Interrelationship Between Industrial Project Risk And Its Characteristics: A Study Based On Structural Model (sm)

SMS Journal of Entrepreneurship & Innovation
5 (1) 92 - 108
https://doi.org/10.21844/smsjei.v5i1.15138

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Abstract

The paper presents a methodology which traces the interrelationship between the project risk and project characteristics, it studies the risk factors and the factors that define project characteristics by the help of literature survey and expert discussion.A mathematical relationship is also developed that includes the effect of risk mitigation on a particular risk. The risk factor when analyzed with both the probability of occurrence and effect of mitigation gives the impact value for that risk. Then we have developed a model in AMOS software for analyzing the effect of risk factors and project characteristic factors on each other, the high value of estimate in between the two proves their interrelated.

Keywords: *Project Management; Project Risk analysis; SM (Structural Modeling) via AMOS; Electrical Transmission line installation project.*

Objective:

Main objectives are –

- Analysis of Risk factors present in Electrical Transmission line installation project and pooling of the risk factors for the second part of the analysis.
- The paper intends to configure the interrelation ship between the Project risk mitigation based on a particular risk, that is analysis of risk by the probability of occurrence and effect of its mitigation for deriving the impact value for that risk and SM (Structural Modeling) by AMOS is the tool used for the deriving of above objective.

1 Introduction

Some industrial projects are more prone to risks due to certain inherent project characteristics. The study deals with a basic assumption that project risk is directly connected with the type of project involved and it is proved with the help of structural modeling (SM).

The number of industries that mainly works on projects of different types is increasing and hence there is a need to characterize project risk on the basis of project type. Using the present scenario it can be very well said that project type influences the different prominent risk factors in different fashion. In our study analysis is done to interrelate each of these project characteristic factors with a simple model that assesses the risk factors involved. The output of this model helps in structural modeling (SM) since it invariably generates the input to be used at SM based method. First of all opinion is taken from different project team members involved in different type of projects, in order to decide the risk factors and

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project characteristic factors. Since the number of firms engaged in projects is very high now days the relevancy of project risk study is increasing. Along with this the literature survey is also done in order to have a pool of risk factors and project characteristic factors.

The process of risk management is a very comprehensive one. The process of preparing a benchmark starts from decision of risk assessment for each project on the basis of different risk factors which are decided to be taken for consideration. This is a dire need to develop a method which can give the weights that needs to be associated with each risk factors selected for consideration. Risk mitigation level is an important factor which is considered for assessment of each risk factor's impact level in the project. Along with it the cost and probability are also considered for deciding the weight of each risk factor, which has acted as a guideline for structural modeling (SM). Our work is closely related with Fan(2007) in which the project risk handling strategies are assessed and the level of mitigation plan's effect is shown, but this work is further enhanced by analyzing risk mitigation from more than oneparameter. Then the study is concentrated upon the collection of factors which shape or characterize the project, these are actually the parameters that are decided by literature survey and expert opinion to define a project type by using different references and hence it is used to envelope projects into different pre set types or categories.

Project risk is actually studied by many authors keeping in view of the performance of the project. There are many studied dedicated to measure project performance from parameters like time, cost and monetary return of the project. A successful project is also the one in which either the risks have not occurred or successfully mitigated. These studies also prove that project characteristics play a very important role in the outcomes of project and certain type of projects are always linked to some special types of risks.

Experts hold a view that mapping of risks according to the project characteristics can be a very practical solution for risk management problems.Many authors Olaru et al. [2014], Ping and Li [2010], Menches and Hanna [2006], and Aloysius [1999]have given various techniques for risk measurement but the risk assessment needs to be tailor made and no single technique was found which can be employed to all the project management phases over different projects. Hence there is an accurate need of development of a project risk management process which is specifically dependent on the characteristics of a project and every attempt is made in this study to develop such a system by correlating project characteristics and project risk.

Finally in our study after analyzing risk factors and project characteristic factors, we have developed a SM for mapping the interrelationship between project risk and project characteristics. The study is especially helpful in configuring the project risk assessment based on the type of project. The study develops a decision tool by which the project risk can be accounted for on the basis of project characteristics.

In any developing nation there is a need for curbing the uncertainties related to project risk and due to the lack of technical expertise present with the contractors which are involved at the site work, project risk management is always in a hampering mode. Hence there is an acute need of developing such a system in which the risk can be accounted with the help of characteristics of a project. On the development of expertise in such a system of risk assessment with respect to project characteristics the single risk management team can be used in many different projects, which can result in cost saving and better expertise development for risk management.

2 Literature Survey

The literature survey can be broadly divided into three sections.
First section deals with the collection and assessment of risk factors, with the inclusion of risk mitigation factors. With the help of this section of the study we have collected risk factors and generated a methodology for calculation of risk impact along with the analysis of risk mitigation level for each risk.

Second section deals with the collection of project characteristics which also includes certain project performance characteristics. The project performance is measured on the basis of these factors only. In our study we have used them as characteristics that are useful in defining a project nature and later on used for mapping of risk.

Third section deals with the model generation using structural modeling in which the AMOS based modeling is done in order to prove the link of risk factors with project characteristics.

Project risk management is accounted by many authors, the viewpoints described by these authors is given below in the table 1, quotes the statements given by the various authors currently in the field of project risk management. It is for this purpose that the year of publishing is also given along with the author's reference in the table1 given below.

Table 1: Quotes given by the various authors recently in the field of project risk management

Acebes et al. (2014)	*Presence of an uncertainty of seasonal type (e.g. meteorological) that affects some of the activities that comprise the project.*
Aziz (2013)	*The delay in construction projects by many factors is usually linked to the performance of time, cost, and quality.*
Greenberg et al. (2011)	*The risk assessment process allows for earlier identification and mitigation of the potential project risks, which allows more time to effectively deal with unknown and unidentified risks that can always arise.*
Hussein and Klakegg (2014)	*Several factors that complicate the definition and management of project success criteria.*
Johansen et al.(2014)	*A project needs to deal with uncertainty in all phase and most projects need to deal with different types of uncertainty in the different phases of project.*
Krane et al. (2014)	*In the project management domain, uncertainty is currently understood as lack of information. But uncertainty could also be understood as lack of certainty.*
Maravas and Pantouvakis(2013)	*Risks are associated with changes in government policy, diverse stakeholder aspirations and the challenges of multiple project procurement.*
Pajares and López (2014)	*Project risk management is concerned with events affecting the success of individual projects.*
Papadaki et al. (2014)	*link between the different levels of the organization to ensure strategic objectives are successfully translated, communicated and achieved.*
Purnus and Bodea(2014)	*Challenges and the complexity of projects (analyzed by simulations).*
Rafindadi et al. (2014)	*Uncertainties as sources of risk affecting success of sustainable construction project.*
Serpella et al. (2014)	*A knowledge management approach could be an interesting and useful framework to improve the deficiencies of the risk management process.*
Sheykh et al. (2013)	*Identification and quantification of all material risks in order to provide a clear understanding of current volatility in each portfolio entity.*
Wang and Li (2011)	• *Transform uncertainty related activities to adapt demands of scientific risk management* • *Standardize project risk collection and management* • *Establish proper issue resolution and escalation*

2.1 Project characteristics and Risk factor collection

The risk factors are collected with the help of studies likeAloini et al. [2012], Dikmen et al. [2008], Baccarini and Archer [2001] and Dey[2001], in these studies an account of generalized risk factors are given that are present in almost every project, although their impact intensitycan vary and the most common risk factors which emerged out are mainly technical, environmental, social, financial and management related risk factors. These risk factors are found commonly in the projects worldwide, although it varies with the project type.Analysis needs to be done in order to find and pool the risk factors corresponding to project specific traits. All the above mentioned authors provide guidelines for risk management by working on these risk factors for developing a better project risk mitigation plan.
The project characteristics is defined and analyzed by different authors, especially those who are engaged in project performance assessment, likeMenches and Hanna [2006], Shao et al. [2012], Brown et al. [2006] and Barber [2004].Some studies also point towards the inclusion of government clearance related risks, since environmental laws and strict state permission laws under jurisdiction of local and central governing authority are major factors that are increasingly contributing towards a major share of total project risk. In most of the project risk studies the risk model is generated in which the collective effect of risk is seen but in our study we have generated a number of factors which are called as project characteristic factors which on combining shows how these are collectively related with risk level of the project. The paper can be directly used as a guideline for deciding the risk mitigation plan for many construction, manufacturing and onsite installation projects like electrical transmission line installation projects, the risk and characteristic inter relation is used by the author with the help of a contractor working in a section of installation of 25 KV line and on applying the inter relationship between the performance parameters and risk level both were found to be showing inter dependence and risk control increased the performance parameters of the project.The simple method of risk impact calculation is applied with the help of site supervisors present and then risk factors are mitigated according to the risk impact value calculated. The observations showed that the project's performance also improved in terms of cost, quality and time. This methodology is still needed to be tested on bigger projects but the preliminary testing shows that results are of practical use in industry. Thus this method is already applied on an installation based construction project and the feedbacks from the site personals have been very encouraging and hence more of such studies are needed in present arena of project management.

The risk models given by the above mentioned authors are more of a generalized type but there are project specific studies also present which shows how much risk factor varies with project types.The pioneer studies in this section are of Wyk et al. [2007], Regos[2012] and Thiry[2002] where power plant and related industries are studied and the risk factors are assessed but somestudies from authors like Chen et al. [2011] andThevendran and Mawdesley [2008] stresses more on some specific risks like human risks and environmental risks over different types of projects.

Hence we have analyzed that there is a mutually inclusive and a two way relationship between different risks and project characteristics. Another set of authors which have contributed in collection of some general risk factors are Tummala and Burchett [1999], Wang and Li [2011], Aloysius [1999] and these factors are also included in our study. The various risk factors collected are shown in table 2.

Table2 Risk factors collected from various authors

AUTHORS/RISK FACTORS	Technical Risk	Environmental Risk	Financial Risk	Human Risk	HR (Management) Risk
Aloini et al. [2]	N	N	N	N	A
Baccarini et al. [5]	A	A	A	A	A
Castro et al. [8]	A	N	N	N	N
Chen et al. [9]	A	A	A	N	N
Dey[10]	A	A	A	A	A
Dikmen et al. [11]	A	A	A	N	A
Erickson et al. [12]	A	A	A	A	A
Fan et al. [13]	A	A	A	N	N
Fang et al. [14]	A	N	A	N	A
Iyer et al. [17]	A	A	A	A	N
Regos[28]	N	A	N	A	N
Thevendranand Mawdesley [35]	N	A	A	A	A
Wu et al. [39]	A	A	N	A	Y
Wyk et al. [40]	A	N	N	N	N
A= ACCEPTED BY AUTHOR , N= NOT REFERENCED					

The main risk factors that are mentioned in literature survey are shown in table 3. These are all the main factors which were found to be commonly suggested by the different authors and finally this collection is discussed by the experts before being finally picked up for analysis. The selected factors are shown in table 3.

Table 3 Risk factors that are selected through literature survey

Risk Factors	Definition
Technical Risk	These are the risk factors which govern the uncertainty or risk pertaining to technical aspects of the project like faulty design, non scientific assumptions etc and usually such risks hold high value of impact but can be rectified with involvement of experienced personnel.
Environmental Risk	These are the risk factors which come under the category of act of god or any such aspect of project which deals with the external geographical aspects of risks. Usually earthquake, flood, storm etc comes under this category. These risks are most uncertain and special measures are to be taken in advance for accommodating such risks.
Financial Risk	The risk associated with project return, economic conditions and uncertain transactions like insurance & delay surcharges are usually acclaimed in this domain .
Human Risk	The human life safety related risks especially in civil work based projects are a major category in this type of risk, proper insurance and practice of safety benchmark can drastically reduce such risk to a greater extent.
Human Resource (Management) Risk	The risks related to inefficient management that can result in wide range of uncertainties ranging from strike to loss of productivity, comes under this category. With the use of efficient planning and proper training such a risk can be reduced to a great extent.

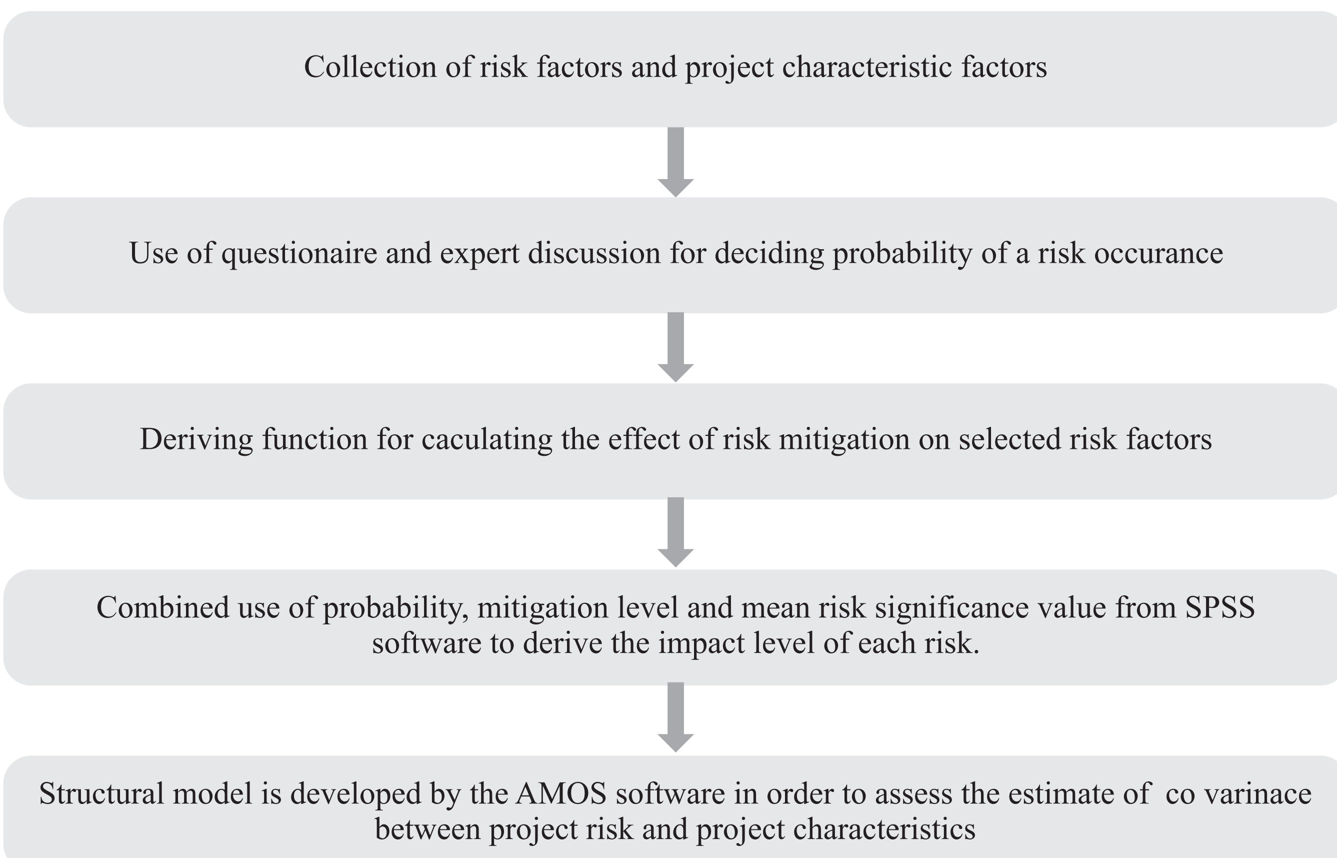
Risk management modules are given by many different authors like Solderholm[2008], Sun and Ma [2008], Tavares et al. [1998] and Aloysius [1999]. These studies present models for risk assessment which are based on project specific data and modules. Hence there is a strict need for such a model which is project specific, so in order to achieve a fit in this aspect we have interrelated project risk with project characteristics in our study.

It can be very well analyzed form the various studies that a two way relationship exist between the different risk factors and project types or characteristics, hence a methodology is developed to show this interrelation. This study has abridged the gap between the project specific risk studies and generalized risk based studies by interrelating the two aspects by SM. SM is one such method by which we have the model developed for project risk factors and project characteristics, it is a technique in which sets of estimates explains the relationships between multiple variables. Special software packages like LISREL and AMOS can be used for applying these models. In our study we have used AMOS software for analysis. Finally the result of SM explains the interrelationship in between the risk factors and project characteristics. These risk factors are then sent to experts for discussion. The experts are the working professionals mainly from the project management area and are having work experience of more than five years coming from diversified domains like power distribution projects, software management projects and construction projects etc. They are from private, public and government organizations. The main factors of both project risk and project characteristics are supported by both literature survey and expert discussion. In order to make the study based on exhaustive theoretical and industry wise practical bases we have taken references from both the literary works and industry, which gives more accurate analysis of both project risk and project characteristics. Hence the study in its different sections reflects the point of view of these authors and industry experts in a proper manner.

3 RESEARCH METHODOLOGY

The main steps involved in the analysis are shown in the process flow diagram of the study given in Figure 1. The collection of risk factors and project characteristics is done through questionnaire and expert discussion.More than two hundred experts have been chosenwhich are having good experience (equal to or more than 5 years) in the field of project management.Mainly site engineers (21 % of the total respondents), site supervisors (4 % of the total respondents), managers (11 % of the total respondents), executive managers (4 % of the total respondents) and engineers (39 % of the total respondents) are involved in the questionnaire and discussion. Experts from a wide number of manufacturing, services and installation firms are included, like software firms, assembly line based manufacturing units and transmission line installation firmsetc for participation in the study. After running questionnaire and expert discussion probability based calculation is done from the values given by the experts in the questionnaire.Finally impact value for each risk is calculated with the help of impact value function generated in the data analysis portion.This data from questionnaire is fed to a SPSS file and is used to run structural model by AMOS software, which shows the estimates of co variation in between risk factor and project characteristic.

Figure 1: Process flow diagram of the study



After the collection of probability andmitigation value the impact value of each risk is calculated. In the second part of the analysis we have prepared a structural model with the help of SPSS and AMOS software, this model is used to generate estimate of deviations produced in one factor with anotherchanged to 1. The structural model used is only to judge the interrelation between two factors. These risk factors and project characteristics are assessed by the experts and the rating provided by these experts is entered in SPSS. One offactors analyzed in SPSSis the overall risk level, which indicates the collective risk level of the project as a whole. Another one is the overall project characteristics in which the project characteristic's collective measurement is done for the overall project. So in order to establish an interrelationship in between the two a structural model is devised in which the value of estimation tells us the effect of risk factors on project characteristics andvice versa.

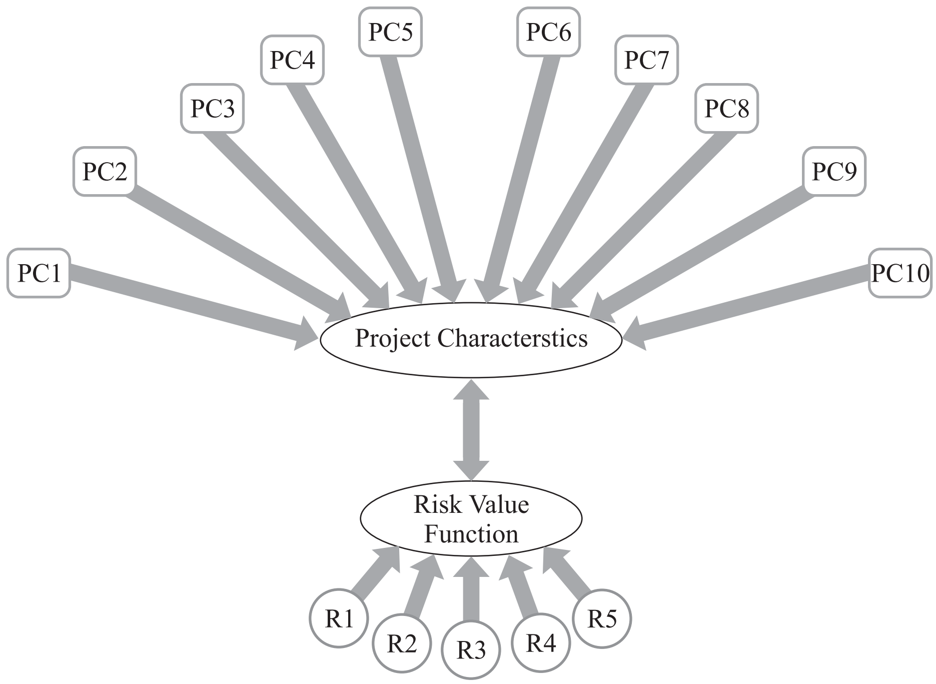
This Study which consists of two sections, first section of collection of project risk and characteristics parameters is already discussed and the other section of analysis on these risk factors and project characteristics is analyzed below, which is the interrelation of project characteristics and risks studied with the help of SEM. The framework which will be delivered is as shown in figure 1. Here we have taken eleven project characteristics and five major risk factors, the risk factors are already mentioned in table 3. The eleven project characteristics which are selected through literature survey and expert discussion are shown in table 4.

Table 4: The project characteristics selected for analysis

Project characteristics	Explanation
PC1	Financial size of the project
PC2	Technical sensitivity level
PC3	Deadline crunch (Sufficient or scarce time available for the various activities)
PC4	Experience of the firm in dealing such projects
PC5	Joint venture with other firms or single party responsible for the project outcomes
PC6	Service or on site/manufacturing type project
PC7	Numbers of alternate paths present for achieving the goal.
PC8	Project to be delivered to industry or general customer.
PC9	Project's profitability level
PC10	Involvement of hazardous material like in the case of nuclear power plants or chemical plants, where separate risk planning and environmental laws are to be followed.
PC11	The raw materials purchasing for the project that is if it is imported from wide number of countries, where international custom laws and coordination among international project teams is needed for preparing even a supplier base.

The proposed model based on interrelation between project characteristic factors and risk factors is shown in figure 2, which shows how project characteristics are merged in to a single factor known as overallProject characteristics and similarly for risk factors, overall combined risk factor is selected. Now the model has shown inter relationship level in between these two factors, shown as a double ended arrow in figure 2.

Figure 2: Proposed Model for interrelationship between project characteristics and project risk.



The overall risk level factor acts as the indicator of all the identified risk factors and the same is applied with overall project characteristic factor. Hence the model is used to show interrelation between the risk factors and project characteristic factors by the help of two above stated factors only.

4 DATAANALYSIS

The data from the questionnaire is filled up in the form of an SPSS software Data View file. This file contains the ratings given to risk factors significance and project characteristics significance on a Likert scale by more than two hundred industry experts from various sectors. The mean of all the readings provided the risk and project characteristics significance level. The data from this questionnaire file needs to be analyzed for risk impact and for calculating the risk impact and the effect of risk mitigation plans on a particular risk, a mathematical function is given in this study by the name of Risk value function, which is explained below.

4.1 Risk value function

The already selected risk factors for our study are –

I. Technical Risk - R1
II. Environmental Risk – R2
III. Financial Risk – R3
IV. Human Risk – R4
V. Human Resource (Management) Risk – R5

Now the impact level of any n^{th} risk (I) on the basis of proportionality advised by experts can be formulated as a product function and mitigation effect is inversely proportional so the overall function can be shaped as -

$$= P * Cc * T * I_t / M_{rn} \quad \dots (1)$$

Where symbols have the following meanings –

(P) is the Probability of risk occurrence

(Cc) is the Cost associated with that risk occurrence
(T)is the time lag the risk will produce when occurred
(I_t) is the interrelation of this risk with other risks and
(M_{rn}) Effect of risk mitigation

4.2 Equation for Effect of risk mitigation (M_{rn})

With the use of mitigation plans for risk, the probability of occurrence reduces from $P_{initial}$to P_{final}using cost (Cm), the ability of risk to influence the project performance reduces from $A_{initial}$to A_{final}, therefore the function for Effect of risk mitigation (M_{rn}) can be written as –

(M_{rn}) = [k (constant) ($P_{initial}$- P_{final}) (A_{final} - $A_{initial}$)]/Cm

Now the notations used in the derivation is given as-

$P_{initial}$- Pi
P_{final}- Pf
A_{final}-Af
$A_{initial}$ – Ai

K and C are constants used in the analysis.

The total mitigation effect will be the integral of (M_{rn}) from $A_{initail}$to A_{final}, which is the direct measurement of ability of risk reduction from an initial state to the final state. It is therefore represented as –

$$M = C\ {}_{Aj}\int^{Af} M_{rn}\, d(Af)$$
$$= C\ {}_{Aj}\int^{Af} [(Pi – Pf)\ (Af- Ai) / Cm]\ d(Af)$$

On solving the integration for upper limit (Af) and lower limit (Aj)we get –

$$\mathbf{M_{rn}= [(K\ Pi/Cm) - (K\ Pf/Cm)]^{*}\ ((Af - Ai)^2/2)} \quad \mathbf{…(2)}$$

For all the risk factors collectively, we have

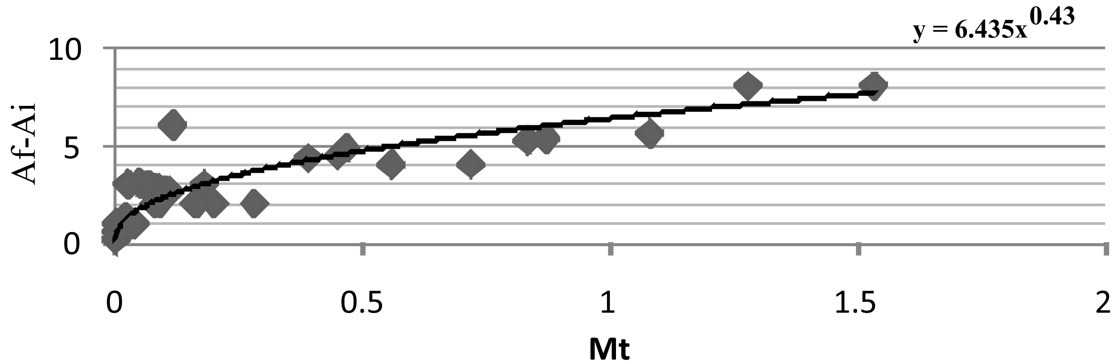
$$\mathbf{M_{total}= {}_{n=1}\sum^{n=5} M_{rn}}$$

Since the cost associated with each risk is (C), the optimal mitigation plan is when C <= M_{rn}. Suppose total cost associated with all five risk is C_{total}, therefore the above equation (2) will hold well only when M_{total}>C_{total}.

Hence the equation (1) is used to calculate the risk function value, the other inputs like probability and cost will be taken on the basis of expert discussion. During the discussion from the experts, the nature of risk mitigation is analyzed with the help of a graph between (Af - Ai) and M_{rn},throughthedata available by the questionnaire for different values of Pi, Pf, CM, Af and Ai for several projects undertaken or worked by these professionals.

From the SPSS filled up data, the graph is drawn on MS Excel between Mrn and (Af - Ai) to understand the effect of risk mitigation plan on risk damping. The function shows square nature. The graph is shown in figure 3. It can be clearly inference from the graph that on increasing the level of Mrn, we found that increase in (Af - Ai) is only up to a certain level and after that the equation shows negligible rise in the value of (Af - Ai) with the increase in Mrn. The equation shown in graph in figure 3 is$y= 6.435x^{.43}$so it can be clearly stated that as the value of (Af- Ai) increases the equation follows more of a square function relationship graph. Hence we can say that the effect of mitigation plan is predominant only in the specific region, since at the higher values of (Af – Ai) the risk mitigation ability is not further increased even if the mitigation level or cost is kept on increasing.Hence risk mitigation needs to be in a specified threshold region only then it will be most profitable.This region can again be decided by the experts or historical data**.** Now the function for risk mitigation is used in deriving the risk factor impact value. So we have proceeded to find the overall risk impact with the help of risk mitigation function derived.

Figure3 Graph between (AF – AI) and MT



In the end we can say that there are reasons why risk mitigation level is to be decided, since the graph shows that the risk mitigation factors are effective in reducing risk up to a certain level only, after that there is no effect over risk prevention or damping even if we keep on increasing the mitigation level. The graph shown in figure 3 is analyzed to explain a very prominent quality of risk mitigation plans, it refers that with the increase in the risk mitigation cost the effect of risk mitigation plan at first increases but it becomes a constant value after that, that is even after increasing the overall mitigation plans input to the greatest extent its effect to minimize a risk remains constant. Hence mitigation should be placed at an optimum point for attaining efficient level of input resources to be used in risk mitigation plan. This value of Effect of risk mitigation (M_{rn}) is used in the risk impact value calculation in the next step of the study.

4.3Risk Impact value equation

We have previously mentioned that the impact level of any n^{th} risk (I) is arranged in the form of an equation (Equation 1) as $I = P * Cc / M_{rn}$, where symbols have the following meanings, Probability (P), Cost associated with that risk occurrence (Cc) and Effect of risk mitigation (M_{rn}) which is derived in equation(2) above, hence M_{rn} function is used to generate impact level of any n^{th} risk (I). So we need a collection of collection of values of P, Cc and $M_{rn}$to be used in the mathematical function, which is done in the next section.

4.4 Analysis for collection of P, Cc and $M_{rn}$to be used in the mathematical function

This part of the study mainly deals with the collection of factors which are useful in analyzing the effect of risk mitigation plans on each type of risk. The project characteristic weights are analyzed for deciding which project characteristics are more important. First of all we have developed a questionnaire through which values of P, Cc and M_{rn}can be assessed for different projects, which is shown in table 6 and during the filling up of questionnaire variety of project management firms,ranging from electrical transmission line installation projects to software related projects are being consulted.

The outputs achieved by using the above formulas are shown in table number 6 and 7. After the questionnaire was analyzed equation (1) and equation (2) are applied to calculate the final risk impact value and also including the value of Mrn derived from equation (2).

Table 5 shows the significance that is attached by the experts to the various project characteristics and risk type on the basis of questionnaire based study, in which all the experts were asked to provide rating on the scale of 1- 5 for each risk type and project characteristics selected for our study. Out of these "Financial size of the project PC1, Experience of the firm in such projects PC4 and Project to be delivered to industry or general customer PC8"has a high mean value of importance. The importance level of risk factor shows that Technical Risk, Environmental Risk and Human Resource Risk are having more importance with all the three factors having a mean value of greater than 3.

Table 5: Showing the average rating of importance (range 1-5) given to project characteristics and risk factors from SPSS software based analysis.

Descriptive Statistics

Sr no.	Parameter Description	N	Mean	Std. Deviation	Variance
1	Technical_Risk	202	3.3218	1.26586	1.602
2	Environmental_Risk	202	3.2228	1.55652	2.423
3	Financial_Risk	202	2.7178	1.13057	1.278
4	Human_Risk	202	2.9257	1.34920	1.820
5	Human_Resource_Risk	202	3.4505	1.27354	1.622
6	PROJECT CHARACTERISTIC 1	202	4.1584	.88921	.791
7	PROJECT CHARACTERISTIC 2	202	3.5099	1.24285	1.545
8	PROJECT CHARACTERISTIC 3	202	3.9653	.83086	.690
9	PROJECT CHARACTERISTIC 4	202	4.0941	1.13122	1.280
10	PROJECT CHARACTERISTIC 5	202	3.2574	1.18156	1.396
11	PROJECT CHARACTERISTIC 6	202	3.8366	1.17098	1.371
12	PROJECT CHARACTERISTIC 7	202	3.9059	1.08635	1.180
13	PROJECT CHARACTERISTIC 8	202	4.0198	1.12396	1.263
14	PROJECT CHARACTERISTIC 9	202	3.5000	1.29772	1.684
15	PROJECT CHARACTERISTIC 10	202	3.5099	1.23884	1.535
16	OVERALL COMBINED RISK LEVEL	202	3.3812	1.19628	1.431
17	OVERALL PROJECT CHARACTERISTIC SIGNIFICANCE	202	3.8069	1.14490	1.311

Table 6: Calculation of Mrn for deriving final Value of Risk impact

Sr no	Project	Pi (Probability before risk mitigation)	Pf (Probability after risk mitigation)	CM (cost to mitigate risk)	AF (ability of risk to impact after applying mitigation plan)	AI (Initial ability of risk to influence, before applying risk mitigation) same as rating	Mrn
1	**Technical Risk**	0.365	0.24	0.03	2.5	3.2	1.0208
2	**Risk Environmental**	0.14	0.12	0.25	1.9	2.7	0.0256
3	**Financial Risk**	0.257	0.24	0.41	1.07	1.5	0.0038
4	**Human Risk**	0.38	0.15	0.059	1.54	2.1	0.6113
5	**Human Resource (Management) Risk**	0.46	0.34	0.4	2.73	3.1	0.0205

Table 7: Final Value of Risk impact

Sr no	Risk Factor (In bracket Risk symbol)	Average Rating	Approximate probability of occurrence (Pi)	Approximate cost associated if risk occurs (In million rupees) (Cc)	Approximate time lag (In years) (T)	Interrelation level with other risks (It)	Mrn	Final Value of Risk impact(Pi*T*Cc*It)/Mrn
1	**Technical Risk**	3.3	0.365	1.58	0.34	0.24	1.0208	0.029
2	**Environmental Risk**	3.2	0.14	0.61	0.43	0.16	0.0256	0.376
3	**Financial Risk**	2.7	0.257	3.4	0.15	0.26	0.0038	2.615
4	**Human Risk**	2.9	0.38	0.14	0.004	0.14	0.6113	0.000
5	**Human Resource (Management) Risk**	3.4	0.46	0.32	0.31	0.57	0.0205	3.958

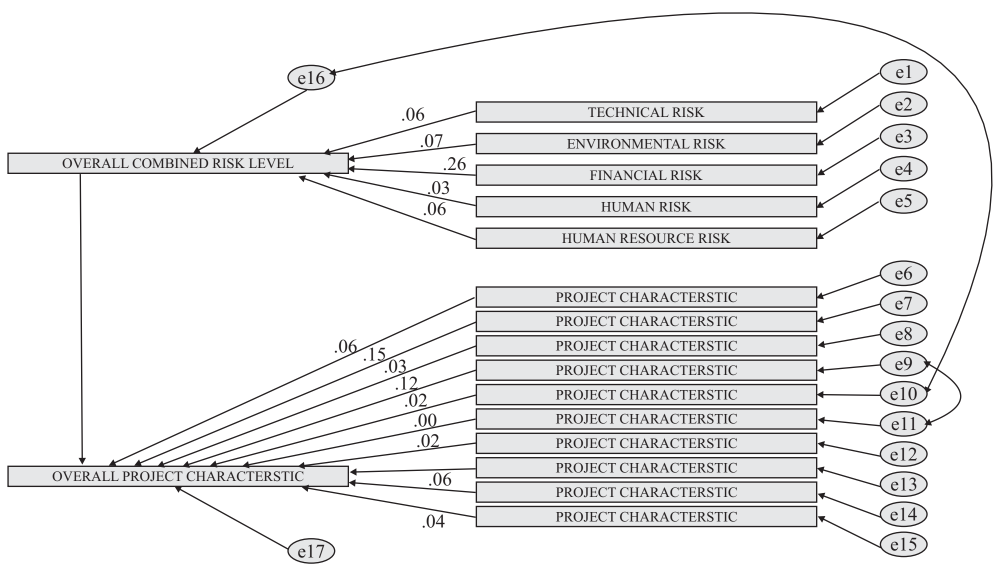
Now the value of risk impact calculated with the help of SPSS based questionnaire and mathematical function will be used for deciding the importance level of each risk factor, but still the co relation between these risks is needed to be calculated. We have used AMOS software based structural modeling technique for calculating the inter relationship between project risk and project characteristics. This structure modeling is given in the next section.

4.5 Structural Model

The overall model which shows the interrelationships between risk factors and project characteristics is being analyzed through SM (Structural Modeling). The proposed model is using the two main segments which are analyzed, one is risk factors and the other is project characteristics. These two aspects are hereby dealt with AMOS software in the form of a SM model which is shown in figure 4. Figure 4 is the screen shot of the output model generated by AMOS. Exhibit of the relationship between project risk and project characteristics is done in the model, that's why the model contains seventeen observable constructs along with the error estimates. In the model the relationship arrows are pointing towards two main constructs mentioned above.

These constructs are overall risk level and overall project characteristics, in the diagram all the risk factors are related with overall risk level and all the project characteristic factors are related with overall project characteristics construct. In this way the whole diagram can be divided under two groups named as risk factors and project characteristics. The estimate shows a high value in between these two main constructs.

Figure 4: Structural diagram from SPSS software of overall risk level construct and overall project characteristic construct



4.6 Output ratios given by the AMOS regarding the validity of the model

The model output Modification indices shows that the discrepancy in the estimate can be minimized by correlating error variance terms e16 and e10, e9 and e11. The model fit summary describes the CMIN and P values of 1.4 and .001 which is admissible on seeing the sample size of more than 200. In base line comparisons the CFI value is .802, which is ideally near to .9 hence can be accepted. Parsimony adjusted measure PCFI is .696 which is also fairly correct. The RMSEA is less than .1 (.049) and PCLOSE is also nearly equal to.5 (.542). The output after running the estimate is showing that a high estimate of .6 lies in between the constructs overall risk level and overall all project characteristics. Hence the structural model shows that our conviction of high interrelation between project characteristics and risk associated with that project is correct. The same could have also been shown with the help of other techniques like simple covariance table but in order to show the interdependence of risk factors and project characteristics among themselves and with each other and to represent it in the form of a model we have to develop a SEM model.

The structural model is shown in figure 4.The model explains the risk factors construct's covariance on the overall risk level construct and different project characteristics construct's covariance with overall project characteristic construct and also analyzes the overall risk level construct and overall project characteristic construct itself, this can be seen in structural model in figure 4.

The direction of estimate is from combination risk factor towards overall project risk characteristic factor, this means that when the project risk is changed by one the deviation produced in project characteristics is .6, similarly if the arrow is reversed then also it shows a value of .51, shown in figure 4. Hence there is a very strong mutual bidirectional co variance in between the two factors as confirmed by the values given in the structural model by AMOS.

5 CONCLUSION AND FUTURE STUDY

The overall analysis confirms that risk of any project is directly dependent on the project characteristics, the main project characteristic factors that are found are "Financial size of the project PC1, Experience of the firm in such projects PC4 and Project to be delivered to industry or general customer PC8." All these stated characteristics have a high mean valueof over 4 out of 5. The risk factor's importance level shows that Technical Risk, Environmental Risk and Human Resource Risk are having more importance with all the three factors having a mean value of greater than 3 out of 5. The highest importance is given to human resource management related risks since most of the experts are considering it to be most important factor.

The structural model also shows that there is a very strong covariance in between the overall project characteristic and overall risk level, in both the cases that is when one is varied against other in the model, the answer in both the cases is .51 and .60 which is a high valueof estimation. Hence the model supports the interrelationship between the two and the study proves that risk management process has to be aligned according to the project characteristics.

In this study it is found that project management is incomplete without project risk management and in order to mitigate the project risk, project characteristics are needed to be assessed. The heavy dependency of project risk on project characteristics shows that if project risk is done in accordance to project characteristics,risk mapping will be more effective. Project characteristics like "Financial size of the project, Technical sensitivity level, Experience of the firm in dealing such projects and Project's profitability" are common for most of the projects and they can be very easily used in risk assessment in many projects. The study is successful in delivering such project characteristics which are very helpful in risk assessment in most of the common industrial projects.

The study can be further enhanced by expanding the domain of survey and such studies can be done for different industrial sectors in a tailor made fashion.Suppose the study is only on the electrical transmission line sector than the interrelation achieved would be specifically for that particular sector only. When the study will be done at this mass level the accuracy will also be going to be increased and hence with the certain amount of changes in this methodology,it can be used to give the risk relationship based on the complexity of the project characteristics of the whole of the whole firmin a particular type of project. This will be very helpful in providing a system for risk assessment on the basis of project characteristics as a whole, since the base of the study is commonthat is very project has certain level of complexity in characteristics and that is why this methodology can be practiced in nearly every type of project irrespective of the project type and firm.

Note: The authors are grateful to the anonymous referees of the journal for their suggestions to improve the overall quality of the paper. Usual disclaimers are applicable.

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