International Journal of Mechanical, Industrial and Aerospace Sciences
ISSN: 2517-9950
Vol:2, No:4, 2008

The Risk and Value Engineering Structures and their Integration with Industrial Projects Management (A Case Study on I. K. Corporation)

Lida Haghnegahdar, and Ezzatollah Asgharizadeh

***Abstract*—**Value engineering is an efficacious contraption for administrators to make up their minds. Value perusals proffer the gaffers a suitable instrument to decrease the expenditures of the life span, quality amelioration, structural improvement, curtailment of the construction schedule, longevity prolongation or a merging of the aforementioned cases. Subjecting organizers to pressures on one hand and their accountability towards their pertinent fields together with inherent risks and ambiguities of other options on the other hand set some comptrollers in a dilemma utilization of risk management and the value engineering in projects manipulation with regard to complexities of implementing projects can be wielded as a contraption to identify and efface each item which wreaks unnecessary expenses and time squandering sans inflicting any damages upon the essential project applications. Of course It should be noted that implementation of risk management and value engineering with regard to the betterment of efficiency and functions may lead to the project implementation timing elongation. Here time revamping does not refer to time diminishing in the whole cases. his article deals with risk and value engineering conceptualizations at first. The germane reverberations effectuated due to its execution in Iran Khodro Corporation are regarded together with the joint features and amalgamation of the aforesaid entia; hence the proposed blueprint is submitted to be taken advantage of in engineering and industrial projects including Iran Khodro Corporation.

***Keywords*—**Management, risk engineering, value engineering, project manipulation, Iran Khodro.

I. Introduction

RISK and value engineering can't be segregated from the project administration on account of the fact that integration mechanisms rehabilitee the data and communication influx and egress. This matter paves the way for delving into time, costs, quality, functions and any other type of inner and reciprocal relationships. The reputation and the validity of the administrator depend upon his capacities to deliver the project to the employer punctually within the predefined budget and at the required qualitative level. The project manager should gain a better cognizance of the entire projects tasks as soon as possible and at the beginning of the project administration process so that he or she will be able to pinpoint the objectives.

Some endeavors are made in risk management to attain the utmost value of each product or project.

Should value engineering and risk management procedures be integrated during the project developments, compilation and recognition, one can gain mastery over the project's worth in a series of consecutive operations by means of several virtuoso workshops to define, analyze and control the pertinent values [6]. Should the projects administrator decide to enhance the capacities of pure savings, he or she should infix them in the project as soon as feasible. Thus he or she can double the risk coefficient relevant to the percentage of surmises to realities. When the project program is compiled, some theoretical data are tucked in it to fill the lacunas occurring due to lack of data. The value manipulation assists in completion of data at the beginning through measurable documented data owing to the functional orientation, accentuating the efficaciousness instead of the solutions as well as the structural master plans and the poly-disciplinary collective tasks. Project administration encompasses 9 data-prone fields. Four quintessential functions (the task scopes, quality, timing and expenditures) and 4 facilitating functions (human resources, prearrangements, risk and communications), the integrative administration of the project comprising compilation, development, implementation and control of the project scheme are mentioned. Customer's desiderata are determined by means of the task quality and scope as well as setting the sources expenses by means of outlays and timings. Therefore the value concept comprises four kernel-prone pivotal functions [7]. Value methodology is also known as value analysis, value engineering and value manipulation. Although it originated in industry at first, it was utilized in other management-prone backgrounds and decision-making fields on a vast basis ascribable to its advantages in problem-solving and reduction of uncalled-for monetary and non- monetary charges (for instance social costs, risk expenses and so on and so forth). Its utilization has become compulsory in some countries based upon the laws and regulations. for instance it has become obligatory to effectuate value engineering perusals in all the prosperity tasks even the

L. Haghnegahdar is with Department of Industrial (Operation & Production) Management, University of Tehran, Tehran, Iran (e-mail:lidahag@yahoo.com).

E. Asgharizadeh, Assistant Professor, is with Department of Industrial Management, University of Tehran, Tehran, Iran (e-mail : asghari @ ut. ac. ir).

military plans and prearrangements whose expenditures outstrips one million casers. The totality of the executive organizations which utilize governmental, federal or state budgets to effectuate their schemes are obliged to report the annual engineering perusals of the previous year to the budget and management administration. Implementation of the value engineering within the project manipulation framework make it feasible to pay attention to all the project components and not to take for granted any single portion of it. The ameliorated timing for the accomplishment of the exploitations can be the foremost goal sans augmenting the charges or diminishing the quality [14].A great number of cognoscenti have commenced to devise some methodologies to utilize the value manipulation right from the beginning of the projects. The aforementioned development has proffered new facilities to integrate value and risk engineering with project management.

We should accept the value and risk methodology as a priceless contraption which should be wielded together with other programs or to brace them up. Risk and value management can be integrated with project administration [6]-[16].Value engineering acts as a technique for the efficacious identification of uncalled-for costs. Thus it is seeking to omit or diminish expenses which are irrelevant to quality, exploitation, useful longevity, apparent beauty or the required specifications of the employer. It can make some ideas of its own to achieve this paragon. There are some concerns regarding the obtained opinions ascribable to risks subsequent to the effectuation of the value engineering [13].

Risk running and analysis is one of the chief decision-making contraptions which can drastically reduce the damages and casualties assignable to unexpected events [2].

According to statistics more than 75% of the projects are not accomplished in accordance with the apportioned expenses and schedules. One of the major reasons of this failure is risky eventualities and occurrences in projects.

Although risk manipulation expenditures may be regarded as an essential obstacle to shun risk analysis, the lack of administration has more outlays [5].

II. Risk Engineering

Risk engineering is a systematic and powerful process which assists us to make identification, analysis and reactions to the projects risks, the mitigation of the projects risks to maximize the upshots of the positive eventualities and to minimize the impact of the occurrence of horrendous events upon the projects objectives. Risk engineering is a process which contributes to the better comprehension of the projects. Thus it facilitates a better more precise programming of the projects from the aspects of the expenditures and timing. Risk management or engineering signifies the utilization of the individuals' or collective proficiencies to ensure the identification of all the risks, their gauging and implementation in projects [8].

According to the Pareto's rule: Risk engineering uses Pareto's rule which says: 80% of a project's risk can be found in 20% of the risks.

A. Risk Engineering assists us to:

1) Identify the itinerary in a better more precise manner to make out risks of achieving the objectives.
2) To adopt better decisions.
3) To view the projects in a realistic manner.
4) To identify / control and convey unexpected factors and perils in a facile manner.
5) To intensify the competitions [8].

B. Risk Definition [4]

Risk is designated as an eventuality whose occurrence probability is known.

Risk means any probable devastation or loss of assets, profits or benefits.

Risk betokens the deviation of the realistic upshots with regard to the expected results.

C. Risk Classifications

The first step in risk control concerns learning the observation methodology and the pertinent classifications. One of the plainest manners of risk categorizations is to use animals' names in their nomenclature.

1. Tigers are risks that are highly probably with intense impacts. Tigers are periclitating animals which have to be shunned away.
2. Alligators are risks with slight occurrence probabilities. Crocodiles are perilous animals which have to be eschewed.
3. Dogs are highly probable risks with trivial effects. Although dogs are faithful and harmless animals, wild rabies-afflicted ones can be minacious
4. Cats are risks with slight occurrences and inconsequential effects. Even the most wicked cats are innoxious to human beings. They should be trained to diminish assets losses. Their training expenditures outstrip their troubles which are worth having a shot at [8].

D. The Risk Effectuation Stages

Risks may be easily concealed so that they won't manifest as losses. Risk administrators should know that each risk has 3 stages. The potential predicament, actual occurrence and efficaciousness are regarded. Potential predicaments do not entail any damages or disservices until they actually transpire or bear effects.

Actual risk eventuation pertains to a problem which impedes progress. The damages actually inflicted upon the profits are called risk impact.

E. Risk Process

Risk engineering comprises two major processes mentioned hereunder:

1. Risk analysis
2. Risk management

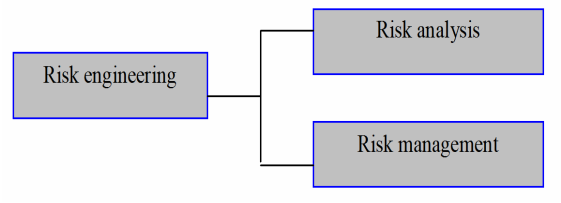


Fig. 1 Risk engineering process

1. Risk Analysis

Risk signifies the probable devastation or financial loss inflicted upon others' assets or profits .Risk analysis in projects management is an inevitable fact. Projects administrators are required to identify and appraise risks to find ways of assuaging them. Risk specialists have transformed their knowledge into a vast statistical field whose accessibility is not a facile task for non-expert persons such as employers. Risk gaffer should have a perfect knowledge of them. In the inspection of some of the corporations and economic activities risk signifies a potential plight which has to be evaded at any costs. Risk manager can not always portend the totality of the latent risks of all projects. Nonetheless it's fruitful to make endeavors to identify more risks including the improbable ones. Risk analysis is the basis of risk management. Risk analysis comprises risk identification and assessment.

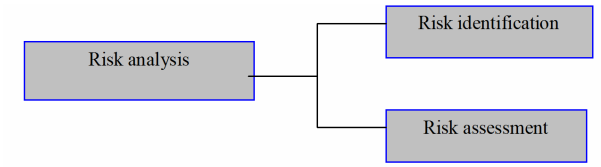


Fig. 2 Risk analysis

Risk Identification

Risk identification is the most crucial phase in risk analysis. Precise risk identification is the basis of the risk administration. Hence it is highly significant to effectuate this phase in an accurate manner [7]. This phase comprises the identification, prioritization and appraisal of risks pertinent to the projects developments, profiles and engineering standards. There are numerous techniques to ascertain a risk. The ensuing ones can be mentioned:

1. The brain storm technique, 2. Check lists and prepared inventories, 3. Questionnaires and interviews, 4. Delphi technique, 5. The cause and effect diagrams, 6. Influence diagrams.

It is recommended to avail an appropriate intermingling of the methodologies in risk identification [8],[12].

Risk Appraisal

Risk appraisal occurs subsequent to their ascertainment. This is the phase in which impact and probabilities of the identified risks of the projects are evaluated. After identifying product, process and project related risks, users proceed to initiate the computation of the significance of each risk by using the risk analysis agent. Both qualitative and quantitative techniques are used for calculating the magnitude of risks. The analysis is carried out for both the likelihood and impact of all the identified risks. The impact analysis is carried out using the Analytical Hierarchy Process (AHP) Concept. A comparative risk ranking technique is used by asking a comparative question about each risk event compared to another risk event. The information gathered through expert judgement is used to compile pair-wise comparisons to feed the AHP [1], [3].

Risk intensity is one of the significant criteria for risks prioritizations. Risk intensity is computed by multiplication of the impacts quantity by the risk occurrence possibility as follows:

Severity = probability * impact

Probability signifies the risk formation potential and its conversion into an efficacious eventuality. The efficaciousness, magnitude or the estimated quantity pertains to the impact which will be left behind lest the risk is ignored. High severity betokens high hazardous factors of the projects. The risk calibration methodology for severity has been limned in the ensuing table.

Project risks can be sundered into 5 groups:

Intense risks (red light), High risks (blue tint), Intermediate risks (green hue), Slight risk (pink tinge), Ignorable risk (brown tinge) [4].

Another method for calculation of the risk magnitude in units of Behaviour (UOB) is calculated from Equation (1).

$$R_i = \sum_{j=1}^{J} d_{ij} \left(P_{ij} \times C_{ij} \right) \quad (1)$$

$$R_{(PK)} = \sum_{\forall i \in PK} \sum_{j=1}^{J} d_{ij} (P_{ij} \times C_{ij}) \quad (2)$$

Dij is the weighted score of risk factor j,Pij is the likelihood of risk factor j and Cij is the impact of risk factor j in a project particular units of Behaviour (UOB).With the abovementioned conversion the measurement unit of risk magnitude Ri is time delay or extra cost overrun generated in UOBi. Since a path set Pk contains UOBs from score to sink, the risk magnitude in a path set Pk (R(Pk)) is the summation of all risk factors and their parameters throughout. Hence,R (Pk) is calculated from Equation (2).

From Equation (2), the risk magnitude of the project is calculated by decomposing the behaviours of risk factor(s) in an individual UOB in to three parameters: weighted score, risk likelihood and risk impact [17],[18],[19],[20].

2. Risk Manipulation

Project risk adminstration on project management generalities comprises the processes relevant to the risk management programming orientation, identification, analysis and responding any type of uncertainty including the maximization of the nonpareil events and minimization of the

horrendous eventualities. There are 4 distinct stages in compiling risk management plans. The first stage is the programming which is prioritized before the acceptance of any commitments to set the project into effect. The 2nd stage concerns reacting to risk which is executed prior to the commencement of the project. The 3rd stage is implementation, which realizes at the beginning of the project. The last phase comprises the maintenance and supervision on implementation of decisions which encompasses the perusals made to keep the program active during the project implementation [15],[22].

These Risk manipulation have been illustrated in Fig. 3.

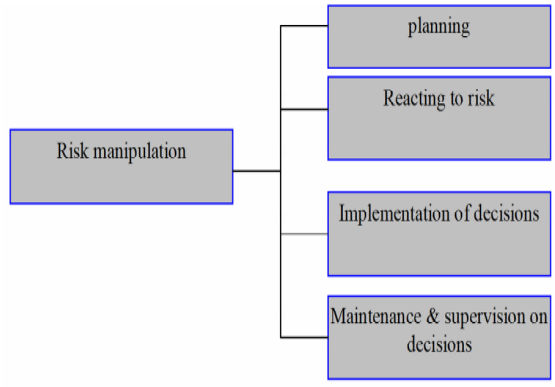


Fig. 3 Risk manipulation

1. The phase of planning and monitoring the decisions: this comprises the identification and breakdown of the totality of the risks pertinent to the projects. This step can be commingled with the functions analysis workshop. The objective is to pinpoint the optimal nature of the project or any all-embracing review not to ascertain any projects risks [7].
2. Reacting to risk stage: That can be avoidance, mitigation, transfer and acceptance. The objective during the first two stages encompasses risk deletion or the project amendment aiming to shun them by making them out precociously and taking prophylactic measures. These two stages include collective ones. That is why they integrate with the value management [21].
3. The implementation stage: This encompasses the analysis of all the previous information pertinent to risks and the effectuation of the detailed analysis of the totality of the project. This stage makes it feasible for the project administrator to assuage his or her own master plans, planning and control systems so that the risk impact can be attenuated or obliterated.
4. The implementation and supervision on decisions phase: This stage deals with the pragmatic confrontation with risk thwacks. Should the three previous stages be carried through efficaciously, it will be rather facile for the risk manager to effectuate this stage. These stages have been illustrated in Fig. 1 [7].

III. The Suitable Time to Effectuate Risk Management

Risk occurrence in the life cycle is not an identical project. It differs based upon the stage in which the project is effectuated. Risk probability is very high in the initial project implementation stages due to the fact that there are numerous unknown parameters in the project. Risk effects are slight at the beginning of the project ascribable to the fact that nothing has been done yet.

The further the project makes headway, the more prominent such repercussions manifest because most of the possible risks actualize during the project progress and manifest their effects.

Risk repercussions maximization spot is at the end of the projects where all the probable risks have either taken place or have gone through the process of manifesting their consequences. Completion time of risk analysis at the beginning of the project but Completion time of risk management, its when operating of project to end of working [1],[4].

IV. Value Engineering

Value engineering and analysis is an organized creative approach which aims to pinpoint inessential expenditures precisely. These are the charges whose spending does enhance none of the qualitative, functional, customer-orientated or apparent aspects. The methodology of a system value determines the pertinent schemes, products, components for setting the worth of each one of them. Value engineering scrutinizes the scheme obligations to determine the realization of the actual value. Thus it seeks the fruition of the indispensable functions with the slightest expenses [11].

Value engineering can be effectuated in all the diverse phases of the project life span in constructional and industrial projects.

According to Pareto's Rule : 80% of a project's costs can be found in 20% of the items.

Nowadays value engineering is a contraption to render a better utilization of the financial sources, project timing and eventually the betterment of the projects value. Value engineering can be utilized as an appropriate strategy to enhance project implementation and to access the supreme purposes of the project. Utilization of the value engineering makes it feasible for the totality of the beneficiaries to make an all-out scrutinization of dissimilar social, environmental, political and legal quandaries.

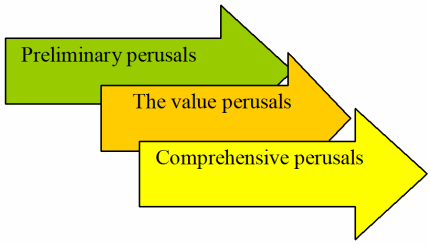
The utilization of this methodology during the past 6 years when the value engineering / management commenced resulted in a saving exceeding 1300 milliard rials in 30 prosperity schemes all over Iran. The return rate of the capital outstripped 50 to 1 in most cases, that is to say, for each rial spent for value engineering perusals and the effectuation of the necessary alterations of the plan more than 50 rials were saved in prefatory investments during the exploitation and maintenance era (which are taken to be the scheme's life span expenses).

Value engineering aids us to define the projects precisely. It pinpoints the employer's desiderata. This renders the project knowledge of the group members identical and the eventual solution of the management quandaries. The best option for

project implementation with further value is latent in value engineering capabilities.
- Augmentation of convergent and divergent thoughts
- Escalation of intellectual and emotional perspicacity
- Collective augmentation

Value engineering is presented as a methodological management style for enhancing value in projects. In fact the chief default option in value engineering is the shift from manufacture-oriented value to the customer orientation. This feature has transformed the value engineering into an efficacious administration contraption to obtain superior competition situations. [10]

V. Conducting Value Engineering



Value engineering is made up of the ensuing phases:

1. Preliminary perusals: comprising the determination of the team members, supervision of the projects' team members, pinpointing the value engineering workshop objectives, setting the perusals scopes and pinpointing the appraisal touchstones.
2. The value perusals: This encompasses the functions analysis phase as well as the creativity, information , idea presentation and developments .Function analysis phase is the heart of value engineering methodology ,this consists of identification, function definition and classifying,Fast chart drawing (Function Analysis System Technique), cost and time determining ,price of every function determining , and to determine the best opportunity for improvement with using of value criterion (with using equation (3)) : at final to select the proper function.

$$VI = \frac{FC}{FW} \qquad (3)$$

FC(Function Cost): The cost that to be spent on account of function accomplishment at present.

FW(Function Worth) : minimum of cost that is a requisite for function accomplishment.

If VI ≤ 1 the proper chooser isn't for value engineering .

If VI>1 the proper chooser is for value engineering .

3. Comprehensive perusals: this consists of altering the eventual distinct components. [4]

VI. A Suitable Time to Effectuate the Value Engineering

Should the value engineering be conducted in the introductory stages of the project implementation, the value engineering expenditures as well as the project alterations outlays will be dwindled because no physical tasks are implemented yet at the time the project is devised. All the design is effectuated upon the paper. Hence it is quite convenient and inexpensive to make alterations so the savings stemming from alterations can be rigorous.

The further the project makes headway from the devising stage, the further costs will be incurred assignable to the fact that some of the charges have actualized. Since the project has to be re-conducted the alterations outlays will increase [7].

VII. Case Study

The value engineering of 40 schemes have been assessed in Iran Khodro Corporation so far and pleasant upshots have been obtained.

Objectives of effectuating value engineering in Iran Khodro Corporation:

1-Efficacious utilization of the fiscal sources
2-Curtailment of the projects implementation outlays
3-Identification of over-design activities
4-Decreasing the exploitation period expenditures
5-Controlling the finalized price of the commodities
6-Diminishing the outlays of the opportunities lost in the manufacturing lines

Disparate projects bearing diverse targets have been defined and conducted in Iran Khodro so far. Value engineering has played a crucial role in fruition of investments in these projects as a fruitful creative efficacious technique.

A.. Classification of the Value Engineering Effectuated Projects

1) Process improvement
2) Industrialization
3) Products expansion and design
4) Systematic – software aspects
5) Infrastructure

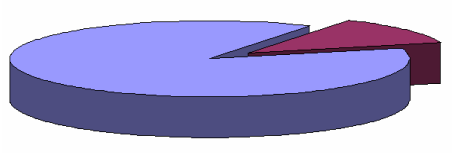
The abundance of diverse assigned projects whose value engineering has to be pinpointed in the ensuing categorizations:

1) Product 11.7%
2) Process amelioration 29.4%
3) Industrialization 52.9%
4) Software 6%

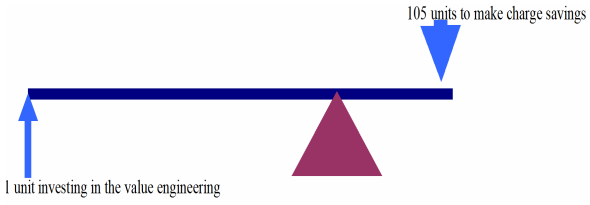
The utmost percentages of the projects concerns the industrialization

Three projects were selected for detail-proffering out of the cited projects.

The sequels of conducting the value engineering in Iran Khodro: Saving: (13%)



Value engineering workshops have entailed other qualitative upshots such as project implementation time curtailment, quality augmentation, higher customers' satisfaction and so on and so forth.



Expenditures of effectuating value engineering workshops:
Consultation expenses
The personnel working time outlays
Research and expansion

According to the effectuated surveys risk engineering of projects has to be implemented prioritization to the value engineering. Hence a blueprint encompassing the risk and value engineering has been proffered.

B. A Template for the Integration of the Risk and Value Engineering in Iran Khodro Corporation

The risk modeling workshop and the value engineering workshop have been commingled in the structural design methodology which is one way of setting the projects into effect so that the totality of the projects; risks will be picked out and scrutinized. This can assist us to single out a vast domain of factors such as social, environmental and locational predicaments as well as the staff security. One of the purposes of the value engineering workshops is the presentation of the risk management solutions and their minimization.

We pinpoint the projects risks during the prefatory perusals. We regard project risk curtailment as one of the objectives of the engineering workshop. We assess the identified risks after categorization. We utilize high occurrence risks as a yardstick during value engineering opinions assessments.

We draw the FAST Diagram in the functional analysis phase. We relate the pinpointed risks to each one of the functions. We deal with idea processing in the creativity phase. We propose the ideas by heeding the curtailment of the identified risks. Then we evaluate ideas based upon the benchmarks which encompass the risks too. Then we opt for the most suitable ideas. The conceptions obtained in the appraisal phase are rendered to the planners to expand notions. It is necessary to pinpoint all the risks in this phase. We determine the manner of reacting to them subsequent to weighing up the risks. Then the team members put forward the proposals to render the decision-makers reach an agreement.

The propositions are submitted for implementation subsequent to agreements made with decision-makers. In the meantime the decisions adopted for reacting to risks are effectuated. The performance is monitored during the effectuation [4],[9].

VIII. Conclusion

Most industries face a challenge called "cost-prone competitions". Thus they should proffer the optimum quality and services to the customers at the slightest price. Iran Khodro Corporation decided to avail risk engineering in projects after the successful implementation of value engineering. Risk and value engineering can't be segregated from the project administration. If we utilize the commingled blueprint and if we collate risk and value processes, we will notice that the preliminary project stages are the best ones for value engineering utilization together with risk management. Hence alterations outlays are minimized and savings are maximized and we manage to recognize projects risks punctually. We use this knowledge in devising engineering alternatives so that we will be prepared to confront and reduce the risk impacts upon the project. If we utilize these two processes in the life span of a project belatedly, we will face less savings and more unknown risks. Thus we have to struggle against their impacts upon the project. This demands undergoing further charges for the effectuation of alterations. Value engineering and risk management use the working group. Hey are made up of diverse stages. The brain storm, creativity, options assessment, presentation of strategies, developments and expansion, options rating and the eventual selection of the best option are used in both methodologies. The most pivotal advantages of conducting risk and value engineering in projects are as follows: Amelioration of the functions expected in the project, betterment and balancing of the quality, enhancement of the project longevity, identification and revamping of risks, clarification of the project specifications based upon the actual applications, balancing the construction and exploitation programs with the timing and expenditures, pinpointing the projects risks and the possibility of manipulating them, proffering realistic programs for the delivery time, balancing the implementation charges with the life span and maintenance outlays. Risk management and VE can be used together as an effective mechanism to provide value successfully throughout the development of new products.

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TABLE I
ESTIMATING RISK LEVELS

Efficaciousness of risk							
Ignorable	Slight	Intermediate	High	Severe			
10	40	40	80	160			
9	18	36	72	144	0.9	High	Risk probability
7	14	28	56	112	0.7	Intermediate	
5	10	20	40	80	0.5	Intermediate	
3	6	12	24	48	0.3	Intermediate	
1	2	4	8	16	0.1	low	

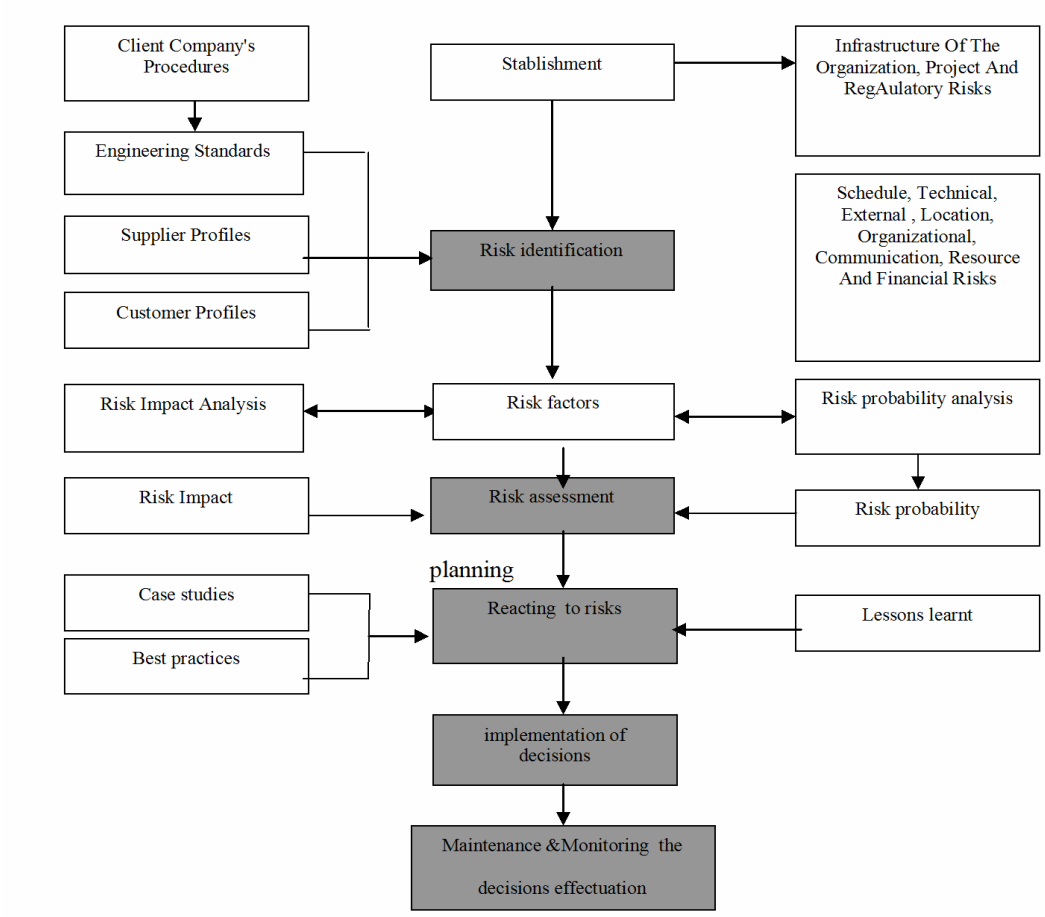

Fig. 4 The Pragmatic Stages of Risk Engineering in Project Administration

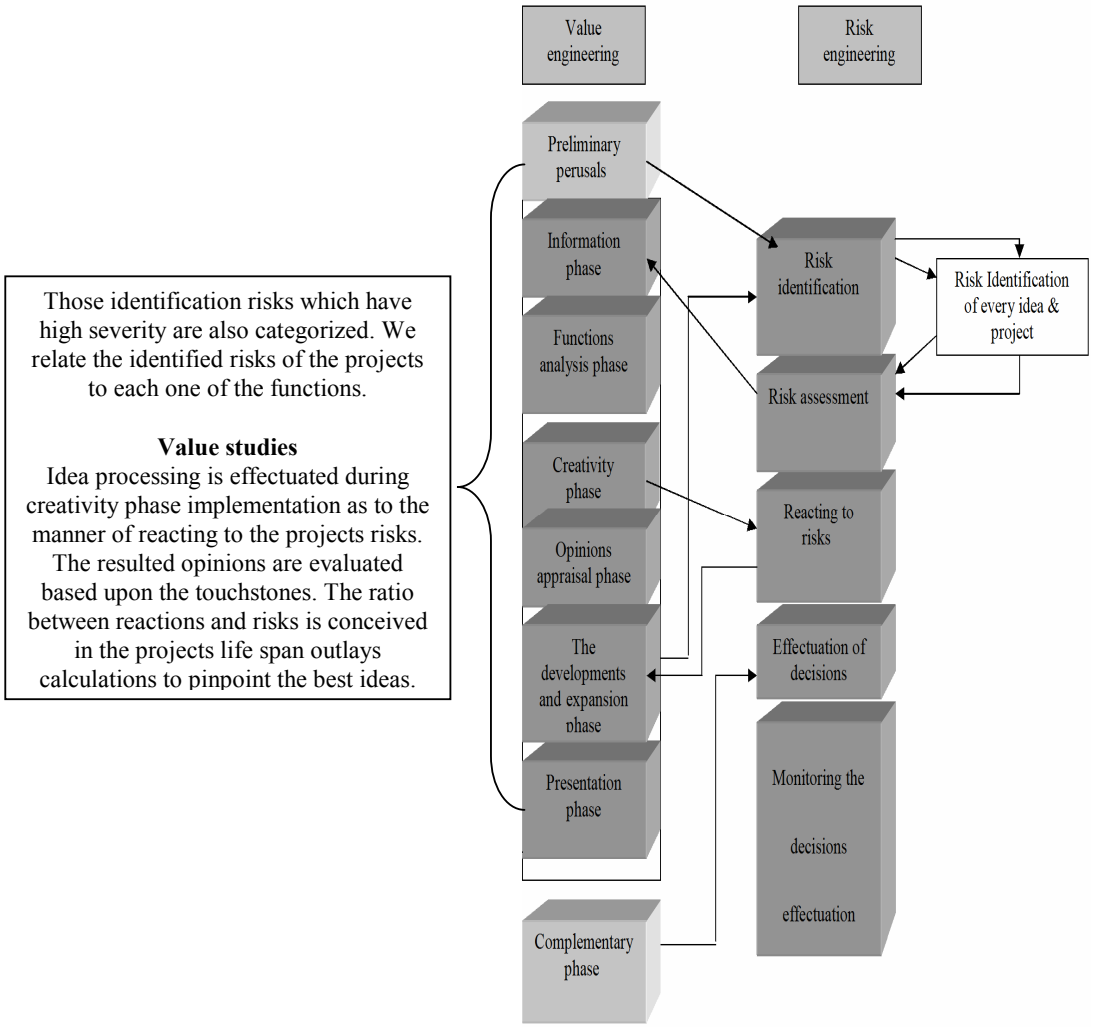

Fig. 5 Mapping VE to RE