IJRRS
International Journal of Reliability, Risk Saftey: Theory and Application

Online ISSN: 2676-3346

Vol. 5/ Issue 2/ 2022/ pp. 117-126
DOI: 10.30699/IJRRS.5.2.12
Received: 2023.05.06, Accepted: 2023.06.10

Original Research Article

A Risk Assessment Model for Exploitation of New Technologies

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Abstract

Considering the importance of risk assessment for exploitation projects of new technologies in the manufacturing power plant equipment industry in MAPNA Group, a suitable model for assessing the related risks was extracted, along with identifying and ranking the factors affecting it. This study was carried out using the library-field method, and data collection tools were questionnaires and interviews. It should be noted that with the review of the literature and study of the related research along with the expert viewpoints, a number of 78 measured variables affecting the risk assessment model for the exploitation of technologies in the power generation industry were extracted. Finally, 43 measured variables that affect the mentioned model were determined after screening by expert judgment and university professors in the form of 8 latent variables. Then, a questionnaire was developed and distributed among 89 experts in the field of power plant equipment, and the completed questionnaires were collected. To test the research model's validation and goodness of fit (GOF), the variables and their effects, confirmatory factor analysis using structural equation modeling and Smart PLS software were used, and 24 measured variables were accepted. In addition, paired comparisons with the analysis of the network process and Super Decision software were used to prioritize the variables affecting the risk assessment model for the exploitation of new technologies in power plant equipment industry. The results show that the risk assessment model for exploiting new technologies in the power plant manufacturing industry includes 7 latent variables: 1- Operational and Processes 2-Human 3- Technical and Technological, 4- Environmental and Industrial, 5- Strategic, 6- Financial, and 7- Managerial. Also, ranking showed that variables such as Technical and technological, Operational and Processes, and Human ranked first to third, and financial variables ranked last.

Keywords: Risk; Risk Assessment; New Technology; Power Generating Industry; MAPNA Group.

1. Introduction & Literature Review

The increasing speed of changes, customer needs and demands, and globalization prioritize risk management for pioneer and prospective companies. To survive in the market, having efficient and proper tools for the identification and assessment of the important risks in the business are considered the keys to management control in an organization. Due to rapid changes in today's environment, individuals and organizations cannot recognize the unknowns properly. Decision-making time has become shorter, and resource constraints often worsen the effects of unmanaged risks in organizations. The more enterprises understand and identify the risks, the better they can manage them and prevent unwanted events. In fact, risk assessment creates greater border profits for the organizations, less precautionary reserves incorporated in the business, more available resources for other activities, and more investment opportunities become possible for the organization.

Utilization of new technology in an organization shall certainly follow an investment. Actually, the leading organizations with the empowerment of research and development create technologies, and the followers sometimes do not have any other choice of collaboration to take advantage of the new technology unless to purchase and transfer it. After the transfer and in the stage of absorption and utilization of the latest technology organization should enhance its capabilities from the aspects of installation, manufacturing, adaptation, and domination of the technology. Therefore, investors shall be aware of this kind of innovation risk after technology transfer.

To ensure the reach of the highest level of efficiency from the capabilities, organizations shall identify the risks related to the process of the new technology utilization and determine the proper responses. Otherwise, the cost of failure in adopting and utilizing the latest technology in the organization increases, and the organization fails to achieve its financial and strategic goals resulting from the

investment in purchasing and transferring the new technology [1].

After a decade of E-class gas turbine technology transfer and its utilization in producing more than 25 thousand megawatts of electricity in Iran, now, after the changes in international political conditions, the power segment in MAPNA Group quickly decided on the technology transfer of class **F** turbine technology. Still, no risk assessment about this operational program has been done at the center of the decision-making committees. It is clear that sometimes organizations may not be able to identify the risks of the new technology utilization and provide them with appropriate responses and even receive proper and precise feedback in time cycles. Still, the least they are expected to do is to identify and assess the risks of such programs in the form of a determined system or a framework. A model can help to a great degree to identify and evaluate the exploitation risk of new technology in the field. However, the real question is how a risk assessment model for exploiting new technologies in the power plant equipment manufacturing industry could be.

It is noteworthy that power plant equipment, especially the power block equipment including turbine and generator, is considered a hi-tech product, and regarding the very high amount of investment in transferring such manufacturing lines and equipment and also the great need of achieving business and strategic objectives, risk assessment of absorption and utilization of this type of technologies is essential for the organization. Suppose there is no risk assessment of the process of production and utilization of these technologies. In that case, it can lead to high levels of waste in the organization's resources and even prevent the organization from achieving the predetermined financial and market targets. This study aimed to provide MAPNA Group, in the field of power plant equipment manufacturing, with a framework to assess the risks of exploiting new technologies to increase the likelihood of achieving greater predetermined financial and strategic objectives of such technology transferring and investment.

This research was innovative for the following reasons:

1. So far, no model has been extracted for risk assessment of new technologies utilization in the power plant equipment industry, and it is for the first time that a study has tried to extract a model and identify factors affecting it.
2. This study was conducted in the MAPNA Group Company for the first time in Iran.
3. For the first time, detecting the factors affecting the risk assessment model of the new technologies was carried out using confirmatory factor analysis and structural equations.

Uncertainty and unreliability are inherent concepts of risk. These terms have dozens of synonyms and are separated from each other proportionately. However, the distinction of these terms is fruitful in the field of risk assessment scale. To be uncertain refers to the conditions in which we do not know what we have identified are possible to occur in real situations or not. This type of uncertainty could be determined when there is a probability of the incidence. The term unreliable includes the assessment of probabilities. Where they are applicable, their expected statistical frequencies will be known. In a case, these two uncertainties are known as doubt (in the sense of an unknown) or cognition (due to the lack of knowledge). While receiving the results scale of the risk assessment, it is very important to know whether a risk had been out of doubt or cognition [2].

Risk is the cumulative impact of the possibility of uncertain events that may affect the project's objectives positively or negatively. In addition, the risk is the amount of exposure to negative events and the likely consequences of these events [3].

Generally, there are two types of risk: (a) business risk (loss and profit), i.e., where there are both the profit and loss aspects, and (b) insured (pure) risk or insurable risk, where there is only the loss aspect of risk. Anything with less than one hundred percent certainty is considered a risk, and anything that can be considered a reality without a doubt is not considered a risk [4].

Based on deeper concepts of risk, organizations face three types of risk:

1. Enterprise risk is caused by a conflict of interest or the misalignment of the interests of shareholders, investors, managers, and the organization's structure.
2. Business risk resulting from unpredicted behaviors of the competitors and customers.
3. Innovation risk resulting from the use of new technology [4].

Risk affects the production capacity and product availability in the exploitation of technologies [5,6,7,8]. Risk is important in accessing production and product availability regarding maintenance and repair [5,9]. On the other hand, [5,10,11,12] emphasized risk factors related to demand, market studies and forecasts of market share and their effects on the success of exploitation of new technologies. Quality risk and achieving adoption, introducing new products, and product portfolio management, as well as branding and differentiating, are very important in exploiting new technologies [7]. Also insisted on the risks of the price fluctuations of water, electricity, and fuel in technology exploitation [5,6,13].

In the research conducted by [9,11,14], risks of collaborations, as well as supplier management, were regarded as important and were taken into consideration. One of the most significant risk factors of success in the exploitation of technology and especially new technologies, according to [11,12,14,15], is the sales risk, the risk factor of selling manufactured products using the new technology and its great effect on business success and technology transfer projects and exploiting it.

Amongst the risk factors in the exploitation of technologies from the perspective of [9] are the correct

design of the processes, the creation of proper organizational structure, and the existence of guidelines and procedures for better implementation of the processes. In addition to the above, in one such study in the area of risk and technology by [16], management risk factor, specifically decision-making risk, has been emphasized. Moreover, in the research conducted by [6,7,13,17], there has been a lot of emphasis on the risk factors of environment and safety and the related effects on the exploitation of new technologies. [17,18] pointed out the political and social risk factors and their impact on utilizing new technologies in organizations.

The risk factor of time-to-market has been determined by [14,16,19] as one of the factors affecting the successful exploitation of new technologies in organizations. Finally, the factor of financial risk and cost management, and budget control were emphasized as the factors of the effective operation of new technologies in organizations [8,16,18].

2. Research Method

Since this research aimed to use the existing knowledge of the MAPNA Group Company experts and to help its managers in the field of exploitation of new technologies, in terms of objective, it is applied research. In addition, because the data were collected by questionnaires and visiting experts of the power plant equipment industry, the research is a descriptive survey. On the other hand, the study was conducted specifically in MAPNA Group Company; from this perspective, it is also a case study. The study population was the managers and experts of the MAPNA Group Company, and 89 people were determined to complete the questionnaire. To collect the data, field, and library studies were also used. The primary conceptual model of the survey obtained through literature review and the analysis of the previous research as well as the experts' view of the MAPNA Group Company, is presented in Figure (1).

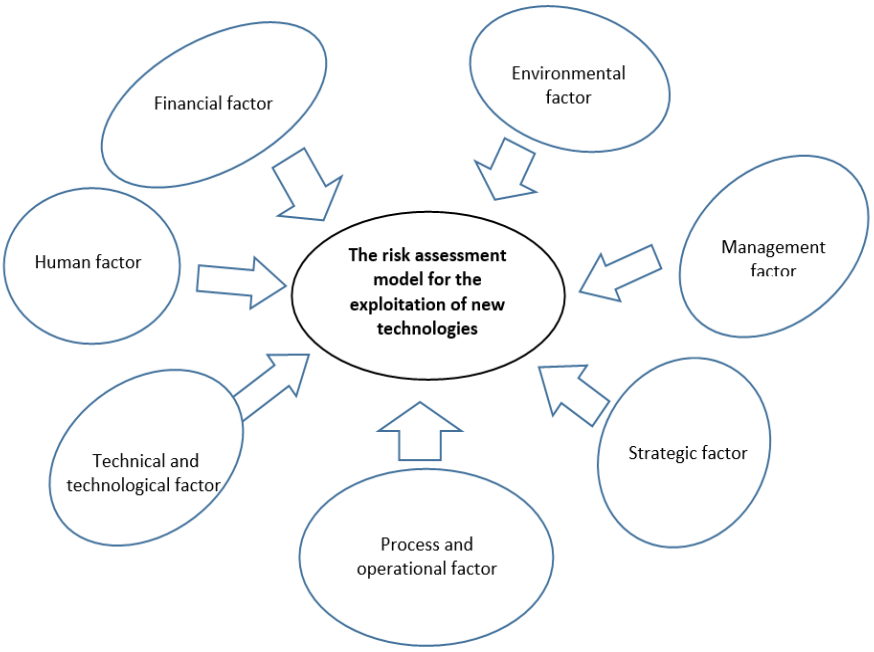

Figure 1. The conceptual model of the research

Regarding the objective, title, and conceptual model of the research, the questions and hypotheses of the study are as follows:

2.1 Questions:

1. What factors affect the risk assessment model for exploiting new technologies in the MAPNA Group?
2. How is the risk assessment model for exploiting new technologies in MAPNA Group?
3. In what order were the factors affecting the risk assessment model of exploiting new technologies prioritized?

2.2 Hypotheses:

Each of the identified factors significantly impacts the risk assessment for the exploitation of new technology in MAPNA Group.

3. The Findings of the First Research Question

To answer this question, the questionnaire with 43 questions, confirmed by experts, was used, and validation of the research model was analyzed using the results of structural equations and Smart PLS software. Figure (2) shows the basic research model with factor loadings.

Figure 3 also shows the assessment model after fitness with a significant coefficient Z. All questions with a factor loading lower than 0.7 were excluded from the research model. In this study, considering Figure (2) and maintaining factor loadings above 6.5 while observing overlap, 19 factors were excluded for the homogeneity of the study model.

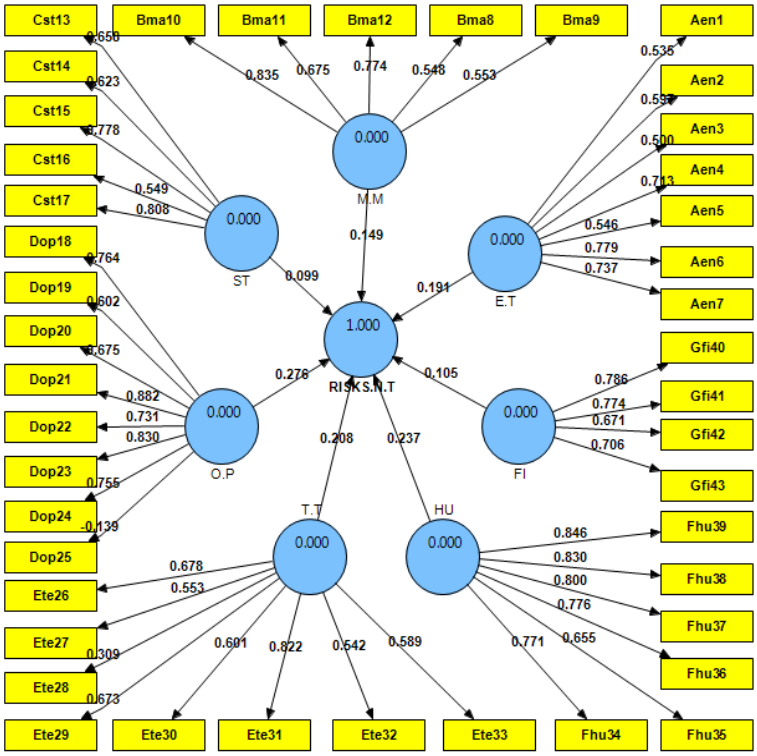

Figure 2. The primary structural equations, along with factor loading coefficients

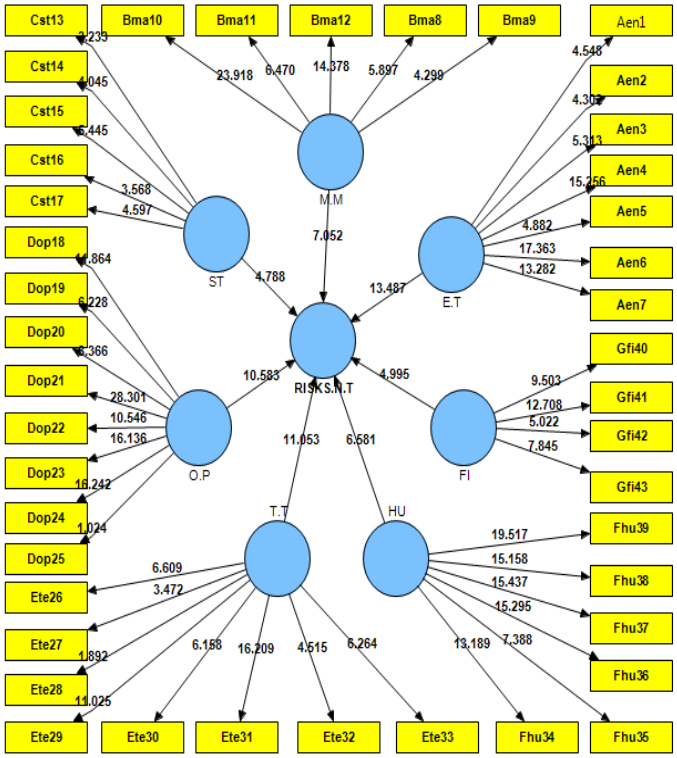

Figure 3. The assessment model after fitness with significance coefficient Z

The results of the reflectance model measurement, structural model, and overall model are summarized in Table 1. Finally, Figure 4 shows the structural model in the state of significant path coefficients, and Figure (5) shows the structural model in estimating the path coefficients.

According to the above table, the factors and indicators affecting the risk assessment model for exploiting new technologies in the power generation industry are according to Table (2).

4. The Findings of the Second Research Question

According to Figures (4) and (5), the risk assessment model for the exploitation of new technologies in the power plant equipment industry was obtained according to Figure (6).

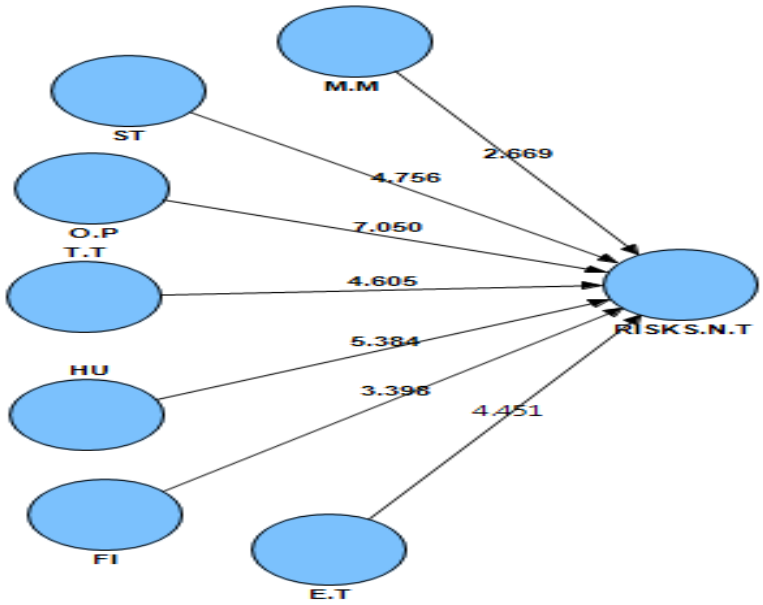

Figure 4. The structural model in the state of estimating the coefficients of the path (standard)

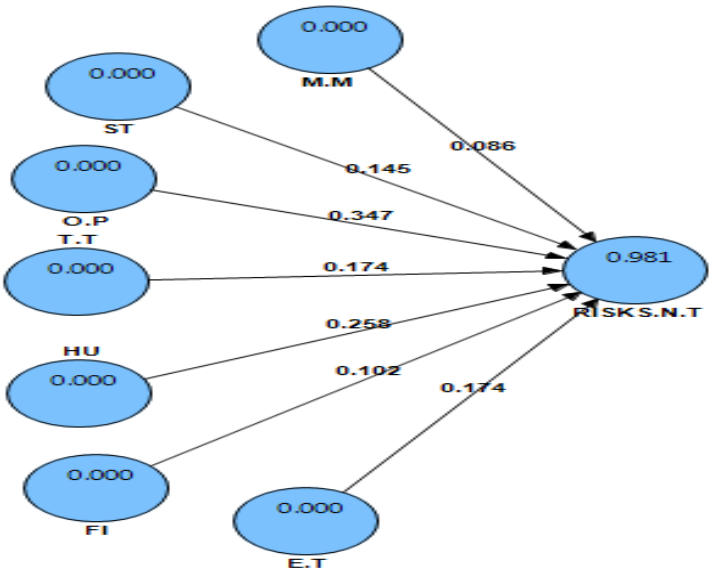

Figure 5. The structural model in the state of meaningful coefficients of the path

Table 1. The results of the fitness test of the research model

Model	Test type			Acceptance criteria	Test result
The analysis of reflectance model measurement	Homogeneity test			Factor loadings of all factors shall be above 0.7	Exclusion of 19 factors with factor loadings below 0.7
	Reliability Test	Cronbach's alpha		Greater than 0.7	OK for all factors
		Composite reliability		Greater than 0.7	OK for all factors
		Shared reliability		Greater than 0.5	OK for all factors
	Validity test	Convergent validity	Meaningful	T Value is above the absolute value of 1.96	OK for all factors
			Homogeneous	All factor loadings after fitness are above 0.7	OK for all factors
			AVE	Above 0.5	OK for all factors
			CR> AVE	The composite reliability for factors is above the AVE	OK for all factors
		Divergent validity	Transverse load test	Factor loadings of all observed variables on the corresponding latent variable shall be at least 0.1 more.	OK for all factors
			Fornell and Lorcker test	AVE root for each factor has been more than its correlation with other reflected factors in the model	OK for all factors
			Quality testing of the assessment model	Shared index coefficient of variation with three poor 0.02, average 0.15, and 0.35 strong values	Quality of measurement has been strong for all factors.
Analysis of Structural Model	Significance coefficient			T value for all relationships between independent and dependent variables shall be greater than the absolute value of 1.96	OK for all research relations
	The coefficient of determination R2			The coefficient of determination values: Strong 0.67, average 0.33, and weak 0.19	The coefficient of determination 0.98 has been strong.
	Predictive Relationship Q2			The coefficient of determination values: Strong 0.35, average 0.15, and weak 0.02	Predictive power was equal to 0.272 and on an average level.
Analysis of the overall model	GOF			The coefficient of determination values: Strong 0.35, average 0.15, and weak 0.02	Equal to 0.798 and very good fitness of the overall model

Table 2. Factors and variables affecting the model for risk assessment of exploitation of new technologies in MAPNA Group

Factors	Code	Factors affecting the risk assessment model for the exploitation of new technologies	Code	Factor Loading (Final)	r^2
Environmental and Industrial	ET	The risk of changes in the specific circumstances of an industry	aen4	0.772	0.595
		Risk of violations of environmental laws and health and work safety rules	aen6	0.826	0.682
		Risks related to international trade, such as non-compliance with international trade rules	aen7	0.833	0.693
Managerial	MM	Risks related to reputation and lack of appropriate imagery in the mind of the customer	bma10	0.846	0.715
		Risks related to the lack of effectiveness of R&D in the organization	bma11	0.791	0.625
		Lack of proper pricing for the products of the new technologies	bma12	0.822	0.675
Strategic	ST	Risks relating to the absence or lack of marketing strategy coordination with the company's overall strategy	cst15	0.836	0.698
		Risk of failure to correctly define objectives and executive plans	cst17	0.879	0.772
Operational and Process	OP	The risk of lack of foresight and careful and timely planning for the supply of spare parts and semi-finished parts	dop18	0.754	0.568
		Risks relating to the mastery of new technology	dop21	0.873	0.762
		Risk processes necessary to ensure the realization of production within budget	dop22	0.762	0.580
		The risk relating to designing and implementing the necessary processes to achieve a stable level of production	dop23	0.842	0.708
		The risk of the complexity level of the technology used	dop24	0.803	0.644
Technical and Technological	TT	The risk of production of reliable, timely, accurate, and mechanized information	ete26	0.748	0.559
		The risk of feasibility studies phase in technology transfer projects	ete27	0.653	0.426

		The risk of the launch of production of the new technology	ete31	0.866	0.749
Human	HU	The risk of failure of inappropriate incentive systems	fhu34	0.781	0.609
		The risk of not being able to train key personnel and experts to exploit new technologies	fhu36	0.803	0.644
		Risk of education issues	fhu37	0.820	0.672
		The risk of lack of succession planning for key positions	fhu38	0.827	0.683
		The risk of employment of efficient and key personnel	fhu39	0.847	0.717
Financial	FI	Risk of debt repayment and loans of transferring the new technology	gfi40	0.828	0.685
		The risk of severe currency fluctuations	gfi41	0.807	0.651
		The risk of mismanagement of intellectual property rights and registration of patent	gfi43	0.698	0.487

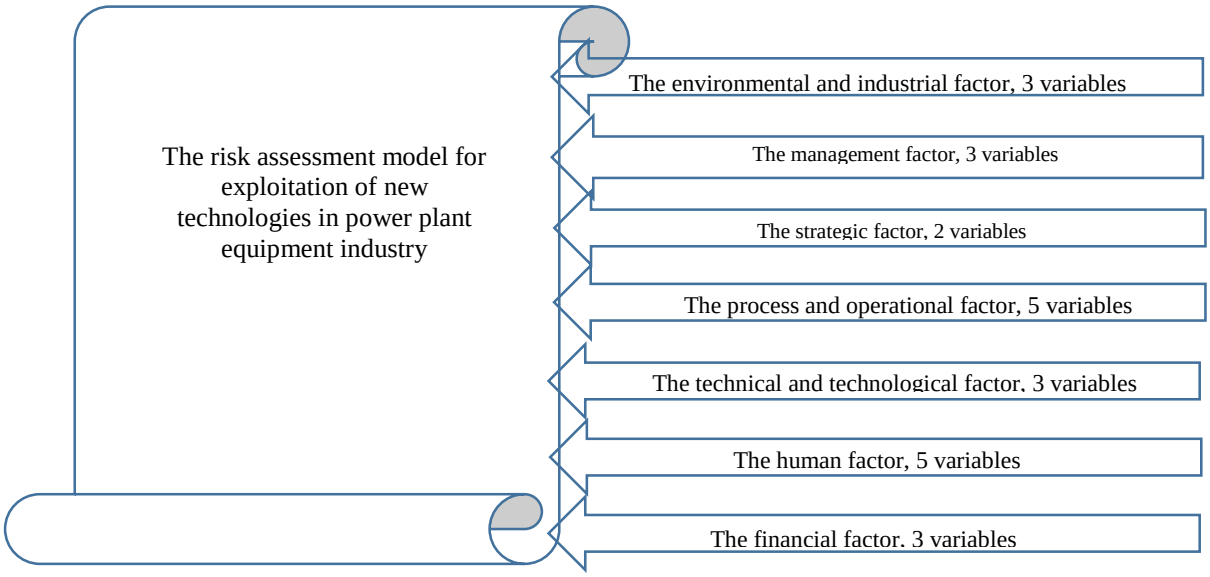

Figure 6. The risk assessment model for the exploitation of new technologies in the power plant equipment industry

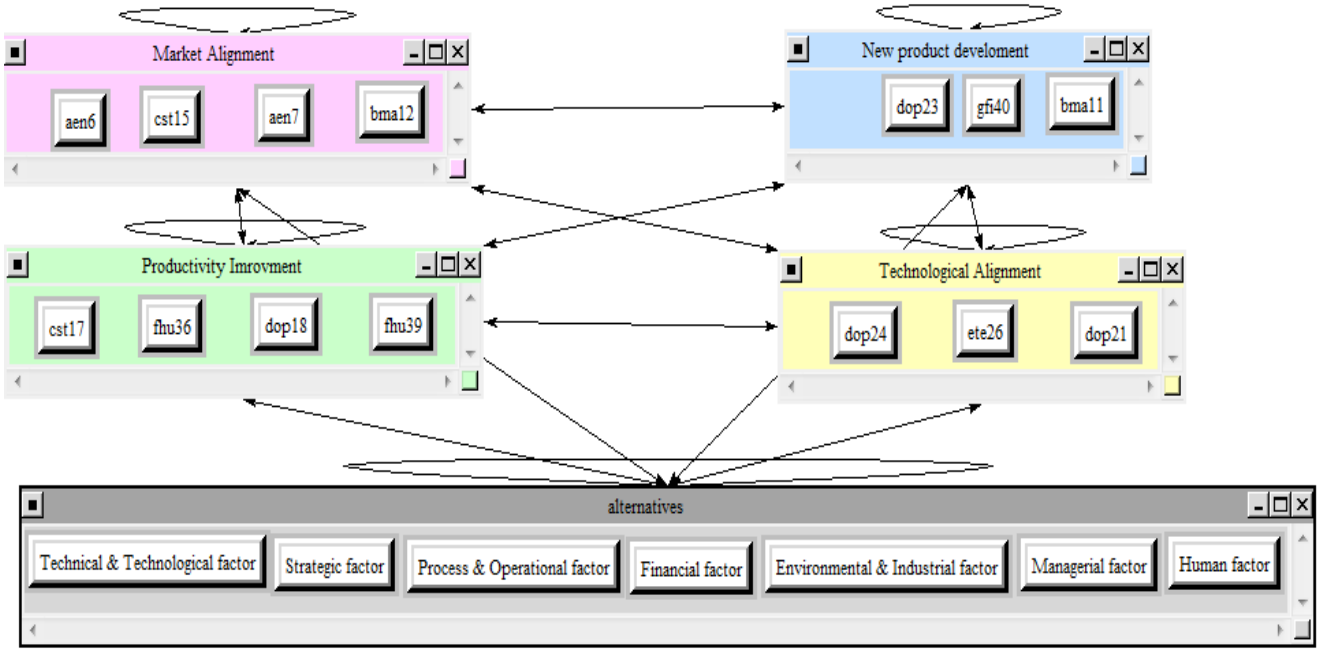

Figure 7. ANP Network to rank factors affecting the risk assessment for the exploitation of new technologies

5. The Results of the Third Research Question

To prioritize factors of analysis of network process (ANP) and Super Decision software, it was acted in accordance with the following steps:

To prioritize factors affecting the risk assessment for the exploitation of new technologies, an analysis of the network process ANP was used. To do so, the views of 7 experts in the MAPNA Group were used, and after completing the questionnaire of paired comparisons by them, to sum up, the results, the geometrical mean was used, and the results were entered into the Super Decision software. The validity of the questionnaires of paired comparisons was confirmed using expert judgment. Considering that the software shows that the coefficient of variance is below 0.1, the reliability was also established.

1. The analysis of network process ANP stages was carried out. Super Decision software was used to analyze the model and prioritize the views and research indices. The structural model using the conceptual model of the research formed the main clusters. Within each cluster, the factors were set which had interfaces as nodes and were related to other nodes within the cluster. Figure (7) shows the structure of the proposed model and the type of relationship between the components in the Super Decision software.
2. The relative weight of the ANP was determined through paired comparisons of the criteria and sub-criteria to compare possible interactions in the network. In this study, weighting the criteria and factors of the ANP model was done based on the expert questionnaire used in the network analysis and multi-criteria decision-making. The method of weighting the criteria in the ANP model was based on the numerical range 1 to 9. The super weight matrix was formed based on the paired comparison, and vector systems were defined and determined, weighing each criterion and factor. Figure 8 presents the results of weighing factors and their impact on the pattern of risk assessment in Super Decision software.

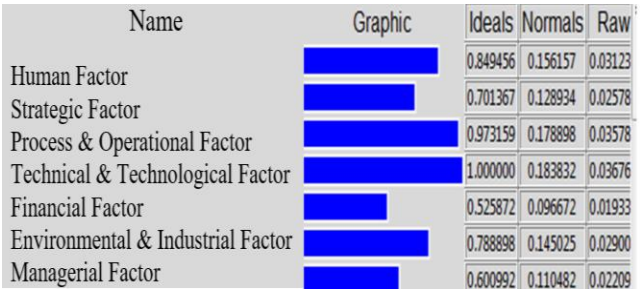

Figure 8. Prioritizing factors affecting the risk assessment for the exploitation of new technologies using ANP

6. Analysis of the Hypothesis

According to the data from the questionnaires and using the output of the significance coefficient of PLS software, it is observed according to Table (3) that all significant coefficients between factors are above the absolute value of 1.96, and this shows that all factors affecting the pattern of the risk assessment model for the exploitation of new technologies in the power generation industry were approved with a significance level of 0.95.

Table 3. The results of hypothesis testing

Factors	Significance coefficient	Result of hypothesis testing
Operational & Process	0.120	Confirmed
Human	0.066	Confirmed
Technical & Technological	0.030	Confirmed
Environmental & Industrial	0.03	Confirmed
Strategic	0.021	Confirmed
Financial	0.01	Confirmed
Managerial	0.007	Confirmed

7. Discussion and Conclusion

This study was conducted to extract a risk assessment model for exploiting new technologies in the power plant equipment industry. The conceptual model resulting from the research can be used in power generation equipment manufacturing companies and power blocks in order to assess the exploitation of imported technologies. This research recognized 24 variables in the form of 7 factors. The results showed that all 7 factors significantly impact the risk assessment model for exploiting new technologies in the power plant equipment industry. According to the findings of the output of Smart PLS software, variables with more r^2 based on Table (2) have a higher share of variance explanation and strengthening and predicting the behavior of the relevant factors; therefore, they require special attention. According to the results presented in Table 2 and Figure 2, the following recommendations are offered:

In technical and technological factors, the risk variable related to the launch of the new technology's production had the most effective share of r^2=0.749 than other variables. To strengthen the strategy, it is proposed to pay more attention to the information technology strategy in the organization. As a result, the production of mechanized information and the creation of integration in different sections of the operation can cause agility and increased productivity in the organization. It is also proposed that the organization defines a project of organizational architecture in operational programs in line with the integration strategy. Also, In the operational and processes factors, the risk variable related to the

mastery of new technology had the maximum total contribution of r^2=0.762 than other variables in the risk assessment model for new technologies. To strengthen the factor, the organization is proposed to take full advantage of and complete functional modules of comprehensive planning of enterprise resources.

In the human factor, the risk variable related to the employment of efficient and key personnel had the largest impact share of r^2=0.717 than other variables. Regarding the control of human factor risk, it is proposed that the organization accurately diagnose human resources management processes and defines improvement projects for all employment, development, training, and motivational systems. Also, in environmental and industrial factors, the risk variable related to the international trade rules and terms of trade had the most effective contribution rate of r^2=0.693 than other variables. It is suggested that to strengthen the factor and to control the corresponding risk, the organization obtains advice from the experts before contracting for the transfer of technology, which contains terms of business activity and market (Territory).

In the strategic factor, the risk variable related to the lack of proper definition of objectives and action plans had the largest impact share of r^2=0.772 than other variables. Regarding the control of the risk of strategic factors, the following are offered: (1) Correct definition of strategic objectives and period reviewing of them based on market and business changes as well as the changes in the policy and terms in the field of power, (2) monitoring the objectives and budget control as tools for the review of the strategic map as an obligation by the organization. Also, In the managerial factor, risk variables related to the brand, reputation, and lack of appropriate mental imagery of the customers had the largest impact share of r^2=0.715 than other factors. To strengthen the factor and control the corresponding risk, it is suggested that the organization takes necessary actions to define the projects of strengthening mental imagery and identity creation through recognizing axial merits and using them in the B2B and B2G markets.

Regarding financial factors, the variable of risk associated with the repayment of loans related to the transfer of technology had the maximum total contribution of r^2=0.685 than other factors. To strengthen the factor and to control the related risks, it is offered to consider the type of business - B2G and B2B- in addition to the point that mainly the negative cash trend of such business in the current conditions causes problems in the repayment of this type of business. Therefore, the organizations must increase the possibility of cash investment of technology transfer in cooperation with JV (Joint Venture) through accurate advice in the related contracts.

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