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ORIGINAL RESEARCH ARTICLE

Identifying and prioritizing investment risks in digital markets using multi-criteria decision making techniques and data mining

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ABSTRACT

The ever-increasing advancement of technology and the adaptation of the common people's lifestyle have led to the emergence of digital markets and the removal of restrictions such as physical presence, specific working hours, etc. Investing in digital markets, as it can be more profitable (compared to previous methods), is also associated with many risks. In this research, the importance of multi-criteria decision-making and data mining and the need to use them in investing in digital markets were investigated. The statistical population of this research was collected over a period of 5 years during the years 2017–2022. For this purpose, SPSS software, the AHP technique, and data mining were used. The research results showed that both in the AHP method and in the data mining method, the receiving and payment portals are the most important.

Keywords: investment risk; digital markets; AHP, data mining

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1. Introduction

One of the most important issues in the economy of any country is the capital market of that country. The investment market is a market that every institutional or individual investor is facing for economic decision-making and ultimately investing in their proper investment. Risk and return are two essential components that have a significant impact on investors financial decisions. Investors are always looking for higher returns and suffer less risk. Stock returns include cash profits, stock price changes, and the risk of measuring uncertainty in achieving expected returns. Also, one of the most important issues in the capital market is the awareness of the risks of companies, especially the systematic risk that plays a significant role in decision-making. Because it is believed that the expected return on corporate stocks is a function of systematic risk. It reflects changes in the return rate of one share compared to the total return market rate. This research was conducted with the aim of identifying and prioritizing investment risks in digital markets.

2. Statement of the problem

It is clear that the new digital realities are closer than they seem. In this rapidly changing world, the winners will be those who can anticipate and react to change, create, and deliver value. For the new customer, be innovative and competent enough to take advantage of the new opportunities created by digital technologies. With the ever-

increasing progress of science and technology and the expansion of the world of communication, all organizations seek to provide as much as possible and provide better services to their customers so that they can avoid theft. While respecting the unique principle of protecting customer rights and using human-made technologies, they lead their competitors. It is to give their customers the possibility to do business with ease and in the shortest time without being physically present in a specific place in the economic field that has a very high risk. Due to the unique features of such an ecosystem, institutions must move on the path of digital transformation and provide innovative financial services in order to survive and progress in a competitive environment. According to the forecast of the research institute Accenture, IBM, and Kichmini Management Consulting Group, the most important drivers of digital technology that play a key role in digital transformation are cloud computing (big data), artificial intelligence and machine learning, the blockchain chain (the Internet of Things), and social media. It is predicted that by taking advantage of all these digital drivers, the digital transformation will take place at a faster pace in the next decade.

3. Significance of the study

Digital transformation has been creating fundamental changes in technology, society, and business models for several years, and if we want to look at these changes from the perspective of "digital Darwinism", the size and long history of a company will no longer guarantee its survival. And only those who are able to survive are able to adapt to new conditions. The evidence shows that resistance and inflexibility in these conditions have resulted in failure in almost all cases. The dimensions of this broad wave of change and transformation are all, in addition to the five trends of changing needs, behaviors, and expectations of customers, technological changes, intensifying competition in the market, changing the cost basis, the new activity ecosystem, and the new rules and regulations governing it. It is important to mention that digital technologies have brought about major changes. In addition to the changes in the way financial services are provided and the risks associated with them, the lack of laws, requirements, and restrictions also brings other risks. The following can be mentioned:

- Losing part of the market share due to new competitors;
- Excess pressure on profit margins as a result of lower revenue;
- Increased operational risk.

—emergence of new market players offering high-quality, cheaper, and more convenient innovative financial services.

These risks are related to the development of fintech companies, which require the special attention of financial market observers. The field of fintech is very wide and covers almost all aspects of the financial system. It is necessary to prepare for changes in the business process in order to avoid It is a very basic and important approach to failing in the competitive market and keeping pace with the path of innovative transformation.

4. Research background

Taghipour et al.[1] studied “Risk analysis in the management of urban construction projects from the perspective of the employer and the contractor.”

Mahboobi et al.[2] discussed “Assessing ergonomic risk factors using combined data envelopment analysis and conventional methods for an auto parts manufacturer”, occupational injuries are currently a major contributor to job loss around the world.

Taghipour et al.[3] studied “The impact of ICT on knowledge sharing obstacles in knowledge management process (including case-study).”

Khalilpour et al.[4] studied "The impact of accountant's ethical approaches on the disclosure quality of corporate social responsibility information an Islamic perspective in Iran."

Mirzaie et al.[5] studied "The relationship between social bearing capacities with conflict as a result, in the perception of the visiting historical sites."

Alamdar khoolaki et al.[6] studied "Effect of integrated marketing communication on brand value with the role of agencies reputation (including case study)."

Taghipouret et al.[7] studied "A survey of BPL technology and feasibility of its application in Iran (Gilan Province)."

Mohammad et al.[8] studied "Assessing the effect of the FRP system on compressive and shear bending strength of concrete elements."

Jalili et al.[9] studied "Comparative study of Khaje Rashid al-Din views on Rab-e Rashidi Islamic Utopia and Kevin Lynch ideas."

Taghipour et al.[10] studied "Insurance performance evaluation using BSC-AHP combined technique."

Rezvani et al.[11] discussed "The design of high-rise building with ecological approach in Iran (Alborz Province)."

Taghipour et al.[12] studied "The identification and prioritization of effective indices on optimal implementation of customer relationship management using TOPSIS, AHP methods."

Taghipour and Yazdi[13] studied "Seismic analysis (non-linear static analysis (pushover) and nonlinear dynamic) on Cable-Stayed Bridge."

Taghipour et al.[14] studied "Investigating the relationship between competitive strategies and corporates performance (case study: Parsian Banks of Tehran)."

Taghipour and Moosavi[15] studied "A look at gas turbine vibration condition monitoring in region 3 of gas transmission operation."

Rahmani et al.[16] studied "Providing health, safety and environmental management (HSE) program in metal mining industry (including case study)."

Taghipour and Vaezi[17] studied "Safe power outlet."

Tarverdizadehet et al.[18] studied "Predicting students' academic achievement based on emotional intelligence, personality and demographic characteristics, attitudes toward education and career prospects through the mediation of academic resilience."

Azarian and Taghipour[19] studied "The impact of implementing inclusive quality management on organizational trust (case study: education)."

Ghadamzan Jalali et al.[20] studied "Explain the relationship between intellectual capital, organizational learning and employee performance of Parsian Bank Branches in Gilan province."

Mohammadi et al.[21] studied "Investigating the role and impact of using ICT tools on evaluating the performance of service organizations."

Abdi Hevelayi et al.[22] studied "Predicting entrepreneurial marketing through strategic planning (including case study)."

Arsalani et al.[23] studied "Investigating the effect of social media marketing activities on brand awareness."

Khorasani and Taghipour[24] studied "The location of industrial complex using combined model of fuzzy multiple criteria decision making (including case study)."

Taghipour et al.[25] studied "Risk assessment and analysis of the state DAM construction projects using FMEA technique."

Hoseinpour et al.[26] studied "The problem solving of bi-objective hybrid production with the possibility of production outsourcing through Imperialist Algorithm, NSGA-II, GAPSO Hybid Algorithms."

Taghipour and Ahmadi Sarchoghaei[27] studied "Evaluation of tourist attractions in Bourujerd County with emphasis on development of new markets by using Topsis Model."

Hashemi et al.[28] studied "The effect of personal factors on increasing the productivity of low-level employees in the General Welfare Department of Tehran Municipality."

Safdarpour et al.[29] studied "The effect of government support on innovation ability (including a case study)."

Ganjali et al.[30] studied "Strategic analysis of household hazardous waste reduction."

Taghipour et al.[31] studied "The impact of managerial factors on increasing the productivity of low-level employees (including case study)."

Ganjali et al.[32] studied "Investigating the relationship between environmental awareness and the level of education and occupation of people."

Baghipour saramiet et al.[33] studied "Modeling of nurses' shift work schedules according to ergonomics: a case study in Imam Sajjad(As) Hospital of Ramsar."

Moradi Lalekaei et al.[34] studied "Measurement of the country of origin of the brand of branding and brand loyalty."

Taghipour et al.[35] studied "Investigating the effect of intelligent ordnance on the level of learning/teaching (including case study)."

Taghipour et al.[36] studied "The study of the effect of smart schools on the level of learning-teaching in high school."

Taghipour et al.[37] studied "The impact of motives from obtaining ISO 9001 certification on organization performance (including case study)."

Taghipour et al.[38] studied "The impact of working capital management on the performance of firms listed in Tehran Stock Exchange (TSE)."

Habibi et al.[39] studied "Designing a smart model for managing Iranian chain stores based on business intelligence (case study of Proma chain store)."

Safdarpour et al.[40] studied The effect of communication on learning ability (including a case study).

Taghipour[41] studied "Modeling the application of knowledge management system in order to improve the technology governance in the automotive industry of Iran using the data mining environment."

5. Statistical population and sampling volume

The statistical population of this research is a period of 5 years during the fiscal years 2017–2022. The number of studied companies, or the size of the statistical population, was 265.

6. Research questions

The present research was conducted in order to identify and prioritize investment risks in digital markets using multi-criteria decision-making techniques and data mining. This research was done to answer these questions:

What are the risks of investing in digital markets?

7. Descriptive statistics

Data analysis was investigated at two descriptive and inferential levels. SPSS software was used for this purpose.

Demographic characteristics of the samples:

A) First part

In this section, the absolute and relative frequencies of gender variables, age, and education levels of the respondents are investigated, which included 25 experts, by using the Delphi method, it was investigated which of the indicators should be are considered and acceptable. In the second place, the probability value of each variable was estimated, and at this stage, questionnaires were distributed and collected among the samples of this research. **Figure 1** shows the descriptive statistics of respondents, pie chart (age category).

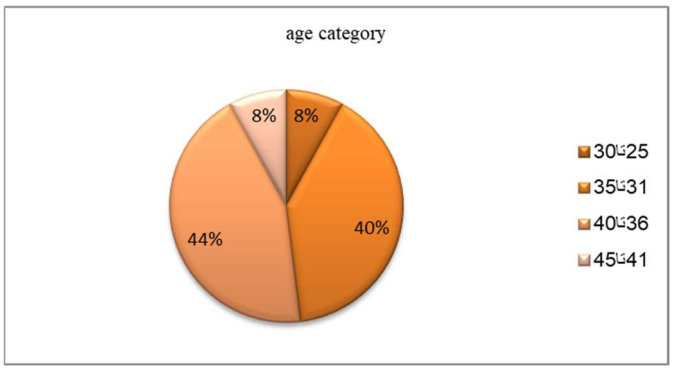

Figure 1. Descriptive statistics of respondents, pie chart (age category).

In a similar way, education and gender were also investigated.

B) The second part

In this section, the study samples of managers and experts on the demographic characteristics in this section are as follows.

Table 1. Absolute and relative frequency of demographic characteristics.

Percent frequency	Property	The number of repetitions
0/40	10	Female
0/60	15	Man
0/100	25	Total

It is done in the same way as education and age. **Figure 2** shows the descriptive statistics of respondents, pie chart (age).

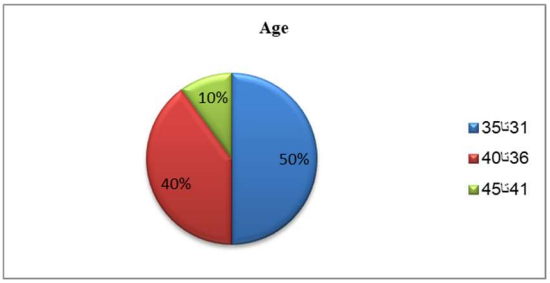

Figure 2. Descriptive statistics of respondents, pie chart (age).

They were examined in the same way as education and gender.

8. Inferential analysis (criteria identification)

Initial verification of primary variables (Delphi)

In this section, the identification of factors is actually the same as the as the indicators and risk criteria for insurance coverage. The Delphi method consists of participants who were selected because of their expertise in the subject, which in the present study includes managers, investors, and analysts. In this method, a series of researcher-made questionnaires are used in order to reach a consensus of opinion. In the first stage, the respondents determine their views and the main issues. In this section, in order to take advantage of the experiences and views of previous experts, it is done to examine the theoretical foundations. In other words, all the criteria that have been mentioned as possible important factors are evaluated by the experts, and finally, the desired criteria are presented to them to receive the opinions of the experts, the initial criteria that are also used to derive them from theoretical bases. are as follows.

Table 2. Risk factors and indicators on investment.

Row	Indicator
1	gender
2	The age of the investor
3	investor
4	Net assets of the company
5	Alignment of investor and company activities
6	Company activity
7	Investor activity
8	Investor's monthly income
9	State or non-state company
10	Song of changes in rules and regulations
11	Company prospects
12	Previous monthly and annual returns of the company
13	Price fluctuations
14	The level of investor consumerism
15	Allocating time for supervision
16	Hope for the future of the investor
17	Being the head of the household of more than two people is the investor
18	The duration of the company's entry into the market
19	The amount of loans and debts of the company
20	The difference between the real value and the market price
21	Receiving and payment portals
22	Overall market performance
23	Being approved by the company
24	The amount of internal/external credits of the company
25	Available options for investment

In this section, according to the opinions of 25 experts who participated in this study, the initial model was approved by consensus, and the experts did not imagine another index for this model. It is worth mentioning that at this stage, all the indicators were examined so that in the next steps, based on accurate

scoring, it can be determined which one should be used, which should remain, and which should be eliminated. In the Delphi method, the estimates provided by experts are expressed in the form of definite numbers, while the use of definite numbers for predictions or decisions makes it far from the real world. On the other hand, experts use their abilities and mental abilities to make decisions, and this shows that the uncertainty governing these conditions is a possibility and not a possibility. This process will result in a single number, which is obtained based on the average of experts' opinions. If the lowest value received is a numerical value higher than 3, the desired criterion is considered an acceptable and important criterion in the Delphi method. It is selected because the overall average of each factor in the survey is determined in the attached tables. Among the selected factors, 20 factors that have an average above 3 are considered for the next round.

Delphi results in the field of risk prioritization factors in digital market capitalization.

In this section (prioritization of risks in investment), 21 factors have been examined. It should be noted that in this section, the answers of the experts focused on the importance of factors in creating the priority of risks in the investment of the participants.

The final factors were obtained from the Delphi method.

According to the comments received from the Delphi method, the final factors that have been examined in this study are as follows:

Table 3. The final factors in prioritizing risks in investing in digital markets.

Row	Indicator
1	gender
2	The age of the investor
3	investor
4	Net assets of the company
5	Investor activity
6	Company activity
7	Investor's monthly income
8	State or non-state company
9	Song of changes in rules and regulations
10	Company prospects
11	Previous monthly and annual returns of the company
12	Price fluctuations
13	Hope for the future of the investor
14	The duration of the company's entry into the market
15	The amount of loans and debts of the company
16	The difference between the real value and the market price
17	Receiving and payment portals
18	Overall market performance
19	Being approved by the company
20	The amount of internal/external credits of the company
21	Available options for investment

The factors are arranged according to their importance in the table below.

Table 4. Prioritization of effective factors in AHP.

Row	Indicator	Proximity factor
1	Receiving and payment portals	0.084
2	Previous monthly and annual returns of the company	0.074
3	The amount of loans and debts of the company	0.074
4	Terms and conditions	0.071
5	Being approved by the company	0.069
6	Net assets of the company	0.063
7	Overall market performance	0.063
8	The amount of internal and external credits of the company	0.057
9	Investor's monthly income	0.054
10	The difference between the real value and the market price	0.049
11	Company prospects	0.045
12	Price fluctuations	0.042
13	State and non-state company	0.040
14	Investor funding	0.039
15	Company Activity	0.038
16	The duration of the company's entry into the market	0.038
17	Available options for investment	0.024
18	Investor activity	0.022
19	Hope for the future of the investor	0.020
20	gender	0.019
21	Age	0.015

As you can see, the payment and receiving portals are the most important, and the previous annual and monthly returns of the company and the amount of loans and debts of the company are jointly in second place. Basically, the first and last investment risks occur at the receiving and payment portal, and any company that has a fast and reliable receiving and payment system has certainly obtained all the legal permits and has a transparent activity from a legal and tax point of view. The monthly and annual returns also return to the market memory; although, compared to traditional markets, the general behavior of digital markets is different, they will not be exempted from this rule. The amount of loans and debts of the company is also like an anchor that prevents the movement and use of the full potential of progress in any company. Laws and regulations are very important for the company and the investor, because if all the legal aspects, such as fines and confiscation, are not considered for the company, the tax for the investor can reduce a large share of the profit. A company that has taken into account all the legal issues and has an acceptable reputation and background is said to be approved. In the 10th place, the difference between the real value and the market price indicates that in the case of trade union actions or government directives and legal restrictions, if these two factors are far from each other, the company and the investor will suffer losses. The investor's funding level will provide peace of mind so that in the event of sudden problems such as natural disasters such as floods and earthquakes or special conditions such as war and sanctions, which all have a direct effect on digital markets, the investor can wait until the conditions improve. return to normal. Gender and age do not matter in the risk of investing in digital markets because the investor will not have to bear any real and difficult physical actions, and all people can benefit from this market with minimum limits.

9. Identifying and prioritizing investment risks in digital markets using data mining

In the previous sections, the important and effective parameters of investing in digital markets have been given. In this section, the available risks can have an impact on the target factor, we are going to cluster information, for this purpose, we use the Genlin test or GEE to check the degree of importance of the variables from the Clementine software.

Table 5. Effective factors in data mining.

Row	Indicator
1	Receiving and payment portals
2	The amount of loans and debts of the company
3	Monthly and annual returns of the company
4	Terms and conditions
5	Net assets of the company
6	Being approved by the company
7	Overall market performance
8	The amount of internal and external credits of the company
9	Investor's monthly income
10	The difference between the real value and the market price
11	Company prospects
12	Price fluctuations
13	State or non-state
14	Investor funding
15	Company Activity
16	The duration of the company's entry into the market
17	Available options for investment
18	Investor activity
19	Hope for the future of the investor
20	gender
21	Age

As can be seen, in data mining, like AHP, receiving and payment portals are the most important; the only difference in the fifth and sixth options is that they have been moved compared to AHP, that is, the company's net assets and approval have changed, but other options are classified exactly like AHP.

10. Research results

In this research, the importance of multi-criteria decision-making and data mining and the need to use them in investing in digital markets have been investigated, and according to the results of multi-criteria decision-making and data mining, high-risk risks in investing in digital markets have been analyzed. Is.

The main core of this research has tried to obtain the application of scientific experiences using multi-criteria decision-making and data mining. The points obtained from this research are as follows:

- Using AHP to obtain investment risks;
- Using data mining to determine investment risks;
- Determining risk priorities and checking the results of all methods.

In this research, the collected data were subjected to the aforementioned digital measurements, which generally result in the following.

Payment and receiving ports are the most important, and the previous annual and monthly returns of the company and the amount of loans and debts of the company are in second place.

Laws and regulations are not hidden in every place and activity, and non-compliance will have unfortunate consequences.

The approval of the company and the company's net worth were the next priorities. In data mining, the company's net worth was first and then the approval, and the rest of the items were ranked the same in both methods.

Author contributions

Conceptualization, PP and SS; methodology, SS and MT; software, MT and SS; validation, SS and MT; formal analysis, PP and MT; investigation, MT and SS; resources, SS and PP; data curation, SS and PP; writing—original draft preparation, PP and MT; writing—review and editing, MT and PP; visualization, MT and PP; supervision, SS and PP; project administration, SS and MT. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare no conflict of interest.

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