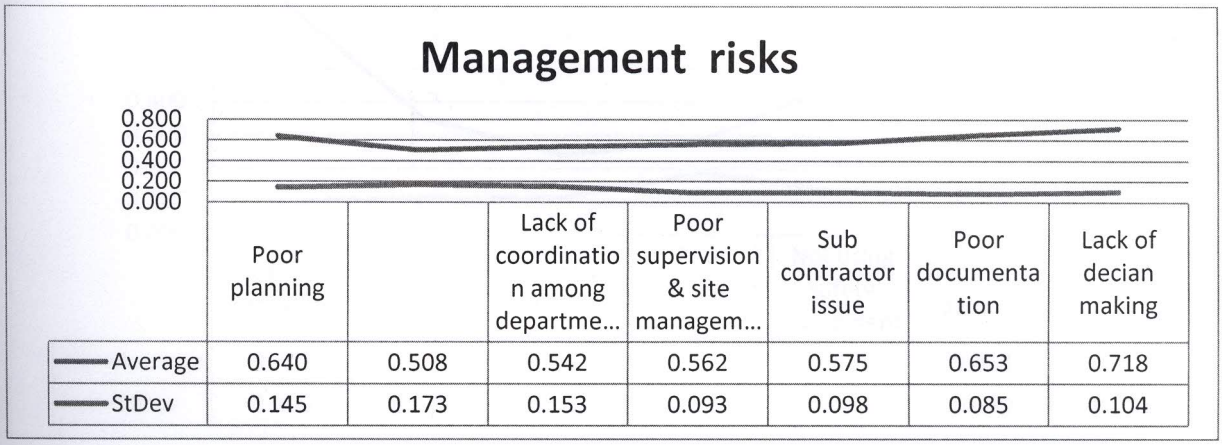
	Failure to identify potential sources	Understatement of the need	Insufficient funding	Dispute with supplier	No response from known quality suppliers	Delay by suppliers	Selecting an inappropriate supplier
Average	0.534	0.503	0.565	0.669	0.594	0.547	0.599
StDev	0.139	0.140	0.094	0.122	0.100	0.085	0.106

HR risks

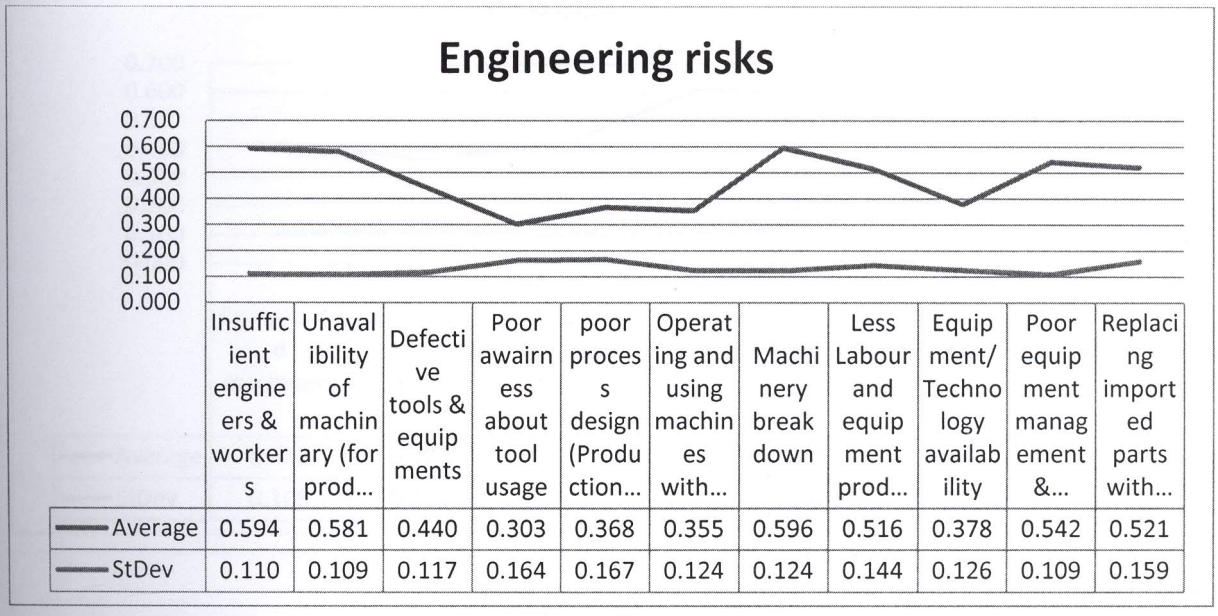


	Labour availability	Resource performance	Human error in process	Conflict among departments/team	Over stress burden on workers	Untrained workers	Poor trainings	Labour disputes	Out sourcing	Shortage/unavailability of skilled worke...
Average	0.619	0.557	0.588	0.716	0.705	0.586	0.471	0.671	0.513	0.555
StDev	0.099	0.155	0.132	0.106	0.102	0.114	0.111	0.120	0.153	0.140

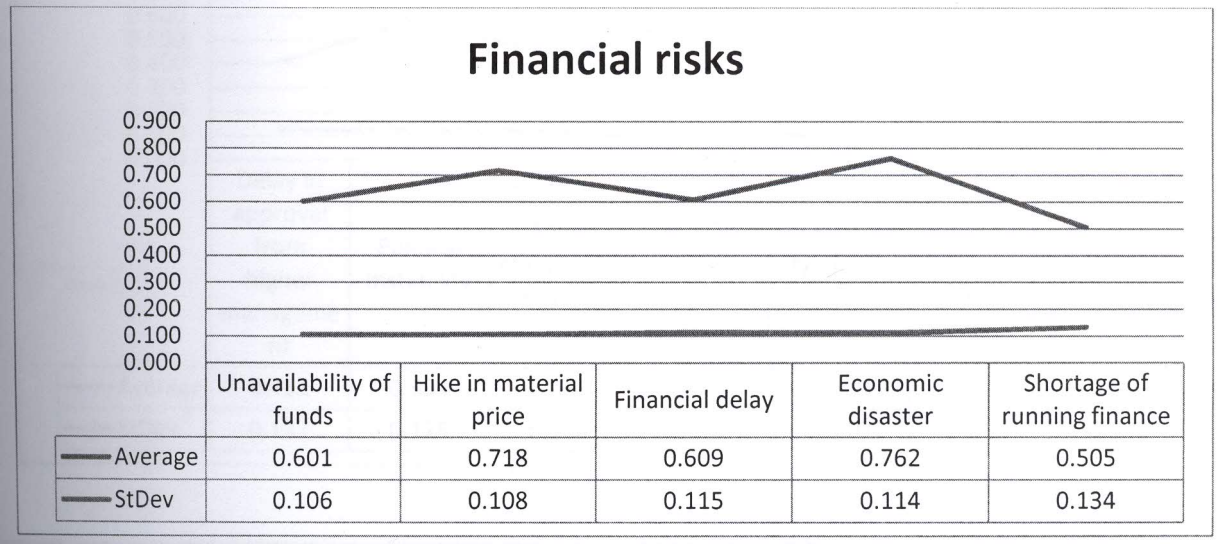
4.2. Impact on cost



	Poor planning		Lack of coordination among departme...	Poor supervision & site managem...	Sub contractor issue	Poor documentation	Lack of decian making
Average	0.640	0.508	0.542	0.562	0.575	0.653	0.718
StDev	0.145	0.173	0.153	0.093	0.098	0.085	0.104

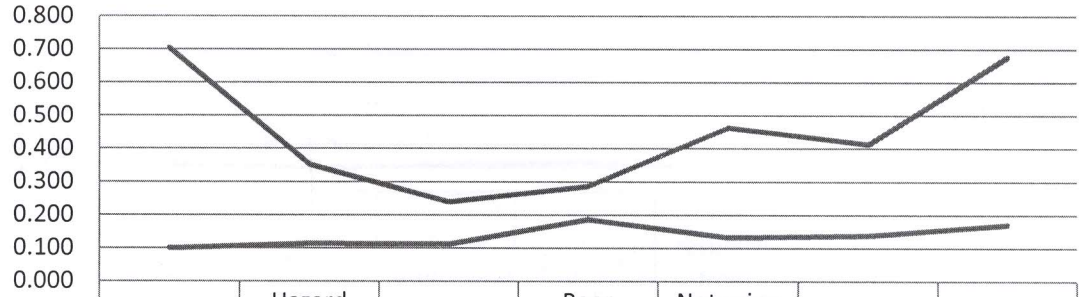


	Insufficient engineers & workers	Unavalibility of machinary (for prod...	Defective tools & equipments	Poor awairness about tool usage	poor process design (Production...	Operating and using machines with...	Machinery break down	Less Labour and equipment prod...	Equipment/ Technology availability	Poor equipment management &...	Replacing imported parts with...
Average	0.594	0.581	0.440	0.303	0.368	0.355	0.596	0.516	0.378	0.542	0.521
StDev	0.110	0.109	0.117	0.164	0.167	0.124	0.124	0.144	0.126	0.109	0.159



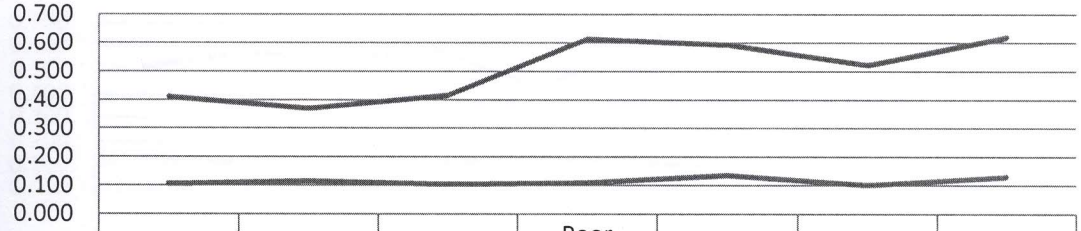
	Unavailability of funds	Hike in material price	Financial delay	Economic disaster	Shortage of running finance
Average	0.601	0.718	0.609	0.762	0.505
StDev	0.106	0.108	0.115	0.114	0.134

H & S risks



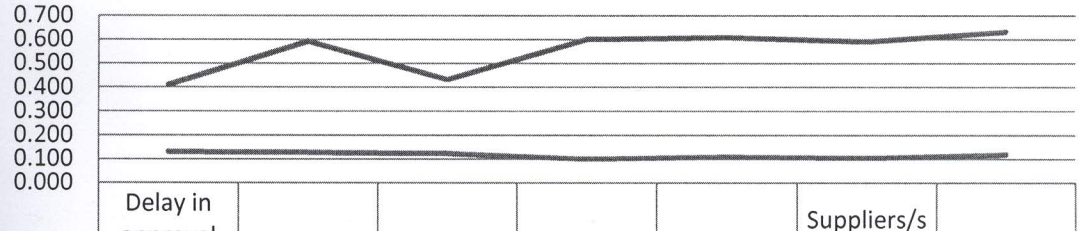
	Fire and explosion	Hazard atmosphere	Excessive noise	Poor lighting on work place	Not using safety equipment	Third party damage	Accidents
Average	0.703	0.352	0.240	0.287	0.464	0.414	0.677
StDev	0.100	0.114	0.113	0.187	0.133	0.139	0.172

Process risks



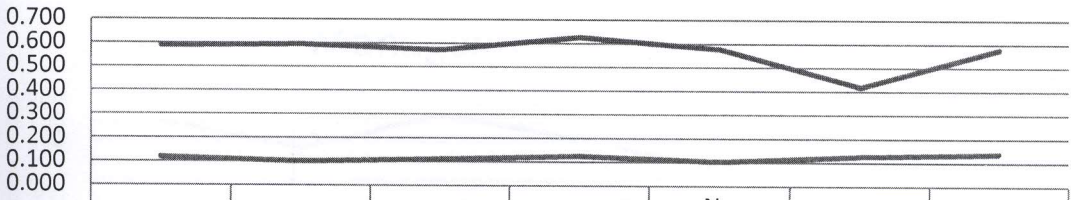
	Complicated machinery	Complicated process flow	Poor process guide lines	Poor material management & planning	Increase material wastage	Defective work	Poor quality control
Average	0.412	0.370	0.417	0.614	0.594	0.523	0.619
StDev	0.105	0.116	0.104	0.110	0.136	0.102	0.131

External risks



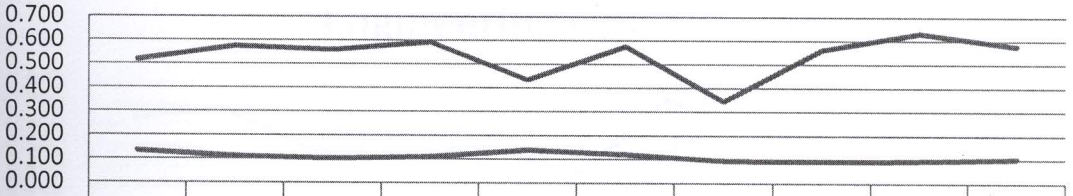
	Delay in approval from higher management	Political instability	Third party/vender delay	Unavailability of equipment	Unavailability of raw material	Suppliers/subcontractors poor performance	Transport strike
Average	0.412	0.594	0.432	0.601	0.609	0.591	0.632
StDev	0.132	0.128	0.124	0.101	0.110	0.105	0.120

Procurement risks



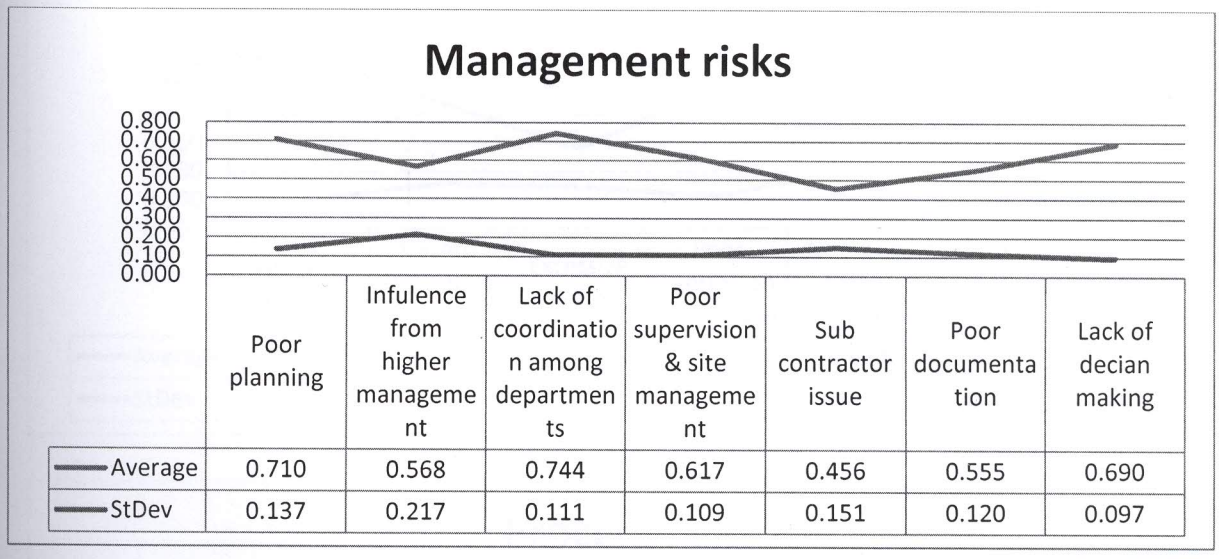
	Failure to identify potential sources	Understatement of the need	Insufficient funding	Dispute with supplier	No response from known quality suppliers	Delay by suppliers	Selecting an inappropriate supplier
Average	0.588	0.596	0.573	0.627	0.578	0.419	0.578
StDev	0.119	0.101	0.112	0.125	0.103	0.127	0.138

HR risks

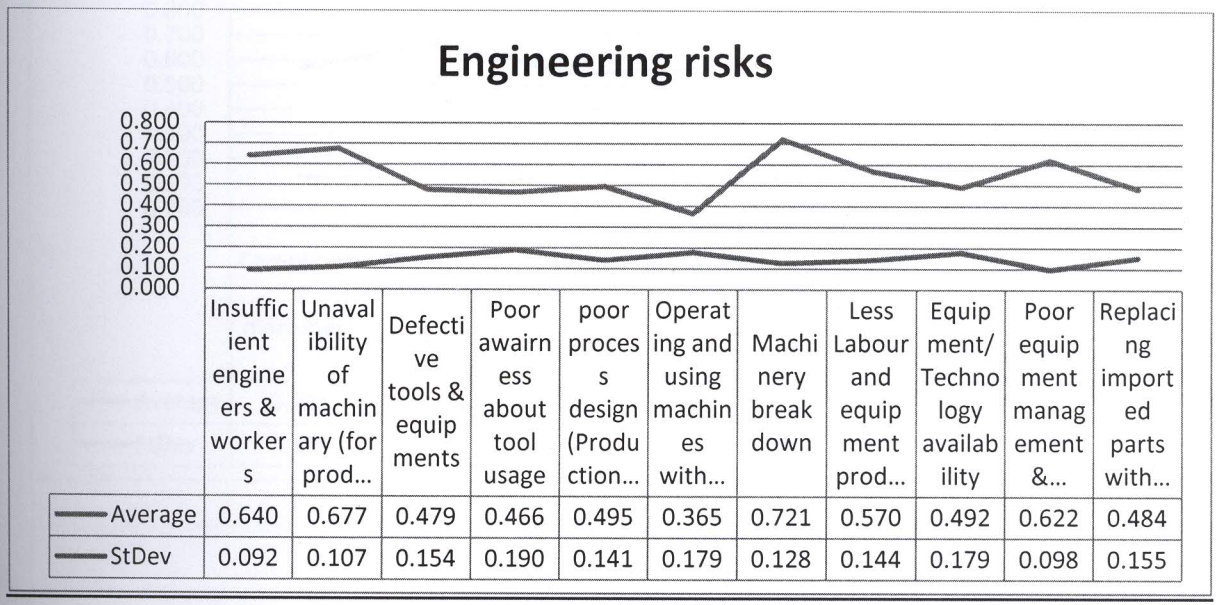


	Labour availability	Resource performance	Human error in process	Conflict among departments/team	Over stress burden on workers	Untrained workers	Poor trainings	Labour disputes	Out sourcing	Shortage/unavailability of skilled worke...
Average	0.518	0.575	0.560	0.594	0.435	0.575	0.344	0.562	0.632	0.578
StDev	0.134	0.113	0.103	0.110	0.139	0.122	0.095	0.093	0.095	0.103

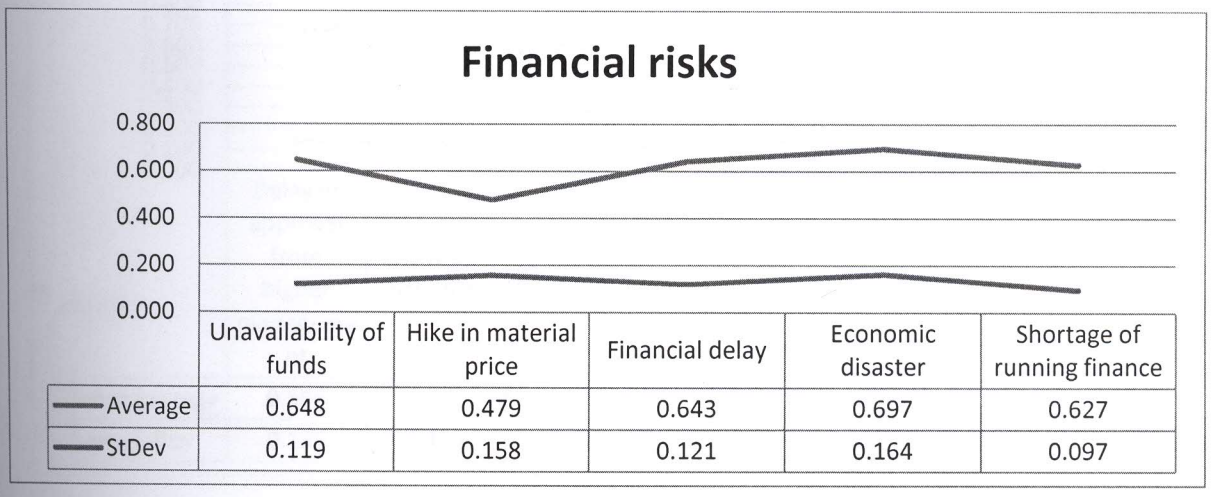
4.3. Impact on Time



	Poor planning	Infulence from higher management	Lack of coordination among departments	Poor supervision & site management	Sub contractor issue	Poor documentation	Lack of decian making
Average	0.710	0.568	0.744	0.617	0.456	0.555	0.690
StDev	0.137	0.217	0.111	0.109	0.151	0.120	0.097

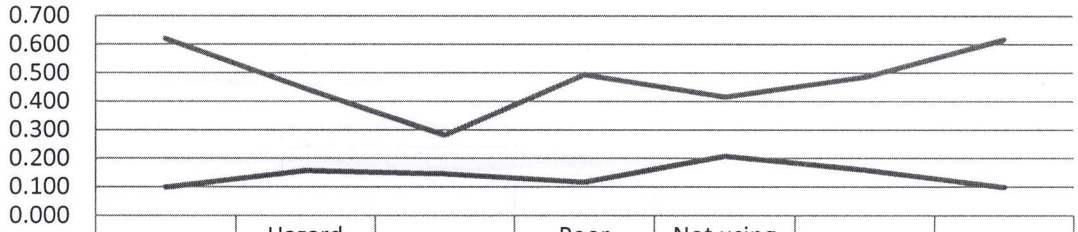


	Insufficient engineers & workers	Unavalibility of machinary (for prod...	Defective tools & equipments	Poor awairness about tool usage	poor process design (Production...	Operating and using machines with...	Machinery break down	Less Labour and equipment prod...	Equipment/ Technology availability	Poor equipment management &...	Replacing imported parts with...
Average	0.640	0.677	0.479	0.466	0.495	0.365	0.721	0.570	0.492	0.622	0.484
StDev	0.092	0.107	0.154	0.190	0.141	0.179	0.128	0.144	0.179	0.098	0.155



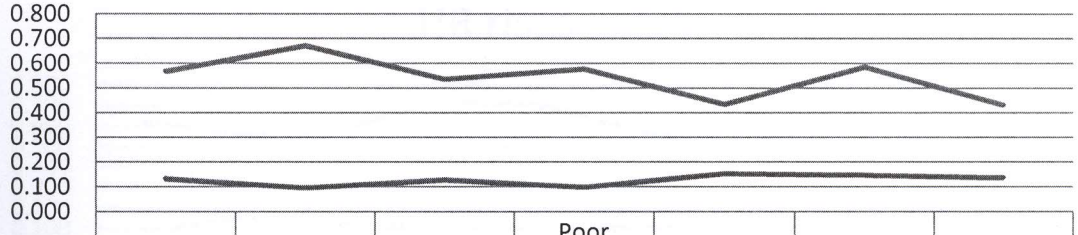
	Unavailability of funds	Hike in material price	Financial delay	Economic disaster	Shortage of running finance
Average	0.648	0.479	0.643	0.697	0.627
StDev	0.119	0.158	0.121	0.164	0.097

H & S risks



	Fire and explosion	Hazard atmosphere	Excessive noise	Poor lighting on work place	Not using safety equipment	Third party damage	Accidents
Average	0.619	0.445	0.282	0.495	0.417	0.487	0.617
StDev	0.099	0.158	0.146	0.117	0.209	0.160	0.099

Process risks



	Complicated machinery	Complicated process flow	Poor process guide lines	Poor material management & planning	Increase material wastage	Defective work	Poor quality control
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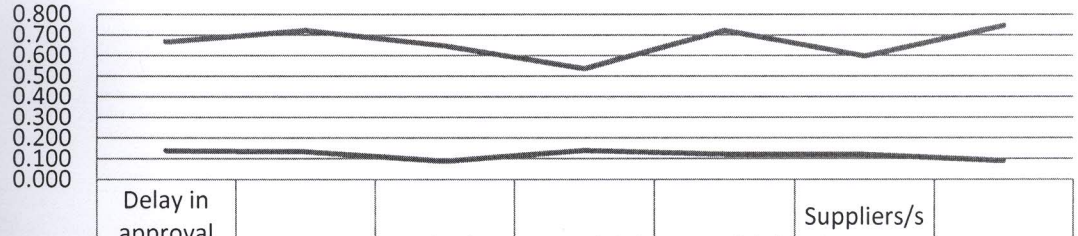
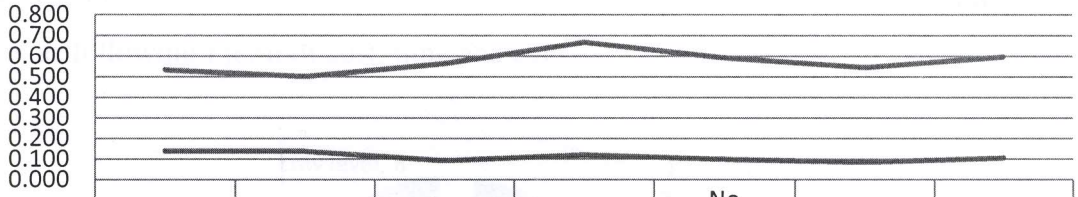
StDev	0.132	0.096	0.129	0.098	0.154	0.147	0.136

External risks



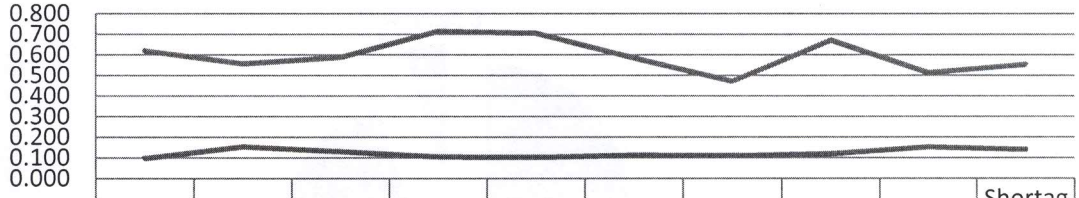
	Delay in approval from higher management	Political instability	Third party/vender delay	Unavailability of equipment	Unavailability of raw material	Suppliers/subcontractors poor performance	Transport strike
Average	0.666	0.723	0.648	0.536	0.723	0.599	0.747
StDev	0.139	0.134	0.088	0.140	0.121	0.120	0.091

Procurement risks



	Failure to identify potential sources	Understatement of the need	Insufficient funding	Dispute with supplier	No response from known quality suppliers	Delay by suppliers	Selecting an inappropriate supplier
Average	0.534	0.503	0.565	0.669	0.594	0.547	0.599
StDev	0.139	0.140	0.094	0.122	0.100	0.085	0.106

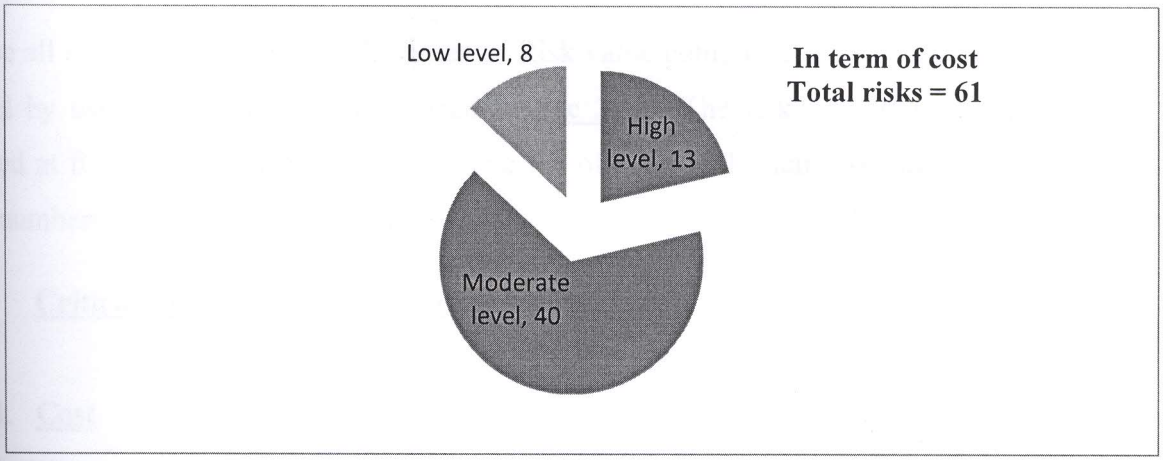
HR risks

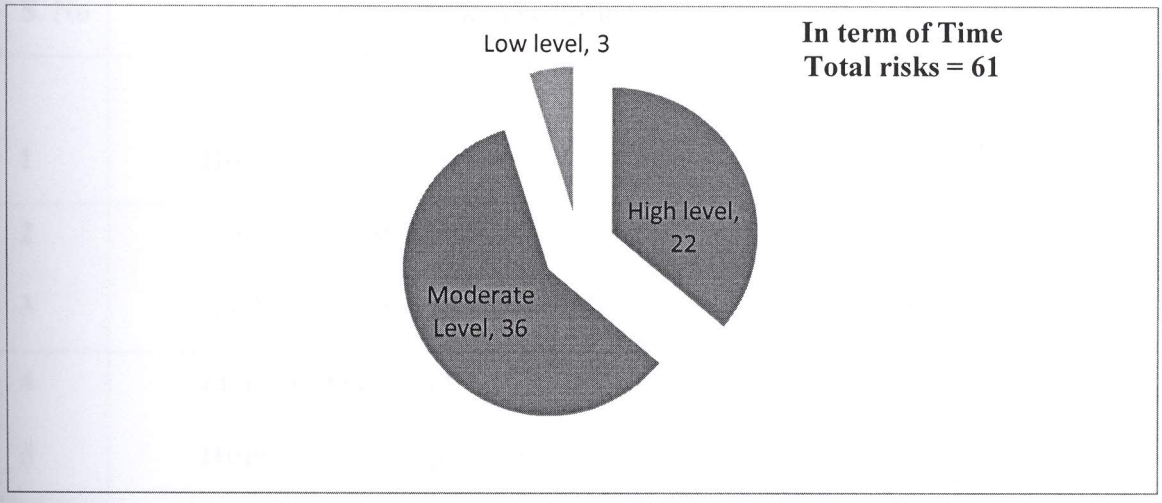


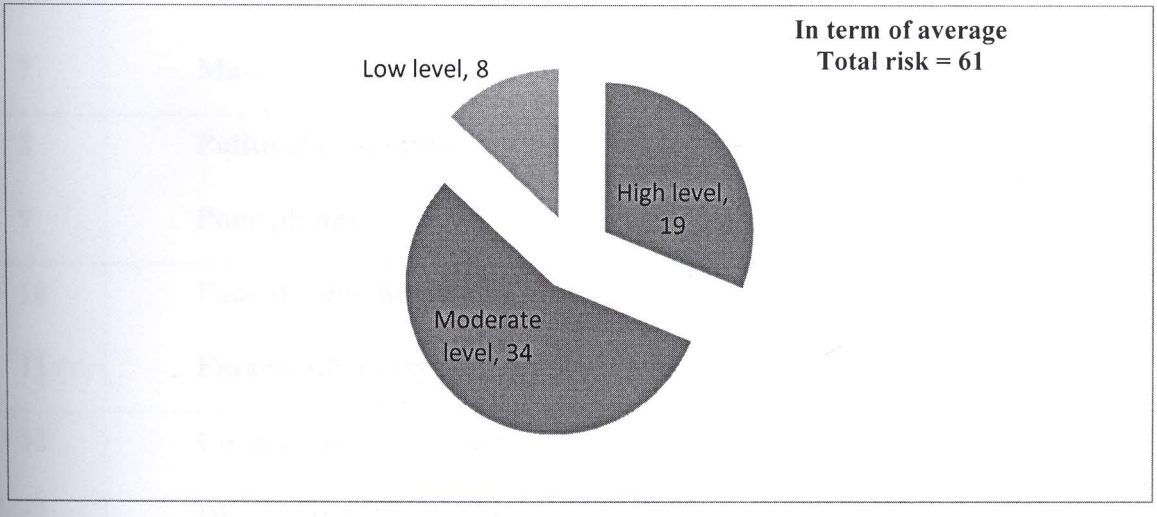
	Labour availability	Resource performance	Human error in process	Conflict among departments/team	Over stress burden on workers	Untrained workers	Poor trainings	Labour disputes	Out sourcing	Shortage/unavailability of skilled worke...
Average	0.619	0.557	0.588	0.716	0.705	0.586	0.471	0.671	0.513	0.555
StDev	0.099	0.155	0.132	0.106	0.102	0.114	0.111	0.120	0.153	0.140

4.4. Risks categorization as per priority level

As per risk probability and risk matrix *APPENDIX Table 8* the number of risks in each category are as following I term of cost, time and average







5. Chapter 5 Conclusion

By making the analysis of all risks identified in risk identification process the critical risks for sugar sector impacting cost and time are respectively as following.

These all risk are sorted out on the bases of Risk value computed in data analysis part in MS Excel by using the equations mentioned in **Sec 3.1.5.** The risk with highest risk value is ranked at first in each aspect. The complete list of risks with their risk value and respective risk numbers are in APPENDIX Table 4, Table 5 & Table 6

5.1. Critical risks in term of cost, time and average

5.1.1. Cost

S. No	Risk description	Risk value
1	Hike in material price	0.357
2	Economic disaster	0.316
3	Lack of decision making ability	0.312
4	Fire and explosion	0.300
5	Human error in process	0.290
6	Transport strike	0.288
7	Machinery break down	0.283
8	Political instability	0.278
9	Poor planning	0.277
10	Poor documentation	0.269
11	Financially delay	0.268
12	Conflict among departments	0.264
13	Dispute with suppliers	0.261

14	Unavailability of funds	0.257
15	Insufficient funding	0.255
16	Poor material management and planning	0.254
17	Unavailability of raw material	0.254
18	Accidents	0.250
19	Lack of coordination among departments	0.250
20	Labour dispute	0.240
21	Shortage of running finance	0.238
22	Shortage/unavailability of skilled worker/engineers	0.232
23	Influence from higher management	0.231
24	Poor quality control	0.231
25	Insufficient engineers/workers	0.224

5.1.2. Time

S. No	Risk description	Risk value
1	Lack of coordination among departments	0.343
2	Machinery break down	0.342
3	Transport strike	0.340
4	Political instability	0.339
5	Conflict among departments	0.319
6	Financial delay	0.309
7	Over stress burden on workers	0.309

8	Poor planning	0.307
9	Human error in process	0.305
10	Unavailability of raw material	0.302
11	Lack of decision making ability	0.300
12	Third party/Vander delay	0.299
13	Shortage of running finance	0.296
14	Economic disaster	0.289
15	Labour dispute	0.287
16	Dispute with supplier	0.279
17	Unavailability of funds	0.277
18	Hike in material price	0.267
19	Fire and explosion	0.265
20	Delay in approval from higher management	0.264
21	Delay by supplier	0.262
22	Poor process guidelines	0.260
23	Influence from higher management	0.259
24	Unavailability of machinery (for production)	0.257
25	Insufficient funding	0.252

5.1.3. Average of critical cost and time risk Number

S. No	Risk description	Risk value
1	Transport strike	0.314
2	Hike in material price	0.312
3	Machinery break down	0.312
4	Political instability	0.309
5	Lack of decision making	0.306
6	Economic disaster	0.302
7	Human error in process	0.297
8	Lack of coordination among departments	0.296
9	Poor planning	0.292
10	Conflict among departments	0.292
11	Financial delay	0.288
12	Fire and explosion	0.282
13	Unavailability of raw material	0.278
14	Dispute with suppliers	0.270
15	Shortage of running finance	0.267
16	Unavailability of funds	0.267
17	Labour dispute	0.264
18	Insufficient funding	0.253
19	Over stress burden on workers	0.250
20	Third party/ Vender delay	0.249
21	Poor documentation	0.249

22	**Poor material management**	**0.247**
23	**Influence from higher management**	**0.245**
24	**Accidents**	**0.239**
25	**Unavailability of machinery (for production)**	**0.239**

5.2. Critical risks in each category in term of cost, time and average

During the risk identification process in sugar industries total 62 risks are been identified. A maximum number of risks were identified in Engineering category and then HR, Procurement and Health & Safety. Three critical risks in each category are mentioned below

5.2.1 Management

a. Cost
   i. Lack of decision making
   ii. Poor planning
   iii. Poor documentation

b. Time
   i. Lack of coordination among departments
   ii. Poor planning
   iii. Lack of decision making

c. Average
   i. Lack of decision making
   ii. Lack of coordination among departments
   iii. Poor planning

While considering the management category the "Lack of decision making" in individuals at different level is ranked at first number in term of cost and average but at 3rd number in term of time. Same like "Poor planning" is ranked as 2nd number in term of cost and time but is ranked at 3rd number while considering the average of both.

5.2.2. Engineering

a. Cost

i. Machinery breakdown
ii. Insufficient engineers & workers
iii. Unavailability of machinery (for production)

b. Time

i. Machinery breakdown
ii. Unavailability of machinery (for production)
iii. Insufficient engineers & workers

c. Average

i. Machinery breakdown
ii. Unavailability of machinery (for production)
iii. Insufficient engineers & workers

In engineering category the "Machine break down" is the most critical risk in term of cost, time and average of both. After that "Unavailability of machinery for production" & "Insufficient engineers and workers" are at 2nd & 3rd respectively.

5.2.3. Financial

a. Cost

i. Hike in material price
ii. Economic disaster
iii. Financial delay

b. Time

i. Hike in material price
ii. Shortage of running finance
iii. Economic disaster

c. Average

i. Hike in material price
ii. Economic disaster

iii. Financial delay

"Hike in material prize" especially in case of raw material is the most critical risk in all aspects. While "economic" disaster is at 2nd number in term of cost & average of both and "financial delay" in different aspects i.e. delay in payments etc. is at third number in term of cost ant average

5.2.4. Health and safety

a. Cost

i. Fire and explosion
ii. Accidents
iii. Not using safety equipment

b. Time

i. Fire and explosion
ii. Accidents
iii. Hazard atmosphere

c. Average

i. Fire and explosion
ii. Accidents
iii. Not using safety equipment

"Fire and explosion" & "Accidents" are the most critical risks in Health and safety category.

5.2.5. Process risks

a. Cost

i. Poor material management & planning
ii. Poor quality control
iii. Increase material wastage

b. Time

i. Poor process guide lines
ii. Complicated process flow
iii. Poor material management & planning

c. Average

i. Poor material management & planning

ii. Poor process guide lines

iii. Poor quality control

"Poor material management & planning" is ranked at level first in term of cost & average of both and "poor quality" is the 2nd important risk which causes the cost overrun. While "complicated process flow" & "Poor process guide lines" are at 2nd level in term of time and average of both respectively.

5.2.6. External Risks

a. Cost

i. Transport strike

ii. Political instability

iii. Unavailability of raw material

b. Time

i. Transport strike

ii. Political instability

iii. Unavailability of raw material

c. Average

i. Transport strike

ii. Political instability

iii. Unavailability of raw material

"Transport strike" and "Political instability" are the most critical in all aspects

5.2.7. Procurement risks

a. Cost

i. Dispute with supplier

ii. Insufficient funding

iii. Failure to identify potential sources

b. Time

i. Dispute with supplier
ii. Delay by suppliers
iii. Insufficient funding

c. Average

i. Dispute with supplier
ii. Insufficient funding
iii. Delay by suppliers

"Dispute with suppliers" is the most critical risk in all aspects and "Insufficient funding" is ranked ant 2nd level in term of cost and at 3rd level in term of time and average of both time & cost.

5.2.8. HR Risks

a. Cost

i. Human error in process
ii. Conflict among departments/team
iii. Labour disputes

b. Time

i. Conflict among departments/team
ii. Over stress burden on workers
iii. Human error in process

c. Average

i. Human error in process
ii. Conflict among departments/team
iii. Labour disputes

"Human error in process" & "Conflict among department/teams" is considered at level first in term of cost and time respectively. While "Labour dispute" and "Over stress burden on workers" are also the risks may causes of cost overrun & time delay respectively.

5.3. Conclusion

Risk management is one of the most important practices all over the world in which the impact of related risks in different categories may be minimized by adopting appropriate risk strategies. The sugar sector in Punjab is required to be aware of the importance of risk management but the issue is there that they are not much known with the benefits of risk analysis and management. Therefore this is the reason they are not treating it as an opportunity so unable to get the benefits of it and mostly suffered due to the risk impact causes in high production cost and schedule disturbing issue. Sugar sector have only 4-5 months working time in a year so the schedule issue may affect the desired result causes of failure to achieve targets. So they should adopt the risk management approach to avoid such a issues.

The one of the basic requirement for risk management implementation is that the stake holder in sugar sector should realize the importance of risk analysis and management. In this research the most effective risk categories having a significant effect on the outcome of sugar sector in term of time & cost are identified through a detailed literature review and by the help of experts in fields and try to cover all the possible most effective risks in related category and then sort out them as per their criticality in each category and also by whole provide the sequenced list of important risk for to look after more effectively.

In short the awareness of risk management is at very low level in the sugar industries. Poor documentation, resistance towards change and the satisfaction of stakeholders(political people, employees etc with present system is the main reasons of this low level of risk analysis and management. By the help of this research I try to contribute as a first step towards the risk consideration and their management and also try to suggest the best possible risk management strategy for each and every risk.

5.4. Recommendation for future work

All the sugar industries are needed to be familiar with the importance of risk management because it is the technique which is going to assist the stack holders to achieve the targets in good and appropriate manner. So it is highly recommend for them to educate the professionals working in industries through risk management trainings and special courses. Further it is also recommended to include the risk related courses at university level especially in engineering stream as the fresh graduates can get its usefulness direction before starting the career in industries.

Similar study can also be performed to classify the more categories and their associated risk for quantification and further improvement in this study. In addition all the identified risk can be further explored towards the assessment of risk consequence in term of cost & time. A research can be carried out to evaluate the present status of awareness and approach towards risk management tools & techniques in industry.

5.5. Limitations

Time was the big problem that was been faced during this research because

- Short duration for research
- As mentioned above that sugar sector has only 4 – 5 months crushing season in a year and during my research the season was on so the stakeholders (Owners, workers etc) have very little time to response and co-ordinates. That's the reason got this amount or responses for which I find the special contacts and request them to fill up the questionnaires. Due to time problem majority of data is been collected by phone calls and personally visits to head offices of different sugar industries

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APPENDIX

(Table 1)
Risk frequency with variance and standard deviation

S.No	Risk ID	Risk Description	Variance	Average	Standard deviation
		Management			
1	**Mgm01**	Poor planning	1.88%	0.710	0.137
2	**Mgm02**	Influence from higher management	4.70%	0.568	0.217
3	**Mgm03**	Lack of coordination among departments	1.22%	0.744	0.111
4	**Mgm04**	Poor supervision & site management	1.19%	0.617	0.109
5	**Mgm05**	Sub contractor issue	2.28%	0.456	0.151
6	**Mgm06**	Poor documentation	1.44%	0.555	0.120
7	**Mgm07**	Lack of decision making	0.94%	0.690	0.097
		Engineering			
8	**Engg01**	Insufficient engineers & workers	0.85%	0.640	0.092
9	**Engg02**	Unavailability of machinery (for production)	1.16%	0.677	0.107
10	**Engg03**	Defective tools & equipments	2.38%	0.479	0.154
11	**Engg04**	Poor awareness about tool usage	3.62%	0.466	0.190
12	**Engg05**	poor process design (Production process)	2.00%	0.495	0.141
13	**Engg06**	Operating and using machines without permission	3.20%	0.365	0.179
14	**Engg07**	Machinery break down	1.64%	0.721	0.128
15	**Engg08**	Less Labour and equipment productivity	2.08%	0.570	0.144
16	**Engg09**	Equipment/Technology availability	3.20%	0.492	0.179
17	**Engg10**	Poor equipment management & planning	0.96%	0.622	0.098
18	**Engg11**	Replacing imported parts with local	2.40%	0.484	0.155

		Financial			
19	**Fin01**	Unavailability of funds	1.41%	0.648	0.119
20	**Fin02**	Hike in material price	2.48%	0.479	0.158
21	**Fin03**	Financial delay	1.46%	0.643	0.121
22	**Fin04**	Economic disaster	2.68%	0.697	0.164
23	**Fin05**	Shortage of running finance	0.94%	0.627	0.097
		Health & safety			
24	**H&S01**	Fire and explosion	0.97%	0.619	0.099
25	**H&S02**	Hazard atmosphere	2.49%	0.445	0.158
26	**H&S03**	Excessive noise	2.12%	0.282	0.146
27	**H&S04**	Poor lighting on work place	1.37%	0.495	0.117
28	**H&S05**	Not using safety equipment	4.35%	0.417	0.209
29	**H&S06**	Third party damage	2.56%	0.487	0.160
30	**H&S07**	Accidents	0.98%	0.617	0.099
		Process			
31	**Pro01**	Complicated machinery	1.75%	0.568	0.132
32	**Pro02**	Complicated process flow	0.92%	0.671	0.096
33	**Pro03**	Poor process guide lines	1.66%	0.536	0.129
34	**Pro04**	Poor material management & planning	0.96%	0.578	0.098
35	**Pro05**	Increase material wastage	2.36%	0.435	0.154
36	**Pro06**	Defective work	2.15%	0.586	0.147
37	**Pro07**	Poor quality control	1.85%	0.432	0.136
38		**External**			
	Ext01	Delay in approval from higher management	1.94%	0.666	0.139
39	**Ext02**	Political instability	1.79%	0.723	0.134
40	**Ext03**	Third party/vender delay	0.78%	0.648	0.088
41	**Ext04**	Unavailability of equipment	1.97%	0.536	0.140
42	**Ext05**	Unavailability of raw material	1.47%	0.723	0.121
43	**Ext06**	Suppliers/subcontractors poor performance	1.43%	0.599	0.120
44	**Ext07**	Transport strike	0.83%	0.747	0.091
45		**Procurement**			
	Proc01	Failure to identify potential sources	1.94%	0.534	0.139
46	**Proc02**	Understatement of the need	1.95%	0.503	0.140
47	**Proc03**	Insufficient funding	0.89%	0.565	0.094
48	**Proc04**	Dispute with supplier	1.48%	0.669	0.122

49	**Proc05**	No response from known quality suppliers	1.01%	0.594	0.100
50	**Proc06**	Delay by suppliers	0.73%	0.547	0.085
51	**Proc07**	Selecting an inappropriate supplier	1.12%	0.599	0.106
52		**HR**			
	HR01	Labour availability	0.97%	0.619	0.099
53	**HR02**	Resource performance	2.41%	0.557	0.155
54	**HR03**	Human error in process	1.74%	0.588	0.132
55	**HR04**	Conflict among departments/team	1.13%	0.716	0.106
56	**HR05**	Over stress burden on workers	1.05%	0.705	0.102
57	**HR06**	Untrained workers	1.31%	0.586	0.114
58	**HR07**	Poor trainings	1.23%	0.471	0.111
59	**HR08**	Labour disputes	1.44%	0.671	0.120
60	**HR09**	Out sourcing	2.35%	0.513	0.153
61	**HR10**	Shortage/unavailability of skilled workers/engineers	1.96%	0.555	0.140

(Table 2)
Impact on cost with variance and standard deviation

S.No	Risk ID	Risk Description	Variance	Average	Standard deviation
		Management			
1	Mgm01	Poor planning	2.11%	0.640	0.145
2	Mgm02	Influence from higher management	2.99%	0.508	0.173
3	Mgm03	Lack of coordination among departments	2.35%	0.542	0.153
4	Mgm04	Poor supervision & site management	0.87%	0.562	0.093
5	Mgm05	Sub contractor issue	0.95%	0.575	0.098
6	Mgm06	Poor documentation	0.73%	0.653	0.085
7	Mgm07	Lack of decision making	1.07%	0.718	0.104
		Engineering			
8	Engg01	Insufficient engineers & workers	1.22%	0.594	0.110
9	Engg02	Unavailability of machinery (for production)	1.19%	0.581	0.109
10	Engg03	Defective tools & equipments	1.38%	0.440	0.117
11	Engg04	Poor awareness about tool usage	2.68%	0.303	0.164
12	Engg05	poor process design (Production process)	2.80%	0.368	0.167
13	Engg06	Operating and using machines without permission	1.54%	0.355	0.124
14	Engg07	Machinery break down	1.54%	0.596	0.124
15	Engg08	Less Labour and equipment productivity	2.08%	0.516	0.144
16	Engg10	Equipment/Technology availability	1.60%	0.378	0.126
17	Engg11	Poor equipment management & planning	1.19%	0.542	0.109
18	Engg12	Replacing imported parts with local	2.54%	0.521	0.159
19		**Financial**			
	Fin01	Unavailability of funds	1.12%	0.601	0.106

20	**Fin02**	Hike in material price	1.18%	0.718	0.108
21	**Fin03**	Financial delay	1.32%	0.609	0.115
22	**Fin04**	Economic disaster	1.29%	0.762	0.114
23	**Fin05**	Shortage of running finance	1.79%	0.505	0.134
24		**Health & safety**			
	H&S01	Fire and explosion	1.00%	0.703	0.100
25	**H&S02**	Hazard atmosphere	1.31%	0.352	0.114
26	**H&S03**	Excessive noise	1.27%	0.240	0.113
27	**H&S04**	Poor lighting on work place	3.51%	0.287	0.187
28	**H&S05**	Not using safety equipment	1.76%	0.464	0.133
29	**H&S06**	Third party damage	1.94%	0.414	0.139
30	**H&S07**	Accidents	2.94%	0.677	0.172
31		**Process**			
	Pro01	Complicated machinery	1.10%	0.412	0.105
32	**Pro02**	Complicated process flow	1.34%	0.370	0.116
33	**Pro03**	Poor process guide lines	1.09%	0.417	0.104
34	**Pro04**	Poor material management & planning	1.20%	0.614	0.110
35	**Pro05**	Increase material wastage	1.85%	0.594	0.136
36	**Pro06**	Defective work	1.05%	0.523	0.102
37	**Pro07**	Poor quality control	1.71%	0.619	0.131
38		**External**			
	Ext01	Delay in approval from higher management	1.74%	0.412	0.132
39	**Ext02**	Political instability	1.64%	0.594	0.128
40	**Ext03**	Third party/vender delay	1.54%	0.432	0.124
41	**Ext04**	Unavailability of equipment	1.01%	0.601	0.101
42	**Ext05**	Unavailability of raw material	1.22%	0.609	0.110
43	**Ext06**	Suppliers/subcontractors poor performance	1.11%	0.591	0.105
44	**Ext07**	Transport strike	1.43%	0.632	0.120
45		**Procurement**			
	Proc01	Failure to identify potential sources	1.42%	0.588	0.119
46	**Proc02**	Understatement of the need	1.01%	0.596	0.101
47	**Proc03**	Insufficient funding	1.25%	0.573	0.112
48	**Proc04**	Dispute with supplier	1.57%	0.627	0.125

49	**Proc05**	No response from known quality suppliers	1.07%	0.578	0.103
50	**Proc06**	Delay by suppliers	1.61%	0.419	0.127
51	**Proc07**	Selecting an inappropriate supplier	1.91%	0.578	0.138
52		**HR**			
	HR01	Labour availability	1.81%	0.518	0.134
53	**HR02**	Resource performance	1.27%	0.575	0.113
54	**HR03**	Human error in process	1.06%	0.560	0.103
55	**HR04**	Conflict among departments/team	1.22%	0.594	0.110
56	**HR05**	Over stress burden on workers	1.94%	0.435	0.139
57	**HR06**	Untrained workers	1.48%	0.575	0.122
58	**HR07**	Poor trainings	0.91%	0.344	0.095
59	**HR08**	Labour disputes	0.87%	0.562	0.093
60	**HR09**	Out sourcing	0.91%	0.632	0.095
61	**HR10**	Shortage/unavailability of skilled workers/engineers	1.07%	0.578	0.103

(Table 3)
Impact on time with variance and standard deviation

S.No	Risk ID	Risk Description			
		Management	**Variance**	**Average**	**Standard deviation**
1	**Mgm01**	Poor planning	1.88%	0.710	0.137
2	**Mgm02**	Influence from higher management	4.70%	0.568	0.217
3	**Mgm03**	Lack of coordination among departments	1.22%	0.744	0.111
4	**Mgm04**	Poor supervision & site management	1.19%	0.617	0.109
5	**Mgm05**	Sub contractor issue	2.28%	0.456	0.151
6	**Mgm06**	Poor documentation	1.44%	0.555	0.120
7	**Mgm07**	Lack of decision making	0.94%	0.690	0.097
		Engineering			
8	**Engg01**	Insufficient engineers & workers	0.85%	0.640	0.092
9	**Engg02**	Unavailability of machinery (for production)	1.16%	0.677	0.107
10	**Engg03**	Defective tools & equipments	2.38%	0.479	0.154
11	**Engg04**	Poor awareness about tool usage	3.62%	0.466	0.190
12	**Engg05**	poor process design (Production process)	2.00%	0.495	0.141
13	**Engg06**	Operating and using machines without permission	3.20%	0.365	0.179
14	**Engg07**	Machinery break down	1.64%	0.721	0.128
15	**Engg08**	Less Labour and equipment productivity	2.08%	0.570	0.144
16	**Engg10**	Equipment/Technology availability	3.20%	0.492	0.179
17	**Engg11**	Poor equipment management & planning	0.96%	0.622	0.098
18	**Engg12**	Replacing imported parts with local	2.40%	0.484	0.155

19		**Financial**			
	Fin01	Unavailability of funds	1.41%	0.648	0.119
20	**Fin02**	Hike in material price	2.48%	0.479	0.158
21	**Fin03**	Financial delay	1.46%	0.643	0.121
22	**Fin04**	Economic disaster	2.68%	0.697	0.164
23	**Fin05**	Shortage of running finance	0.94%	0.627	0.097
24		**Health & safety**			
	H&S01	Fire and explosion	0.97%	0.619	0.099
25	**H&S02**	Hazard atmosphere	2.49%	0.445	0.158
26	**H&S03**	Excessive noise	2.12%	0.282	0.146
27	**H&S04**	Poor lighting on work place	1.37%	0.495	0.117
28	**H&S05**	Not using safety equipment	4.35%	0.417	0.209
29	**H&S06**	Third party damage	2.56%	0.487	0.160
30	**H&S07**	Accidents	0.98%	0.617	0.099
31		**Process**			
	Pro01	Complicated machinery	1.75%	0.568	0.132
32	**Pro02**	Complicated process flow	0.92%	0.671	0.096
33	**Pro03**	Poor process guide lines	1.66%	0.536	0.129
34	**Pro04**	Poor material management & planning	0.96%	0.578	0.098
35	**Pro05**	Increase material wastage	2.36%	0.435	0.154
36	**Pro06**	Defective work	2.15%	0.586	0.147
37	**Pro07**	Poor quality control	1.85%	0.432	0.136
38		**External**			
	Ext01	Delay in approval from higher management	1.94%	0.666	0.139
39	**Ext02**	Political instability	1.79%	0.723	0.134
40	**Ext03**	Third party/vender delay	0.78%	0.648	0.088
41	**Ext04**	Unavailability of equipment	1.97%	0.536	0.140
42	**Ext05**	Unavailability of raw material	1.47%	0.723	0.121
43	**Ext06**	Suppliers/subcontractors poor performance	1.43%	0.599	0.120
44	**Ext07**	Transport strike	0.83%	0.747	0.091
45		**Procurement**			
	Proc01	Failure to identify potential sources	1.94%	0.534	0.139
46	**Proc02**	Understatement of the need	1.95%	0.503	0.140

47	**Proc03**	Insufficient funding	0.89%	0.565	0.094
48	**Proc04**	Dispute with supplier	1.48%	0.669	0.122
49	**Proc05**	No response from known quality suppliers	1.01%	0.594	0.100
50	**Proc06**	Delay by suppliers	0.73%	0.547	0.085
51	**Proc07**	Selecting an inappropriate supplier	1.12%	0.599	0.106
52		**HR**			
	HR01	Labour availability	0.97%	0.619	0.099
53	**HR02**	Resource performance	2.41%	0.557	0.155
54	**HR03**	Human error in process	1.74%	0.588	0.132
55	**HR04**	Conflict among departments/team	1.13%	0.716	0.106
56	**HR05**	Over stress burden on workers	1.05%	0.705	0.102
57	**HR06**	Untrained workers	1.31%	0.586	0.114
58	**HR07**	Poor trainings	1.23%	0.471	0.111
59	**HR08**	Labour disputes	1.44%	0.671	0.120
60	**HR09**	Out sourcing	2.35%	0.513	0.153
61	**HR10**	Shortage/unavailability of skilled workers/engineers	1.96%	0.555	0.140

(Table 4)
Risk Value in different aspects

S.No	Risk ID	Risk Description	Risk value(cost)	Risk value (Time)	Risk value(Avg)
		Management			
1	**Mgm01**	Poor planning	0.277	0.307	0.292
2	**Mgm02**	Influence from higher management	0.231	0.259	0.245
3	**Mgm03**	Lack of coordination among departments	0.250	0.343	0.296
4	**Mgm04**	Poor supervision & site management	0.196	0.216	0.206
5	**Mgm05**	Sub contractor issue	0.219	0.173	0.196
6	**Mgm06**	Poor documentation	0.269	0.228	0.249
7	**Mgm07**	Lack of decision making	0.312	0.300	0.306
		Engineering			
8	**Engg01**	Insufficient engineers & workers	0.224	0.242	0.233
9	**Engg02**	Unavailability of machinery (for production)	0.221	0.257	0.239
10	**Engg03**	Defective tools & equipments	0.165	0.180	0.173
11	**Engg04**	Poor awareness about tool usage	0.106	0.163	0.134
12	**Engg05**	poor process design (Production process)	0.133	0.179	0.156
13	**Engg06**	Operating and using machines without permission	0.123	0.127	0.125
14	**Engg07**	Machinery break down	0.283	0.342	0.312
15	**Engg08**	Less Labour and equipment productivity	0.195	0.215	0.205
16	**Engg09**	Equipment/Technology availability	0.121	0.158	0.140
17	**Engg10**	Poor equipment management & planning	0.209	0.240	0.224

18	**Engg11**	Replacing imported parts with local	0.212	0.197	0.204
		Financial			
19	**Fin01**	Unavailability of funds	0.257	0.277	0.267
20	**Fin02**	Hike in material price	0.357	0.267	0.312
21	**Fin03**	Financial delay	0.268	0.309	0.288
22	**Fin04**	Economic disaster	0.316	0.289	0.302
23	**Fin05**	Shortage of running finance	0.238	0.296	0.267
		Health & safety			
24	**H&S01**	Fire and explosion	0.300	0.265	0.282
25	**H&S02**	Hazard atmosphere	0.154	0.195	0.174
26	**H&S03**	Excessive noise	0.107	0.126	0.116
27	**H&S04**	Poor lighting on work place	0.103	0.178	0.141
28	**H&S05**	Not using safety equipment	0.184	0.165	0.174
29	**H&S06**	Third party damage	0.121	0.142	0.132
30	**H&S07**	Accidents	0.250	0.228	0.239
		Process			
31	**Pro01**	Complicated machinery	0.157	0.216	0.186
32	**Pro02**	Complicated process flow	0.137	0.249	0.193
33	**Pro03**	Poor process guide lines	0.202	0.260	0.231
34	**Pro04**	Poor material management & planning	0.254	0.239	0.247
35	**Pro05**	Increase material wastage	0.224	0.164	0.194
36	**Pro06**	Defective work	0.156	0.174	0.165
37	**Pro07**	Poor quality control	0.231	0.161	0.196
38		**External**			
	Ext01	Delay in approval from higher management	0.163	0.264	0.213
39	**Ext02**	Political instability	0.278	0.339	0.309
40	**Ext03**	Third party/vender delay	0.199	0.299	0.249
41	**Ext04**	Unavailability of equipment	0.169	0.151	0.160
42	**Ext05**	Unavailability of raw material	0.254	0.302	0.278
43	**Ext06**	Suppliers/subcontractors poor performance	0.188	0.190	0.189
44	**Ext07**	Transport strike	0.288	0.340	0.314
45		**Procurement**			

	Proc01	Failure to identify potential sources	0.201	0.182	0.192
46	**Proc02**	Understatement of the need	0.193	0.163	0.178
47	**Proc03**	Insufficient funding	0.255	0.252	0.253
48	**Proc04**	Dispute with supplier	0.261	0.279	0.270
49	**Proc05**	No response from known quality suppliers	0.145	0.149	0.147
50	**Proc06**	Delay by suppliers	0.201	0.262	0.232
51	**Proc07**	Selecting an inappropriate supplier	0.196	0.203	0.199
52		**HR**			
	HR01	Labour availability	0.201	0.241	0.221
53	**HR02**	Resource performance	0.199	0.193	0.196
54	**HR03**	Human error in process	0.290	0.305	0.297
55	**HR04**	Conflict among departments/team	0.264	0.319	0.292
56	**HR05**	Over stress burden on workers	0.190	0.309	0.250
57	**HR06**	Untrained workers	0.205	0.209	0.207
58	**HR07**	Poor trainings	0.110	0.150	0.130
59	**HR08**	Labour disputes	0.240	0.287	0.264
60	**HR09**	Out sourcing	0.223	0.181	0.202
61	**HR10**	Shortage/unavailability of skilled workers/engineers	0.232	0.223	0.227

(Table 5)

Risk ranking in different categories

S.No	Risk ID	Risk Description	Risk rank(Cost)	Risk rank(Time)	Risk rank(Avg)
		Management			
1	Mgm01	Poor planning	2	2	3
2	Mgm02	Influence from higher management	5	4	5
3	Mgm03	Lack of coordination among departments	4	1	2
4	Mgm04	Poor supervision & site management	7	6	6
5	Mgm05	Sub contractor issue	6	7	7
6	Mgm06	Poor documentation	3	5	4
7	Mgm07	Lack of decision making	1	3	1
		Engineering			
8	Engg01	Insufficient engineers & workers	2	3	3
9	Engg02	Unavailability of machinery (for production)	3	2	2
10	Engg03	Defective tools & equipments	7	7	7
11	Engg04	Poor awareness about tool usage	11	9	10
12	Engg05	poor process design (Production process)	8	8	8
13	Engg06	Operating and using machines without permission	9	11	11
14	Engg07	Machinery break down	1	1	1
15	Engg08	Less Labour and equipment productivity	6	5	5
16	Engg09	Equipment/Technology availability	10	10	9
17	Engg10	Poor equipment management & planning	5	4	4
18	Engg11	Replacing imported parts with local	4	6	6
		Financial			
19	Fin01	Unavailability of funds	4	4	5

20	**Fin02**	Hike in material price	1	5	1
21	**Fin03**	Financial delay	3	1	3
22	**Fin04**	Economic disaster	2	3	2
23	**Fin05**	Shortage of running finance	5	2	4
		Health & safety			
24	**H&S01**	Fire and explosion	1	1	1
25	**H&S02**	Hazard atmosphere	4	3	4
26	**H&S03**	Excessive noise	6	7	7
27	**H&S04**	Poor lighting on work place	7	4	5
28	**H&S05**	Not using safety equipment	3	5	3
29	**H&S06**	Third party damage	5	6	6
30	**H&S07**	Accidents	2	2	2
		Process			
31	**Pro01**	Complicated machinery	5	4	6
32	**Pro02**	Complicated process flow	7	2	5
33	**Pro03**	Poor process guide lines	4	1	2
34	**Pro04**	Poor material management & planning	1	3	1
35	**Pro05**	Increase material wastage	3	6	4
36	**Pro06**	Defective work	6	5	7
37	**Pro07**	Poor quality control	2	7	3
38		**External**			
	Ext01	Delay in approval from higher management	7	5	5
39	**Ext02**	Political instability	2	2	2
40	**Ext03**	Third party/vender delay	4	4	4
41	**Ext04**	Unavailability of equipment	6	7	7
42	**Ext05**	Unavailability of raw material	3	3	3
43	**Ext06**	Suppliers/subcontractors poor performance	5	6	6
44	**Ext07**	Transport strike	1	1	1
45		**Procurement**			
	Proc01	Failure to identify potential sources	3	5	5
46	**Proc02**	Understatement of the need	5	6	6
47	**Proc03**	Insufficient funding	2	3	2
48	**Proc04**	Dispute with supplier	1	1	1
49	**Proc05**	No response from known quality suppliers	7	7	7
50	**Proc06**	Delay by suppliers	4	2	3
51	**Proc07**	Selecting an inappropriate supplier	6	4	4

	HR				
HR01	Labour availability	7	5	6
HR02	Resource performance	8	8	8
HR03	Human error in process	1	3	1
HR04	Conflict among departments/team	2	1	2
HR05	Over stress burden on workers	9	2	4
HR06	Untrained workers	6	7	7
HR07	Poor trainings	10	10	10
HR08	Labour disputes	3	4	3
HR09	Out sourcing	5	9	8
HR10	Shortage/unavailability of skilled workers/engineers	4	6	5

(Table 6)
Risk ranking (Overall)

S.No	Risk ID	Risk Description	Risk rank(Cost)	Risk rank(Time)	Risk rank(Avg)
1	Mgm01	Poor planning	9	8	7
2	Mgm02	Influence from higher management	23	23	31
3	Mgm03	Lack of coordination among departments	19	1	6
4	Mgm04	Poor supervision & site management	39	35	29
5	Mgm05	Sub contractor issue	29	49	48
6	Mgm06	Poor documentation	10	32	26
7	Mgm07	Lack of decision making	3	11	4
8	Engg01	Insufficient engineers & workers	25	27	21
9	Engg02	Unavailability of machinery (for production)	28	24	15
10	Engg03	Defective tools & equipments	47	45	51
11	Engg04	Poor awareness about tool usage	60	52	59
12	Engg05	poor process design (Production process)	54	46	52
13	Engg06	Operating and using machines without permission	55	60	60
14	Engg07	Machinery break down	7	2	3
15	Engg08	Less Labour and equipment productivity	41	36	36
16	Engg09	Equipment/Technology availability	56	55	53
17	Engg10	Poor equipment management & planning	31	29	24
18	Engg11	Replacing imported parts with local	30	39	46
19	Fin01	Unavailability of funds	14	17	14
20	Fin02	Hike in material price	1	18	17
21	Fin03	Financial delay	11	6	10
22	Fin04	Economic disaster	2	14	2
23	Fin05	Shortage of running finance	21	13	20
24	H&S01	Fire and explosion	4	19	12

25	H&S02	Hazard atmosphere	51	40	56
26	H&S03	Excessive noise	59	61	61
27	H&S04	Poor lighting on work place	61	47	57
28	H&S05	Not using safety equipment	45	50	55
29	H&S06	Third party damage	57	59	54
30	H&S07	Accidents	18	31	19
31	Pro01	Complicated machinery	49	34	44
32	Pro02	Complicated process flow	53	26	30
33	Pro03	Poor process guide lines	33	22	41
34	Pro04	Poor material management & planning	16	30	23
35	Pro05	Increase material wastage	26	51	50
36	Pro06	Defective work	50	48	39
37	Pro07	Poor quality control	24	54	49
38	Ext01	Delay in approval from higher management	48	20	25
39	Ext02	Political instability	8	4	5
40	Ext03	Third party/vender delay	38	12	22
41	Ext04	Unavailability of equipment	46	56	45
42	Ext05	Unavailability of raw material	17	10	9
43	Ext06	Suppliers/subcontractors poor performance	44	42	34
44	Ext07	Transport strike	6	3	1
45	Proc01	Failure to identify potential sources	36	43	43
46	Proc02	Understatement of the need	42	53	47
47	Proc03	Insufficient funding	15	25	28
48	Proc04	Dispute with supplier	13	16	11
49	Proc05	No response from known quality suppliers	52	58	40
50	Proc06	Delay by suppliers	35	21	38
51	Proc07	Selecting an inappropriate supplier	40	38	32
52	HR01	Labour availability	34	28	27
53	HR02	Resource performance	37	41	37
54	HR03	Human error in process	5	9	18
55	HR04	Conflict among departments/team	12	5	8
56	HR05	Over stress burden on workers	43	7	16
57	HR06	Untrained workers	32	37	33
58	HR07	Poor trainings	58	57	58
59	HR08	Labour disputes	20	15	13
60	HR09	Out sourcing	27	44	42

61	HR10	Shortage/unavailability of skilled workers/engineers	22	33	35

(Table 7)
Proposed risk response strategy

S No.	Risk Description	Risk response -	Risk Register Remarks Suggestions
1	Poor planning	Mitigate	System improvement, may use planning tools and implement updated ERP system which may help for better planning
2	Influence from higher management	Mitigate	System improvement .established hierarchy structure with defined responsibilities should be there
3	Lack of coordination among departments	Mitigate	System improvement regarding internal process improvements. Motivational trainings and team work promotion activities should be there
4	Poor supervision & site management	Mitigate	They should adopt management tools and also implement checklists and reporting template for site performance
5	Sub contractor issue	Mitigate	Contractual relationship can be strong by using agreed upon terms and conditions
6	Poor documentation	Mitigate	Use templates for each and every work/task
7	Lack of decision making	Mitigate	Provide training to the concerns for to improve their analysis ability conclusions. Leader ship building and management trainings should be there
8	Insufficient engineers & workers	Transfer	May get the services of some job hiring consultants for requirements.
9	Unavailability of machinery (for production)	Mitigate	Apply the preventive maintenance schedule and take necessary actions to mitigate the risk
10	Defective tools & equipments	Mitigate	Implement quality standards for tools and also perform their calibration process after recommended time period.
11	Poor awareness about tool usage	Mitigate	Arrange special trainings for toll usage
12	poor process design (Production process)	Mitigate	Making process flow plan as per particular condition to reduce the overall process time
13	Operating and using machines without permission	Avoid	Nominate the special person to operate the machines. Impose fine and proper system improvement can be use to avoid this
14	Machinery break down	Mitigate	Apply preventive actions to reduce the break down
15	Less Labour and equipment productivity	Mitigate	Efficiency of Labour may be enhanced by offering different motivation packages. For to improve equipment performance perform

			recommended preventive action time to time
16	Equipment/Technology availability	Transfer	Transfer to engineering company/consultant .
17	Poor equipment management & planning	Mitigate	System improvement, proper management and planning is needed
18	Replacing imported parts with local	Mitigate	Make best possible to avoid the usage of local parts. Maintain the inventory stock for critical machine spare parts
19	Unavailability of funds	Transfer	System improvement, cost management plan should be there to look after all the financial status and involve bank to share the risk
20	Hike in material price	Transfer	Make a contractual relationship with the material provider for suitable time to avoid the problem in price
21	Financial delay	Transfer	Transfer to bank to make it possible on time financial activities
22	Economic disaster	Transfer	Transfer to bank for mange economical status
23	Shortage of running finance		Better cost management plan should be there and also maintain the cash in/out flow
24	Fire and explosion	Mitigate	Use fire safety equipments and provide trainings to the people to deal with this risk
25	Hazard atmosphere	Mitigate	Proper ventilation system should be there
26	Excessive noise	Mitigate	Make corrective actions to reduce the machinery noise and also use safety equipments to reduce the noise impact
27	Poor lighting on work place	Mitigate	Proper lighting arrangements should be there and also make arrangements for best utilization of sun light in day timings.
28	Not using safety equipment	Mitigate	Implement safety measures. arrange training regarding safety issues and usage of safety equipments
29	Third party damage	Transfer	Transfer to the particular company/party
30	Accidents	Mitigate	System improvement, implement safety measure to reduce the chance of accidents
31	Complicated machinery	Mitigate	Provide trainings about the machines for operators as well as engineering crew
32	Complicated process flow	Mitigate	Improve process flow system by the help of working crew.
33	Poor process guide lines	Mitigate	Hang notice boards and working guide line of different places
34	Poor material management & planning	Mitigate	Material management plan should be there to assist the managers about how much material is required and where. Also update the how much we have to make better planning regarding material
35	Increase material wastage	Mitigate	Improve efficiency of machines and process flow. Motivate workers to get maximum output from process as they can to reduce the loss and wastage
36	Defective work	Mitigate	Implement quality control measures. Check lists may be used to reduce the defects in work

37	Poor quality control	Mitigate	System improvement, Implement quality control measures. Check lists may be used to reduce the defects in work
38	Delay in approval from higher management	Mitigate	Upgrade ERP system and implement online approvals at different levels.
39	Political instability	Accept	Wait until the enviourment be stable
40	Third party/vender delay	Mitigate	Upgrade Terms & Conditions to sort out the issue. Decide some adjustment measures in case of delay
41	Unavailability of equipment	Transfer	Select the Vander and order them for required equipments
42	Unavailability of raw material	Transfer	Make a contract with suppliers for desired period for continuous supply of raw material
43	Suppliers/subcontractors poor performance	Mitigate	Update contracts and revise terms & conditions
44	Transport strike	Transfer	Make contract with transporters for required time on agreed upon terms & Conditions
45	Failure to identify potential sources	Mitigate	Market research
46	Understatement of the need	Mitigate	Competent persons should be there to explain the needs. Purchase order should be started from the concern technical person who need something and he should finalize the specification of requirement
47	Insufficient funding	Mitigate	System improvement. Should launch a budget in which suitable funding to each department should be finalized. Involve bank to sort out the financial issue
48	Dispute with supplier	Transfer	Should go for mediation firm to sort out the dispute and if not possible then litigation may be the option
49	No response from known quality suppliers	Mitigate	Should have more than one suppliers that may be used in case of getting no response from one
50	Delay by suppliers	Mitigate	Upgrade Terms & Conditions to sort out the issue. Decide some adjustment measures in case of delay
51	Selecting an inappropriate supplier	Avoid	Cut off the contractual relationship and go for the other options
52	Labour availability	Transfer	May get the services of some job hiring consultants for requirements.
53	Resource performance	Mitigate	Trainings and also may offer incentives to enhance their performance
54	Human error in process	Mitigate	Proper training sessions should be arranged for workers related to their work/job
55	Conflict among departments/team	Mitigate	System improvement, Management should play role to sort out the issues among departments.
56	Over stress burden on workers	Mitigate	Suitable number of workers should be appointed for particular job. Resource smoothing technique may be used
57	Untrained workers	Mitigate/	Arrange trainings/or transfer to hiring

		Transfer	consultant for trained workers
58	Poor trainings	Transfer	May get the services of training providing firms
59	Labour disputes	Mitigate	Adopting best labour policies and by keeping good relationship with unions. Involvement of union's leaders in finalizing of internal labour policies may also help to mitigate the risk
60	Out sourcing	Mitigate/ Transfer	Mitigate the outsourcing by providing the maximum trainings to the professionals / Contact HR consultant firm to provide the experts in particular area
61	Shortage/unavailability of skilled workers/engineers	Transfer	May get the services of some job hiring consultants for requirements

Risk responsibilities

1) Risk Identification: All stakeholders
2) Risk Registry: Manager/Departmental heads
3) Risk Assessment: All stakeholders
4) Risk Response Options Identification: All stakeholders
5) Risk Response Approval: Risk manager/Departmental head/manager with concurrence from CO
6) Risk Contingency Planning; Risk/Planning Manager(s)
7) Risk Response Management; Manager/Departmental heads
8) Risk Reporting; Risk Manager
9) Risk response owners; may include.....
    - Engineering manager
    - HR manager
    - Admin Manager
    - Procurement Manager

(Table 8)
Risk score and priority level matrix

Risk Probability and Impact Matrix					
Probability	**Threats**				
0.9	0.09	0.27	0.45	0.63	0.81
0.7	0.07	0.21	0.35	0.49	0.63
0.5	0.05	0.15	0.25	0.35	0.45
0.3	0.03	0.09	0.15	0.21	0.27
0.1	0.01	0.03	0.05	0.07	0.09
Impact	**0.1**	**0.3**	**0.5**	**0.7**	**0.9**

(Table 9)
Risk priority table

Sr #	Risk score/Number	Risk priority level
1	0.45 - above	Very High
2	0.26 – 0.44	High
3	0.15 – 0.25	Moderate
4	0.07 – 0.14	Low
5	0.01 – 0.06	Very Low

(Table 10)
Risk Response time

S.No	Risk priority level	Action Time
1	Very High	Immediate Action
2	High	
3	Moderate	Take necessary Action
4	Low	
5	Very Low	Can be ignored

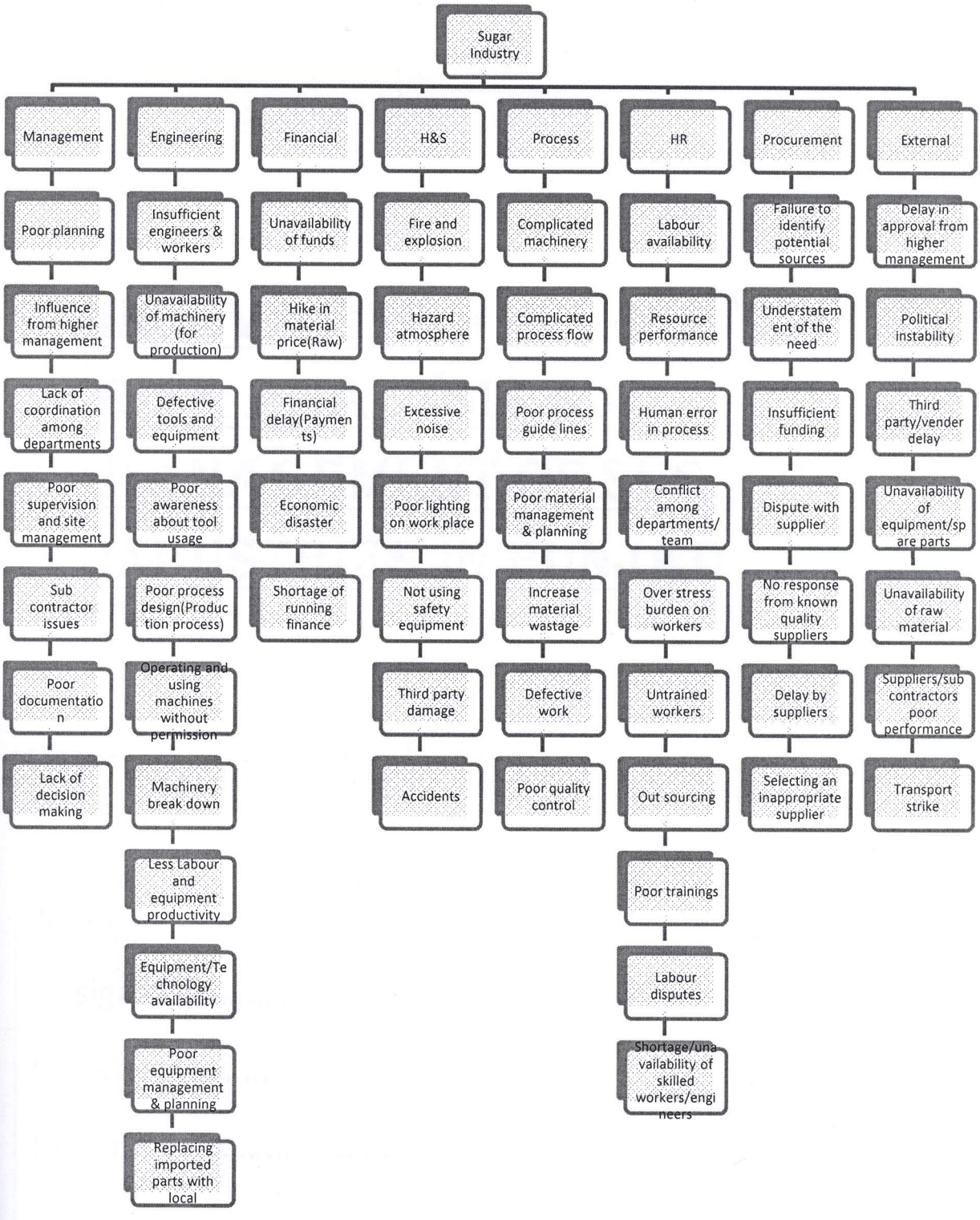
(Table 11)
Risk reporting template

	Identify risk	Risk Assessment			Risk Management			
Sr #	Risk description	level	impact	Time scale	Responsible Person	Action	Reviewed risk level	Remarks

(Table 12)
Risk tracking template

Sr.#	Issue	priority	Open Date	Close Date	Comments

Risk breakdown structure



Questionnaire

Bahria University Lahore campus

INNOVATIVE APPROCH TO RISK ANALYSIS AND MANAGEMENT OF SUGAR INDUSTRIES IN PUNJAB

Respondant Data

Name.....

Designation.....

Company.....

Remarks.....

.....

Signature.....

GENERAL INSTRUCTIONS FOR FILLING THE QUESTIONNAIRE

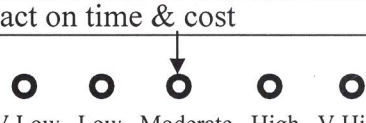
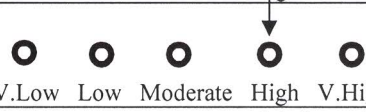
1. Please fill in the following questionnaire on the basis of the facts of your company.
2. Questionnaire is divided into different categories like management risks, engineering risks etc. and the particular related risk are in each category.
3. All Questions carries different options. Please answer all questions. In case any question is not applicable to your company, please mention in remarks
4. The Questionnaire contains questions with different options rank them with best option as per your experience.
5. Please make tick mark in check boxes for selection of options.
6. Please use extra sheets for answering any question, if needed. Also mention the question number in additional sheets.

Note.

Probability mean chances that risk will happen

Impact mean if occurs then the impact on objectives

For example:-

1. Influence from higher management (Risk Description)		
Risk frequency (Chance of happens)	Impact on time & cost	
		Time
		cost

We consider a risk **Influence from higher management** and it has the high chance that it will occur and have the moderate impact on time but have high impact on cost. As per condition tick mark from the options.

Management risks

Here are the most possible risks related to management category. Please select the possible option for frequency that how many chances that the particular risk will happen and how much its impact on time and cost

1. Poor planning		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

2. Influence from higher management		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

3. Lack of coordination among departments		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

4. Poor supervision and site management		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

5. Sub contractor issues		
Risk frequency	Impact on time & cost	
o o o o o V.Low Low Moderate High V.High	o o o o o V.Low Low Moderate High V.High	Time
	o o o o o V.Low Low Moderate High V.High	cost

6. Poor documentation		
Risk frequency	Impact on time & cost	
o o o o o V.Low Low Moderate High V.High	o o o o o V.Low Low Moderate High V.High	Time
	o o o o o V.Low Low Moderate High V.High	cost

7. Lack of decision making		
Risk frequency	Impact on time & cost	
o o o o o V.Low Low Moderate High V.High	o o o o o V.Low Low Moderate High V.High	Time
	o o o o o V.Low Low Moderate High V.High	cost

Engineering risks

Here are the most possible risks related to engineering category. Please select the possible option for frequency that how many chances that the particular risk will happen and how much its impact on time and cost

1. Insufficient engineers & workers		
Risk frequency	Impact on time & cost	
o o o o o V.Low Low Moderate High V.High	o o o o o V.Low Low Moderate High V.High	Time
	o o o o o V.Low Low Moderate High V.High	cost

2. Unavailability of machinery (for production)		
Risk frequency	Impact on time & cost	
o o o o o V.Low Low Moderate High V.High	o o o o o V.Low Low Moderate High V.High	Time
	o o o o o	cost

	V.Low Low Moderate High V.High	

3. Defective tools and equipment		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

4. Poor awareness about tool usage		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

5. Poor process design (Production process)		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

6. Operating and using machines without permission		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

7. Machinery break down		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time

	O O O O O V.Low Low Moderate High V.High	cost

8. Less labour and equipment productivity		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

9. Equipment/Technology availability		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

10. Poor equipment management & planning		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

11. Replacing important parts with local		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

Financial risks

Here are the most possible risks related to financial category. Please select the possible option for frequency that how many chances that the particular risk will happen and how much its impact on time and cost

1. Unavailability of funds		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

2. Hike in material price		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

3. Financial delay (Payments)		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

4. Economic disaster		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

5. Shortage of running finance		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

Health and safety risks

Here are the most possible risks related to health & safety category. Please select the possible option for frequency that how many chances that the particular risk will happen and how much its impact on time and cost

1. Fire and explosion		
Risk frequency	Impact on time & cost	
o o o o o V.Low Low Moderate High V.High	o o o o o V.Low Low Moderate High V.High	Time
	o o o o o V.Low Low Moderate High V.High	cost

2. Hazard atmosphere		
Risk frequency	Impact on time & cost	
o o o o o V.Low Low Moderate High V.High	o o o o o V.Low Low Moderate High V.High	Time
	o o o o o V.Low Low Moderate High V.High	cost

3. Excessive noise		
Risk frequency	Impact on time & cost	
o o o o o V.Low Low Moderate High V.High	o o o o o V.Low Low Moderate High V.High	Time
	o o o o o V.Low Low Moderate High V.High	cost

4. Poor lighting on work place		
Risk frequency	Impact on time & cost	
o o o o o V.Low Low Moderate High V.High	o o o o o V.Low Low Moderate High V.High	Time
	o o o o o V.Low Low Moderate High V.High	cost

5. Not using safety equipment		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

6. Third party damage		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

7. Accidents		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

Process risks

Here are the most possible risks related to Process category. Please select the possible option for frequency that how many chances that the particular risk will happen and how much its impact on time and cost

1. Complicated machinery		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

2. Complicated process flow		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

3. Poor process guide lines		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

4. Poor material management& planning		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

5. Increase material wastage		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

6. Defective work		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

7. Poor quality control		
Risk frequency	Impact on time & cost	
o o o o o V.Low Low Moderate High V.High	o o o o o V.Low Low Moderate High V.High	Time
	o o o o o V.Low Low Moderate High V.High	cost

HR risks

Here are the most possible risks related to HR category. Please select the possible option for frequency that how many chances that the particular risk will happen and how much its impact on time and cost

1. Labour availability		
Risk frequency	Impact on time & cost	
o o o o o V.Low Low Moderate High V.High	o o o o o V.Low Low Moderate High V.High	Time
	o o o o o V.Low Low Moderate High V.High	cost

2. Resource performance		
Risk frequency	Impact on time & cost	
o o o o o V.Low Low Moderate High V.High	o o o o o V.Low Low Moderate High V.High	Time
	o o o o o V.Low Low Moderate High V.High	cost

3. Human error in process		
Risk frequency	Impact on time & cost	
o o o o o V.Low Low Moderate High V.High	o o o o o V.Low Low Moderate High V.High	Time
	o o o o o V.Low Low Moderate High V.High	cost

4. Conflict among departments		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

5. Over stress burden on workers		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

6. Untrained workers		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

7. Poor trainings		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

8. Labour dispute		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

9. Shortage/unavailability of skilled workers/engineers		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

10. Out sourcing		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

External risks

Here are the most possible risks related to external category. Please select the possible option for frequency that how many chances that the particular risk will happen and how much its impact on time and cost

1. Delay in approval from higher management		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

2. Political instability		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

Procurement Risks

Here are the most possible risks related to procurement category. Please select the possible option for frequency that how many chances that the particular risk will happen and how much its impact on time and cost

1. Failure to identify potential sources		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

2. Understatement of the need		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

3. Insufficient funding		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

4. Dispute with supplier		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

5. No response from known quality suppliers		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

6. Delay by suppliers		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost

7. Selecting an inappropriate supplier		
Risk frequency	Impact on time & cost	
O O O O O V.Low Low Moderate High V.High	O O O O O V.Low Low Moderate High V.High	Time
	O O O O O V.Low Low Moderate High V.High	cost