Power System Protection and Control
ISSN:1674-3415

PRESENTING AN INTEGRATED MODEL OF RISK MANAGEMENT AND VALUE ENGINEERING WITH EMPHASIS ON THE ROLE OF HUMAN RESOURCES IN ROAD CONSTRUCTION PROJECTS

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Received:26 September 2025 **Revised**:19 October 2025 **Accepted**: 22 November 2025

***ABSTRACT*:**

In road construction projects, optimal risk management and value creation are of great importance. This study presents an integrated model of risk management and value engineering with emphasis on the pivotal role of human resources. The main goal is to improve project performance by identifying and controlling risks, optimizing costs, and improving quality by utilizing human resource capabilities. In this model, using qualitative and quantitative methods, project risks are first identified and prioritized, then by applying the principles of value engineering, solutions are presented to reduce costs and increase efficiency. The results show that the proposed integrated model can lead to reduced delays, resource optimization and increased sustainability of road construction projects. This model, emphasizing the role of human resources, provides a comprehensive framework for effective project management.

Keywords*: Risk Management, Value Engineering, Human Resources, Road Construction Projects.*

INTRODUCTION

The useful life of road construction projects in the world has been able to set new records by relying on new management techniques. According to the latest statistics provided, the useful life of asphalt pavements in the world has increased to about 15 years, while according to the report of the Research Center of the Ministry of Roads and Urban Development, this number is limited to a maximum of 5 years in Iran. This fact is raised while the raw materials for road construction in Iran can be made available to projects due to the vast aggregate mines in the country and the petroleum materials used in asphalt pavements with high quality and cheap prices. Therefore, in diagnosing the pathology of this decrease in productivity, we must look for the weakness of the human factors affecting the project execution process.

Project management knowledge has been created and developed with the aim of implementing and completing the project within the framework of the desired goals by spending minimal resources in the form of documented and defined solutions for carrying out projects (Azimian, 2021). Regarding value engineering and risk management, it should be said that the two categories of value engineering and risk management have been used separately in various construction projects for years, and each of them, with its own approach and emphasis, tries to better implement construction projects. Therefore, value engineering and risk management are processes that can be used at different stages of the project. However, the highest usefulness of the two aforementioned processes is determined when they are applied in the initial stages of the project (Tajdin et al., 2023). Risk management and value engineering are both emerging and new phenomena in Iran. In Iran, on the other hand, due to frequent crises and increasing shortage of resources, modern management is forced to use all its tools and capabilities to achieve goals. Almost all managers are looking for tools to reduce the risks and consequences of decisions to the minimum

 DOI: 10.46121/pspc.53.4.17

possible (Pelleh et al., 2019). Risk management is a new tool that has been able to find a suitable place for itself in a short time. Apart from risk quantification tools that prevent its general adoption due to complex calculations, simple tools and qualitative risk assessment are simple and derived from logical thinking. The combination of various design factors in construction projects is predicted in such a way that most risks are transferred to non-decision-making factors (Wei, 2022). With the three-factor combination (client, consultant, and contractor), which is a common and established combination, design risks are transferred to the design consultant and implementation risks to the contractor. In four-factor combinations, management risks are transferred to project management and the remaining management risks are transferred to these two factors. The emergence of value engineering and its mandatory application in costly and complex projects creates a difficult situation for the employer due to its unconventional nature and thinking outside the box of common and accepted habits and methods (Khalef et al., 2021). It is necessary to pay attention to this point that in the decision-making process for implementing projects, given that in our country the government is the employer and the decision-maker for the implementation of many large projects, in many cases the irrational conservatism and risk aversion of government managers has led to the selection of costly and low-value options. The reason for this conservatism and reasonable risk aversion should be sought in the risk that managers perceive from different options. These perceived risks, along with a lack of awareness and knowledge of the proposed designs and the risks of the various elements of these designs, lead to the selection of suboptimal options and the loss of opportunities (Razi, 2021). Risk management is one of the main and inseparable parts of the engineering profession. This management is a systematic process for defining, analyzing, and responding to system risks. The task of risk management is to increase the probabilities and recurrence periods of desirable events and reduce the probability of undesirable events or reduce the severity of the negative effects of undesirable events. This process can be considered a decision-making process for selecting and implementing the most cost-effective techniques and actions in dealing with various system risks in order to minimize that risk in the system. Risk management talks about eliminating, reducing, and transferring the negative consequences of incidents and taking advantage of potential opportunities. Undoubtedly, in implementing any system in projects, the role of human resources cannot be ignored because if there is efficient human resources and the necessary training for them regarding the implementation of new systems, it can be hoped that the system has been implemented in a good way and has benefited from its benefits in projects. However, studies show that research has only sought to implement risk management and value engineering in projects and has not considered the role of human resources, and this has caused the failure of most risk management and value engineering projects in road construction projects and has also caused many delays in the process of carrying out road construction projects. Therefore, the aim of this study is to answer the main question of how the integrated risk management and value engineering model will work with an emphasis on the role of human resources in road construction projects and how will it lead to improved project implementation?

Kafashi et al. (1401) conducted a study titled “Investigating the Impact of Project Management, Construction Management, and Risk Management on Time, Cost, and Project Execution Process”. Based on the results, dam-tunnel-road projects are ranked first to third. For the three project options, mass construction projects, high-rise construction projects, and finally conventional buildings are ranked first to third in the project group. Accordingly, mass construction projects have the highest weight and are more important. For the case study, high, medium, and low importance mass construction projects were considered as options and ranked based on the same criteria. The results showed that low-importance mass construction projects were ranked first, followed by high and medium importance projects in the second and third ranks, respectively.

Hosseini and Hoshyar (1400) conducted a study entitled “A Combined Model of Risk Management and Value Management Based on Multi-Criteria Decision Making in the Selection of Contractors for Construction Projects”. This model is designed based on criteria and sub-criteria extracted from the research literature, whose importance is scored using the best-worst method. Then, contractors were prioritized using VIKOR methods and gray relation analysis. According to the computational results, it can be said that the strategic risk criterion has obtained the highest score among the criteria and the other risks criterion has obtained the lowest score among the criteria. In the operational risk dimension, the technical error sub-criterion has the highest weight and the fraud sub-criterion has the lowest weight. In the strategic risk dimension, the social dissatisfaction sub-criterion has the highest weight and the environmental dissatisfaction sub-criterion has the lowest weight. In the human resource risk dimension, the cost risk conditions sub-criterion has the highest weight and the technical risk sub-criterion has the lowest weight. In the other risks dimension, the financial risk sub-criterion has the highest weight and the external risk sub-criterion has the lowest weight. In the value engineering dimension, the turnover volume sub-criterion has the highest weight and the financial savings sub-criterion has the lowest weight. Finally, the prioritization of

DOI: 10.46121/pspc.53.4.17

contractors is reported based on the comparison of the results obtained from solving the VIKOR methods and gray relationship analysis.

Tajdin et al. (2023) conducted a study entitled Feasibility study of improving the value of large construction projects using a combination of value engineering and the ANFIS method. The results showed that the criterion of "appropriate planning…" had the greatest impact on improving the value of the project and the criterion of "preventing the interference of work and responsibility…" had the least impact. Both of the aforementioned criteria were placed in the cost group, which indicates a higher importance of this group than other groups.

He (2022) conducted a study entitled A Decade of Value Engineering in Construction Projects. It has been found that new research in the past decade has continuously improved the efficiency and productivity of value engineering methods. Current work focuses on integrating value engineering with other disciplines, applying value engineering to different project areas, evaluating value engineering performance, and developing new value engineering technologies. This extensive review highlights some of the key areas that need to be addressed to ensure continuous value transformation in the construction industry.

Razi (2021) conducted a study titled "Investigating the Risks Associated with Public Road Infrastructure Construction Projects". The analysis showed that when considering all the factors related to the objective, the most important factor in project risk was the risk arising from land acquisition issues, followed by environmental factors arising from weather and uncertainty. Operational risk arising from delays in providing approval for construction plans, which causes delays in project delivery, was considered as the last prioritized risk factor in the construction project.

RESEARCH METHOD

The present research is in the category of applied research according to its objectives and is a descriptive and exploratory field research in terms of the research process. The research steps are as follows:

First step: In this step, the research using the meta-analysis method will first identify reliable information sources according to the entry and exit criteria of articles and theses.

Second step: In this step, the content analysis method will be used to localize the identified components. This approach will help to identify and determine the level of theoretical agreement between experts regarding the components and sub-components, and the components and sub-components with the least agreement between experts will be eliminated.

Third step: In this step, the components and sub-components that were finalized will be provided to the experts in the form of a researcher-made questionnaire and will be analyzed using structural equations.

The statistical population of the research is road construction project experts, including university professors, project managers, employers and contractors who have more than 10 years of experience in the field of risk management and value engineering of road construction projects, a minimum master's degree in the field of road construction management, and are fully familiar with the subject. The sample size will be determined by a non-random method and theoretical saturation.

RESEARCH FINDING

Qualitative section

Sample size adequacy test: Variables that are more suitable for model analysis are at the distance measurement level, but in some cases, ordinal and nominal variables are also used. It should be noted that the researcher can include any number of variables related to the research problem in the analysis.

Findings from interviews and research literature: As mentioned, the content analysis approach was used to obtain the dimensions of the initial model. In the content analysis method, the categories and subcategories of each were identified during interviews with experts and research literature. In this regard, it can be stated that according to the above table, each of the open concepts was first compiled and finally, according to the main concept of the

DOI: 10.46121/pspc.53.4.17

Power System Protection and Control
ISSN:1674-3415

phrase, a central code was identified, which is the subcategory of each class of determined categories and was placed in its corresponding category, which can be effective on the model.

Table 1. Qualitative findings

Factors / Subcomponents	Input	Process	Output
Recruitment and selection	•		
Performance assessment	•		
Reward and compensation	•		
Employee training and development	•		
Employee attitude	•		
Innovation	•		
Future of human resources	•		
Human resource environment	•		
Productivity	•		
Compliance with the employer	•		
Employee health	•		
Participation	•		
Planning	•		
Reporting	•		
Identification	•		
Monitoring		•	
Informal groups		•	
Commitment		•	
Agility		•	
Learning		•	
Risk awareness		•	
Knowledge updating		•	
Flexibility		•	
Promotion		•	
Ethics		•	
Dynamics		•	
Knowledge		•	

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Skills		•	
Ability			•
Preventive responses			•
Strategic planning			•
Key employees			•
Competence			•
Change management			•
Job safety			•
Technology			•
Employee readiness			•
Stakeholder groups			•
Risk level control			•
Behavioral risk			•
Recruitment and selection			•

Findings of the quantitative section

Descriptive findings of the sub-components: The results obtained can be stated that considering that the sub-components were measured with a 5-point Likert scale, examining Table 2 shows that all the means of the sub-components are greater than the cut-off point (cut-off point) of the 5-point Likert scale (3), and considering that this mean is also greater than the cut-off point of the spectrum, it does not cause any particular problem. The above results show that the respondents answered the research questions in line with the research objectives and the data are scattered around the mean with a standard deviation proportional to the mean, and the results obtained from the analysis of the mean and standard deviation can be seen in the table below.

Table 2. Descriptive findings of the sub-components

Standard deviation	Average	Subcomponents
0.435	3.45	Recruitment and Selection
0.654	3.21	Performance Evaluation
0.324	3.65	Reward and Compensation
0.657	3.32	Employee Training and Development
0.611	3.25	Employee Attitude
0.543	3.04	Innovation
0.577	2.97	The Future of Human Resources
0.765	3.78	The Human Resources Environment
0.432	3.94	Productivity
0.654	3.11	Employer Compliance
0.610	3.67	Employee Health
0.656	3.44	Participation
0.732	3.56	Planning
0.546	3.41	Reporting
0.756	4.01	Identification
0.875	4.53	Monitoring
0.633	3.67	Informal groups

DOI: 10.46121/pspc.53.4.17

0.382	3.23	Commitment
0.365	3.17	Agility
0.435	3.77	Learning
0.461	3.54	Risk-taking
0.547	3.09	Perception
0.632	3.44	Knowledge update
0.616	3.87	Flexibility
0.734	3.52	Promotion
0.453	3.67	Ethics
0.422	3.54	Dynamics
0.432	3.98	Knowledge
0.265	3.43	Skills
0.435	3.65	Ability
0.465	3.25	Preventive Responses
0.534	3.90	Strategic Planning
0.656	3.45	Key Personnel
0.544	3.67	Competence
0.656	3.65	Change Management
0.632	3.46	Occupational Safety
0.581	3.98	Technology
0.777	5.67	Employee Readiness
0.435	4.87	Stakeholders
0.276	3.78	Risk Level Control
0.656	3.28	Behavioral Risk

Exploratory factor analysis

In order to conduct exploratory factor analysis, the principal component analysis method and Varimax rotation were used, and 3 dimensions were extracted as model dimensions along with subcomponents.

Table 3. Results of exploratory factor analysis

Factors / Subcomponents	Input	Process	Output
Recruitment and Selection	0.764		
Performance Evaluation	0.735		
Reward and Compensation	0.793		
Employee Training and Development	0.744		
Employee Attitude	0.784		
Innovation	0.755		
The Future of Human Resources	0.876		
The Human Resources Environment	0.765		
Productivity	0.711		
Employer Compliance	0.744		
Employee Health	0.790		
Partnership	0.773		
Planning	0.865		
Reporting	0.843		
Identification	0.712		
Monitoring		0.764	
Informal groups		0.777	
Commitment		0.705	
Agility		0.815	
Learning		0.790	
Risktaking		0.792	

DOI: 10.46121/pspc.53.4.17

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ISSN:1674-3415

Awareness		0.798	
Knowledge update		0.764	
Flexibility		0.777	
Progress		0.705	
Ethics		0.815	
Dynamics		0.790	
Knowledge		0.792	
Skills			0.798
Ability			0.764
Preventive Responses			0.777
Strategic Planning			0.705
Key Personnel			0.815
Competence			0.790
Change Management			0.792
Occupational Safety			0.798
Technology			0.764
Employee readiness			0.777
Stakeholder groups			0.705
Risk level control			0.815
Behavioral risk			0.790
Total initial specific values	1.24	2.16	3.90
Percentage of variance	12.65	21.78	34.69
Percentage of cumulative variance	45.65	66.56	87.67

Model Quality Check

To check the quality of the model, the redundancy check index and the coefficient of determination are used. Table 4 shows that 89 percent of the model changes are predicted by the identified subcomponents of the model. If the redundancy index is greater than zero, the observed values are well reconstructed and the model has predictive ability. In this study, this index is above zero for the model.

Table 4 Model Quality Check Indices

Redundancy	Coefficient of determination	Model
0/655	0/89	Integrated risk management and value engineering model with emphasis on the role of human resources

Data Dispersion Examination

A review of Table 5 shows that the data distribution of all sub-components of the model is normal because the skewness and kurtosis are between (1 and -1).

Table 5 Test of normality of data distribution for model dimensions

Elongation	Scattering [1]	Model Dimensions
0.533	0.633	Input
0.732	0.546	Process
0.289	0.656	Output

Checking the subcomponents' collinearity

Another prerequisite for data analysis is checking the absence of multiple collinearity of variables. To check this condition, the variance inflation factor (VIF) and tolerance are used. So if the inflation factor is above 5 and the

[1] Skewness

DOI: 10.46121/pspc.53.4.17

tolerance is less than 0.1, it means that there is collinearity between the variables. As can be seen in Table 6, the model dimensions do not have a variance inflation rate higher than 5 and a tolerance less than 0.1, so multiple collinearity is not observed between the model dimensions.

Table 6 VIF test for checking the multiple non-collinearity of subcomponents

Tolerance	VIF rate	Model Dimensions
0.433	2.207	Input
0.535	1.870	Process
0.454	2.874	Output

Examining the divergent validity for the dimensions of the research model

One of the methods of measuring this validity is the Fornell-Locker test. Table 7 shows the results obtained for the dimensions of the research model. The following table shows that the constructs are completely separate, that is, the principal diameter values for each latent variable are greater than the correlation of that dimension with other latent reflective dimensions in the model.

Table 7 Fornell-Locker index for examining the discriminant or divergent validity index

3	2	1	Dimensions	Row
		1	Input	1
	1	0/831	Process	2
1	0/886	0/764	Output	3

Model Reliability Tests

Cronbach's Alpha Test:

In fact, internal reliability indicates the level of correlation between a construct and its related indicators, the level of which is set higher than 0.7.

Table 8 Results of Cronbach's Alpha Coefficients

Cronbach's alpha coefficient	Indicators
0/965	Input
0/960	Process
0/925	Output

All Cronbach's alpha coefficients of the variables are greater than 0.7, so the reliability from the point of view of this test is confirmed.

Model Quantification

In this section, considering that it was determined what the dimensions of the model were, the sample size is appropriate, and all the identified dimensions are effective on the desired model, the model will be quantified using the partial squares technique and the bootstrapping t-test, the results of which are shown in Table 9. The above results show that all the coefficients obtained for the dimensions of the model were positive, which can be

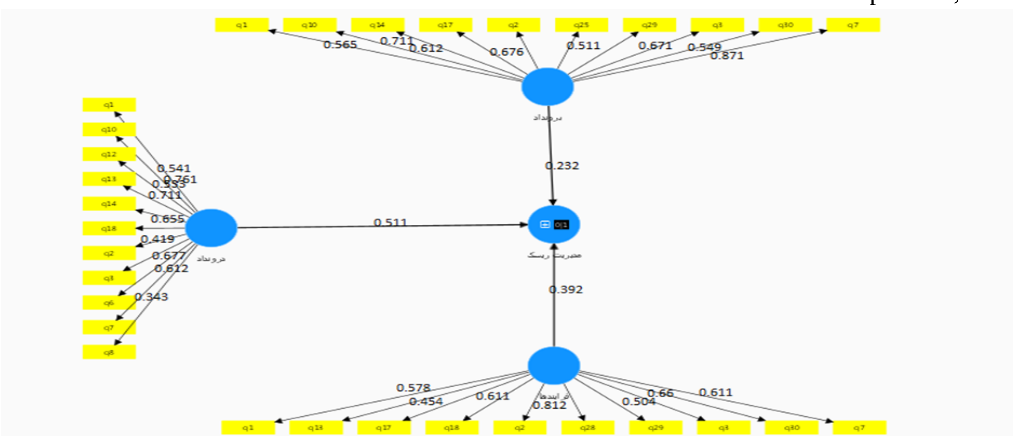

Figure 1 Model in standard mode

 DOI: 10.46121/pspc.53.4.17

concluded that the model is significant and the results obtained can be relied on.

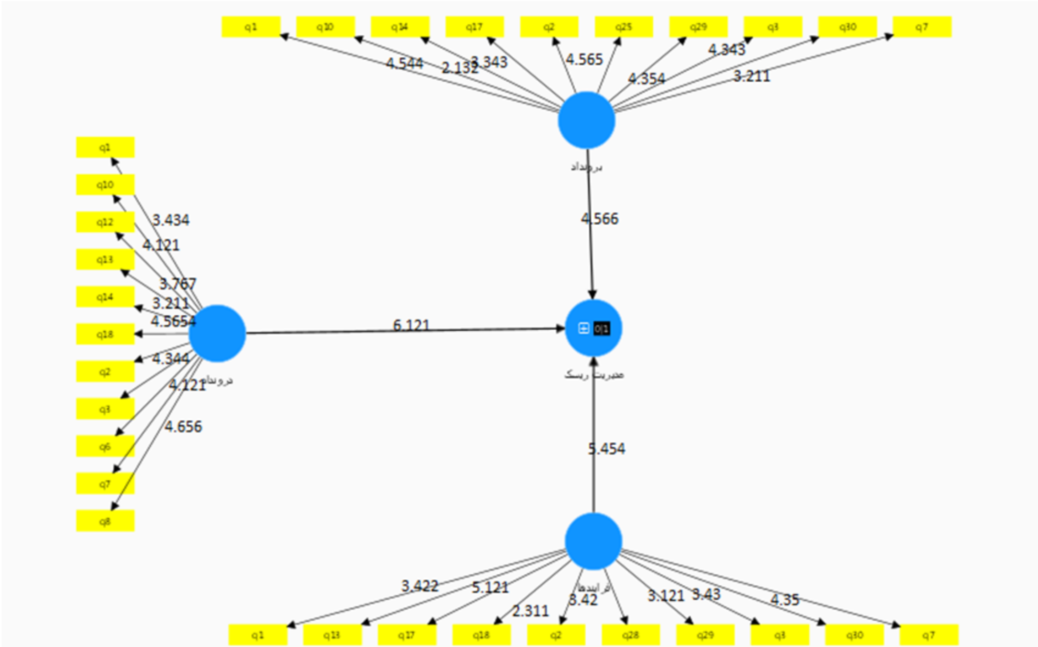

Figure 2 Model in significant state

Table 9 Path coefficients

Significance level	t-value	Coefficients	Path coefficients
0.000	6.121	0.232	Input
0.000	4.566	0.392	Process
0.000	5.545	0.511	Output

Model Fit

Next, goodness of fit indices including GFI, AGFI and RMSEA were used to fit the model. The values obtained in Table 10 show that the model results are reliable.

Table 10 Statistics related to the goodness of fit of the model

Fit indices	Symbol	Criteria	Research values	Fit Result
Chi-square distribution over degrees of freedom	X^2/df	≤3	1.34	Good Fit
Root mean square error of estimation	RMSEA	≤0/08	0.03	Good Fit
Goodness of fit index	GFI	≥0/9	0/94	Good Fit
Adjusted goodness of fit index	AGFI	≥0/9	0/91	Good Fit
Comparative fit index	CFI	≥0/9	0/95	Good Fit
Incremental fit index	IFI	≥0/9	0/93	Good Fit
Soft fit index	NFI	≥0/9	0/92	Good Fit
Non-soft fit index	NNFI	≥0/9	0/96	Good Fit
Coefficient of determination	R2	≥0/67	0/76	Good Fit

DISCUSSION AND CONCLUSION

Human resource risk management should be an integral part of all businesses, regardless of their size or industry. Today, HR professionals need to have a risk management plan in place to help their organization monitor and prevent potential risks. In the event of a potential risk occurring in the organization, a well-prepared risk plan helps the organization mitigate the risk and minimize its impact. Hence, a proper HR risk management plan enables HR managers to deal with employees involved in organizational risks, manage employees within the organization, and also make appropriate hiring decisions. Every HR department should be aware of the various laws and regulations that the organization and its employees must comply with, as organizations may unknowingly

DOI: 10.46121/pspc.53.4.17

fail to comply with them and possibly face lawsuits. As such, it is essential for the HR department to be aware of all local laws and regulations and ensure that all employees comply with them. When welcoming new employees, HR should also take the time to get feedback from new employees about their experience with the onboarding process. If new employees experience a confusing process, it may be difficult for them to understand the important tasks they can participate in. HR risk management goes a long way in keeping the organization and its employees happy and on track to achieve business goals. Therefore, focusing on managing risks related to compliance, the hiring process, and employee growth is critical to organizational success. Value engineering and risk management are inseparable. Risk management creates value for all companies. The goal of value engineering is to select and implement the best performance options, but there is always some uncertainty about the options selected. The goal of risk management is to recognize and manage this uncertainty. It is obvious that risk management cannot completely eliminate the uncertainty in achieving the objectives, but it provides methods for determining the elements that cause this uncertainty so that management can identify and manage them effectively instead of being surprised. With this method, the manager understands the value of the functional elements of the product and, as far as possible, will be able to identify the probability, severity and type of risk phenomena. An integrated risk management and value engineering program allows the definitive cost of quality issues that are difficult to quantify to be calculated and the problem to be analyzed more accurately. Risk analysis is an excellent mechanism for accurately comparing the initial design and the options designed in the value engineering process.

Value engineering has also been proposed for years as an efficient method of optimizing large industrial projects. In value engineering, hundreds of alternatives are created for a problem, but whether we will achieve the desired results or not is another question. Therefore, risk analysis is also considered an inseparable component of value engineering. In addition, value engineering does not conflict with management tools, including risk management. Managers are pressured on the one hand and their responsibility for the area under their authority along with the risk of the proposed options on the other hand, often putting managers in a difficult situation. Applying risk management and value engineering in project management (given the complexity of the project implementation process) can become an irreplaceable tool for identifying and eliminating any item that causes unnecessary costs and waste of time. Without harming the basic functions of the project. Human resource management plays a key role in identifying potential human resource risks related to behavior and performance or ineffective management styles before they occur, and helps HR teams and professionals think through potential scenarios and their outcomes. Effective HR risk management focuses on analyzing the risks that an organization's employees pose to the business, and by planning and implementing the right strategies and preventive measures, it reduces the potential hazards and risks that may arise in the workforce, creating a productive, positive and sustainable work environment. HR risk management examines and assesses the risks and threats related to inadequate management of employees, their behavior, or the risks related to specific methods that HR uses to hire and fire employees. Creating a sense of risk in human resource management is very important to prevent human resource risk as an important part of human resource management of any company or organization, and they must actively identify, prevent and investigate potential risks in order to effectively protect and utilize human capital. Like risk, the role of human resources in businesses is pervasive and pervasive. Human resource management will be effective when it is integrated with the decision-making process at all stages of the business. This factor will cause the identification and recognition of the products produced, financial issues and decision-making processes to have a human impact, for example, which option is created? How are the decisions made implemented? As well as how are they followed up and monitored? It all depends on the people. Separating the management team and employee-related issues from production, financial issues and marketing management will cause frustration for people and create unnecessary risks in the economic activities of the business. To better understand the common relationship between human resource management and risk management, you should first learn the concept of human resource management. This concept includes the process of training, developing, motivating and protecting employees in order to achieve organizational goals. Effective human resource management encourages employees to achieve their own life goals. Human resource management is a process that can be divided into specific categories, some of which are: job analysis, recruitment, orientations and orientations, training, employee-employer interaction, performance appraisal, correction and discipline.

Understanding these categories will help you better understand the relationship between human resource management and risk management. Failure to successfully implement these categories will increase risk and cause irreparable damage to the business process due to the lack of attention to employee participation. The first category of job analysis is writing job specifications. Job analysis determines the tasks and skills required for a person to be able to do a specific job. In this case, the main emphasis is more on what the organization needs to address the issue of who should be promoted or easily recruited to the organization. The tasks that are considered necessary

 DOI: 10.46121/pspc.53.4.17

to achieve the organization's long-term goals determine the tasks and skills required. In summary, job specifications indicate what the employee's activities include (job title, assigned tasks, rewards, skills, knowledge and abilities required to perform the job). In group businesses, the job specifications of group members often include the responsibilities of management and employees of the organization. Such a combination of responsibilities makes career analysis in group businesses important. The second activity of human resource management is recruitment. The goal of this work is to attract those forces who have the ability to perform the task in the desired position in an efficient manner. In today's tight and diverse job market, the recruitment process is one of the most difficult activities of human resource management. The job position must be explained to its prospective applicants with great care and creativity. From among the vast number of job applicants, individuals should be selected whose relationship with the employers will ultimately lead to a successful relationship.

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DOI: 10.46121/pspc.53.4.17