



# Presenting a model of determinants venture investment using the Soccer League Competition Algorithm (SLCA)

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## Abstract

The present study aimed to investigate the determinants venture investment in companies listed on the Tehran Stock Exchange using Soccer League Competition Algorithm. The present study is applied in terms of aim and descriptive-correlational in terms of method and nature. The financial data of 100 companies listed in the Iran Stock Exchange for 5 years of 2014 to 2019 were selected as a sample and were analyzed using Excel, Eviews and Matlab software. First, the determinants of venture investment in Tehran Stock Exchange (investment volume, rate of export, company tax, disclosure index, rule of law index, diversification of the industry, diversification of the stages of the company's life cycle, type of ownership, number of sectors and subsidiary companies, company investment, company size and company age) were identified. By using the Soccer League Competition Algorithm, a predictive model was created to determine the investment risk based on the extracted indicators. Then, the accuracy of this model in terms of predicting the riskiness of the investment was compared with simulated annealing algorithm, the NN neural network, and the SOM neural network.

**Keywords:** Venture investments, Predictive model, Soccer League Competition Algorithm, Tehran Stock Exchange

## Introduction

Iran's economy is based on the money market or. In other words, its economy is bank-oriented. In the past years, the liquidity problems and the financial stability of Iranian banks have faced risks, and this has caused significant damage to the banks' assets and weakened their financial status (Abdollahipour MS, 2018). Also, investment in newly established companies has a more significant risk compared to other companies, while a small number of newly established companies have refundable capital (Sajjadi &

Esmail Hafezi, 2014). This issue has caused a type of venture investment that banks as a source of financing do not accept such a significant risk. Hence, start-ups may face difficulties in financing because they are usually young and small with limited assets and generally face credit constraints. Thus, traditional bank loans are usually not an alternative option for financing these companies, and financing through debt is not solution for them. The experiences of various countries such as America, India, Canada, etc., in establishing financial institutions in the area

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of venture investment show that if the conditions are provided by the Ministry of Construction, such investments will be the most suitable way for the development of innovative projects (Asgharian et al., 2016). Since the beginning of the 20th century, the behavior of venture investment has experienced interesting changes, so that the rate of this type of investment has increased in emerging markets (Peter Groh & Wallmeroth, 2016). For this reason, participation in venture investments has been proposed as an alternative solution for such companies. Some institutional investors such as insurance companies, banks or investment funds invest in a certain type of young companies due to the nature of their innovative risk, which is referred to as venture investments. In this method, venture investments play a major role in the economy. For example, Intel, Microsoft, Cisco Systems, and Apple Computers are all global high-tech companies in which venture investment has played an important role in their promotion.

Nowadays, these companies employ tens of thousands of people globally and contribute to major leaps in modern technology. It indicates the important effects of this type of investment in the economy. Thus, it is important and necessary to investigate the factors affecting venture investments in any economy. In this regard, the present study was conducted on companies listed in the Tehran Stock Exchange. In other words, the main goal of the present study is to find the model of determinants venture investment in Tehran Stock Exchange. In this article, to test the research hypotheses, the classified and audited financial data of the companies listed in the

Tehran Stock Exchange were used. The reasons for selecting the mentioned statistical population is that the Tehran Stock Exchange Organization has relatively comprehensive information about the state of companies and the trend of their financial and economic performance, and it can be said that it is the only source of information that can be used to access the financial information sources of companies to test the research models (Shams et al. 2015).

### ***Theoretical Foundations***

#### *The concept of venture investment*

Venture capital is capital that is provided to young, small, fast-growing companies with economic future, along with management assistance. Venture capital is an important source of financing for small and start-ups. In other words, investment companies provide money and management experience to growing companies, and they use these facilities for advertising, research, creating infrastructure, and producing products. The investing company is called VC firm and the money given to the growing company is called venture capital fund. Venture investment companies generally invest in companies that have achieved a new technology or method, and these investors own the company's stock for the money they invest, and accordingly generate money. Invested venture capital fund is generally liquidated when its shares are traded (Peter Groh & Wallmeroth, 2016). The origin of the term "venture investor" was a person named Jane Whiter, who used this term for the first time in 1939 at the general meeting of the American Bankers Association. At the beginning of the formation of venture



investment, this investment was often made by rich people. These people were often the owners of high-paying jobs that were also dealing with such investments. Nowadays, these people are called business angels. However, with the modernization of venture investment, this investment method itself became an independent business and specialized companies were created in this area (Hain et al., 2018).

#### *Financing methods and venture investment indicators*

Among the most important methods of financing venture investment, we can refer to the following cases:

- Capital of friends and relatives
- Credit cards
- Business rescue angels
- Suppliers and customers
- Lending institutions such as banks and credit institutions
- Venture investors
- Rent subject to possession
- Commercial banks
- Selling shares and entering the stock market
- Collective financing

Among the venture investment indicators, we can refer to the following cases:

- Attention to newly established companies
- Risk taking
- Long-term perspective
- Profitability motivation
- Participation in the management of companies

- Participation in the ownership of companies

- Withdrawal from investment

-Global experiences on venture investment (Razavi et al., 2017)

The experiences of various countries to create financial institutions in the area of venture investment show that if appropriate mechanisms and infrastructure are provided, such investments will be the most appropriate way to develop innovative projects. Banks and other lending centers have not supported these plans due to the existing risks. Not supporting these projects leads to the loss of opportunities for technology development and job creation in the country (Bonini & Alkan, 2017). The important point in the financing structures of such projects is the existence of initial capital and starting-up a business. Thus, if the owner of the project or the main idea developer cannot provide the necessary and initial financial resources and even the necessary guarantees for the investor, he or she will face the first and most serious problem.

In this case, assuming that he can manage the management and market issues and analyze the situation, his main concern will be how to provide these resources and spend a lot of time and energy. This process also requires going through complex processes in most financial institutions and banks and other government companies. Banks and financial and credit institutions and funds as well as various investment companies have a serious presence in the area of growth of various industries and support of profitable economic projects, but some technological

plans and ideas are knowledge-oriented. Thus, in the financial markets of the world, we have recently seen the formation of new investor institutions. These financial institutions invest in formal and informal capital markets with direct and active participation in new technological projects as well as in companies with higher risk than average risk. Among them, we can refer to stock market, land and real estate companies, gold and foreign exchange. Such financial institutions are also called venture investing funds or companies (Bonini & Alkan, 2017). The United States of America plays a major role in the development of the venture investment industry. Based on the statistics, the performance of financial institutions in this country, in addition to reducing the rate of return on investment, has contributed to develop small and medium-sized industries and creation of value in investable companies. Such a process finally resulted in creation of employment and the development of the domestic economy in this country (Karim, 2019).

#### *Venture investment in Iran*

One of the important missing links in the entrepreneurship chain in Iran is venture investment companies, and there are few organizations and companies that have fully

observed the venture investment principles. The private sector has not acted alone in any of the companies and funds formed in Iran in this area and they have acted often with the participation and support and capital of the government. For this reason, most of the current expenses of these funds and companies are provided by the public sector. Unfortunately, in recent years, the standard structure that is in accordance with the global norm and managed by the professional team has not been seen in these companies. Without having an entrepreneurial view in this industry, one cannot expect growth and success from it. Thus, government's view, which is mainly performed by institutions such as the Presidential Scientific and Technological Deputy, with the aim of supporting knowledge-based enterprises, cannot lead to the development of the venture investment industry in Iran (Askari Masooleh & Afshar, 2015).

#### *Venture investment structure*

To survive in the high-risk market where they work, these companies must use a smart and efficient structure, which this structure varies depending on the policies and goals of that company. The general framework of these companies includes the following parts (Figure 1).

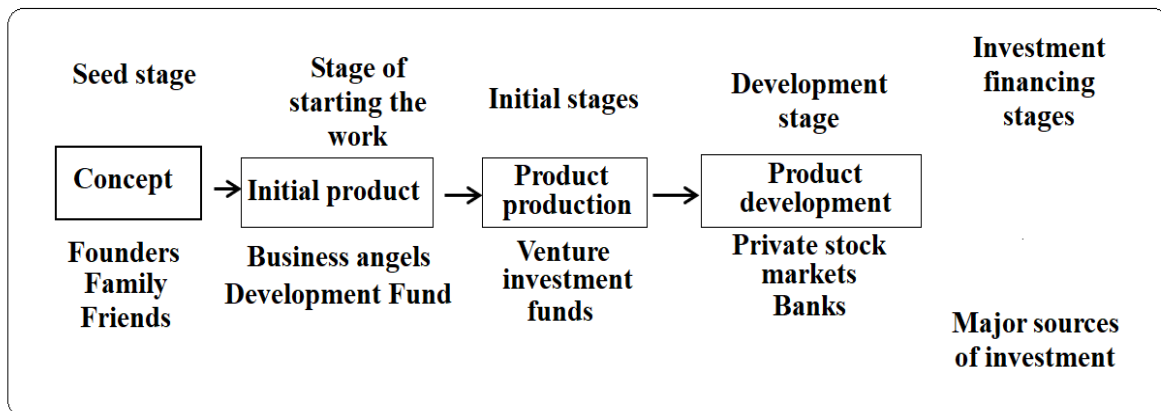


Figure 1. Financing chain in venture investment

## Research Background

(Alinejad et al., 2019), designed and developed a model using fuzzy inference system and neural network to evaluate the innovation capacity of knowledge-based companies in the Pardis science and technology park. For this purpose, 25 indicators were used, and some indicators such innovations in the product, the ability to record and retrieve information, the ability to create ideas, the total number of scientific and technical employees, and the research and development costs of the intellectual property system process were more important. To evaluate the model, the parameters of mean squared error, the relative error percentage, the absolute mean error and the coefficient of explanation were calculated. The results indicated accuracy and the reliability in predicting the output of the model. This study is in line with the article in terms of method, but the criterion of venture investment in knowledge-based companies has not been investigated.

(Ghazanfari et al., 2018), designed a corporate venture investment model for technology companies in Iran. To present the model, the exploratory method of fundamental theory was used. In this model, the process of coding data obtained from interviewing with industry and university elites was used. Also, in this model, corporate venture investment was identified as the main phenomenon, and the causal, contextual and intervening conditions were described as factors that are related to this phenomenon. In addition, the measures and actions related to corporate venture investment and the outcomes and consequences for the investor company were stated. In this study, the factors affecting the use of corporate venture investment were classified more regularly and the relationship between the factors was expressed more clearly. In this study, environmental turbulence, intense competition, and intellectual property protection regime were considered as independent variables.

(Dehghani Eshrat Abad & Albadavi, 2017), evaluated venture investment in start-up

businesses and the way of calculating the value of these businesses using the real options approach. Since investment in start-up businesses is faced with a high level of uncertainty and managers have a variety of flexibility in making decisions, traditional methods ignore this uncertainty and flexibility. For this purpose, to calculate the net present value of investment, they used Monte Carlo least squares simulation method. According to the results of the simulation, the ownership percentage of entrepreneurs and venture investor was determined. Also, by comparing the results of the proposed approach and the net present value method, it was found that the traditional methods are not value enough to value such businesses .

(Talebi et al, 2017) modeled the structural relations of the main factors for evaluating the risk of venture investment. For this purpose, in this study, the main factors of risk evaluation were first identified by reviewing the subject literature and experts' opinions. Then, using the Interpretive Structural Modeling (ISM) method, the number of levels and factors of each level were determined. According to experts in this area, there are 10 key and effective factors in the evaluation of the risk of venture investment, which are classified into three levels. In the first level, investment volume, rate of return, and liquidity volume were the most influential factors. The market or industry factor, product or service, and economic conditions as mediating factors whose risk level is influenced by third level factors were in the second level, and experiences related to the

product, entrepreneur's personality, ability and management skills and product life cycle were placed in the third level.

(Ekhlesi & Ansari-Chaharsooghi, 2017), identified the factors affecting the process of formation of strategic brand venture (SBV) investment in Iran. For this purpose, qualitative research method of data-based theory and semi-structured interviews with managers and experts of venture investor companies were used. The results of the interviews have been shown through 18 factors within six categories related to the main phenomenon including causal conditions (active competitive environment, emergence of innovative ideas, attractiveness of the market), axial category (continuous search for domestic and foreign markets, opportunity evaluation, selection and organizing strategy and strategic investment), contextual conditions (economic and political situation, risk of investors and startups, business ecosystem), intermediary or intervening conditions (logical interaction, global experience) as well as actions and interactions and outcomes (smart strategic management, communication network, branding and high-quality investment).

In a study entitled "Investigating the feasibility of the venture investment industry in Iran: opportunities, challenges and pathology", (Askari Masooleh & Afshar, 2015), examines the feasibility of venture investment and the importance of this type of investment in financing companies and entrepreneurial individuals in Iran. First, the concepts and theoretical



foundations of the article are examined based on previous experimental studies. Then, the importance and necessity of paying attention to venture investment, the life cycle of the structure of the investing companies, the possibility of venture investment in Iran and its challenges, the laws of venture investment, the status of the actors of this industry in Iran and the future opportunities of this type of investment are discussed. Finally, with paying attention to formation of the private sector in Iran in the form of Article 44 and the need to use new investment methods to create mobility and expand entrepreneurship and financial engineering in the private sector, the necessity and pathology of venture investment in Iran was explained.

In a study, (Asgharian et al., 2016). Examined the "venture investment industry (investment process and evaluation tool)". They stated that obtaining the necessary funds to launch businesses has always been a challenge for entrepreneurs. The process of obtaining the necessary funds may take months and discourage entrepreneurs from managing businesses. Also, without adequate financing, start-ups will never succeed. Given the necessity of venture investment issue and lack of fundamental studies in this area, the present study was conducted to review comprehensively the venture investment industry. Thus, after the initial introduction of venture investment, the venture investment industry will be discussed. Then, the theoretical framework related to venture investment will be discussed in detail. Finally, in addition to an overview of the factors affecting the venture

capital size, we will also discuss venture capital investments in emerging companies. In a study, (Shams & Makouee, 2014), examined the role of venture investment in financing entrepreneurial businesses. They concluded that the best method of providing capital by entrepreneurs is to use venture investment sources, because government and bank financing methods are more willing to work with established companies with known management that have the power to repay installment loans. In a study entitled "Determinants of venture investment: A panel analysis in different regions of the United States of America", (Karim, 2019), investigated this issue. The aim of mentioned study was to examine the relationship between economic growth, research and development costs, and population density and total venture capital investments during 2006-2016.

Using a fixed effect model, a positive relationship between population density and total venture investment can be concluded. It was also found that economic growth and gross expenses in the area of research and development have not had significant statistical effects. (Hegeman & Sørheim, 2021), examined which companies invest in technology start-ups and why they do this. This study reviewed 26 startup technology companies between 1999 and 2012 in Norway. The results revealed that small and medium-sized companies are active corporate investors and investment motivations are more diverse than what has been thought.

(Nguyen & VO, 2021), examined the association between asset market liquidity

and venture investment. The results revealed that asset liquidity and venture investments have a positive relationship with low levels of asset liquidity, but a negative relationship with high levels of liquidity. Therefore, the relationship between these is u-formed and reverse. They also found that the more industrial experience companies have, the more willing they are to invest in an asset market than companies without industrial experience.

(Shuwaikh & Dubocage, 2021), examined whether the innovative outputs of entrepreneurial companies can respond to complementary resources from different types of venture capital funds, including independent venture capital IVC and corporate venture capital CVC, or whether access to complementary resources by investors has an effect on innovation performance. The result revealed that companies with CVC support show higher rates of innovation returns compared to the companies with IVC support. Three mechanisms that affect the effect of complementary resources of corporate investors compared to IVC resource include absorption capacity, business similarity and geographic proximity.

(Berger & Hottenrott, 2021), examined sources of venture investment for startups. The results revealed that government subsidies for startups through the provision of certificates and liquidity in the early stages have a positive effect on subsequent financing. This study showed that there is a correlation between subsidies and all sources of venture capital (government

venture capital, independent venture capital, corporate venture capital, business angels). (Cheng et al., 2019), examined the spatial dynamics and determinants of sustainable financing of venture investment in China. Using a panel data set at the city level, this research first examined the spatial dynamics of venture investment in China. They identified 5 important and influential factors in the formation and improvement of local venture investment activities including: government intervention, withdrawal opportunity, accumulation of human capital, the new invention and transportation infrastructure. In the next step, in this study, the vital role of international venture investment and domestic institutional factors in the formation of the venture investment industry in China was examined. The study shows understanding of the distribution and operational patterns in the venture investment market of China and provides several concepts for entrepreneurs and policy makers of venture investment activities in developing economies.

In a study entitled "Determinants venture investment in developed and emerging economies: The effects of relational and institutional trust", (Hain et al., 2018), collected data from China during 2000 to 2016. Also, in this study, geographic, cultural and institutional proximity effects as well as organizational and communication trust were addressed. Results of the study indicated a reduction in the negative effects of geographic and cultural distance, especially in cases where organizational trust is more relevant for





investment in emerging economies, and relational trust is more relevant for investment in developed economies.

(Bonini & Alkan, 2017), examined this issue in a study entitled "Macro and political determinants venture investment around the world". The main aim of the study was to identify the main factors of venture investment around the world. For this purpose, macro factors from the literature on venture investment such as initial public offering (IPO), labor market strength, technological opportunities, stock market, gross domestic product (GDP), interest rate, inflation and corporate income tax were tested. In this study, a combination of data from 16 countries from 1995 to 2002 was used. Results of the study based on fixed and random effects models revealed that one of the most important determinants of venture investment is the total value of traded shares. It can also be stated that the corporate income tax rate, entrepreneurial activities, inflation, labor market strength, GDP growth and some political risk variables, investment features, social and economic conditions and corruption are factors affecting venture investment.

(Peter Groh & Wallmeroth, 2016), examined this issue in a study entitled "Determinants of venture investment in emerging markets". For this purpose, data of 118 emerging countries from 2000 to 2013 were used. The empirical results of the study revealed that the activity of mergers and acquisitions, legal rights and support of investors, innovation, IP protection, corruption, as well as corporate tax and unemployment have significant effects on

venture investment. It was also shown that the intensity and direction of the effect of the determinants for the groups of the two countries are different for several parameters, which confirms the results of previous studies that the factors guiding venture investment in developed and developing countries are different.

#### *Research hypotheses:*

The first hypothesis: the investment volume of mergers and acquisitions has an effect on venture investment in the Tehran Stock Exchange.

The second hypothesis: Exports have an effect on venture investment in Tehran Stock Exchange.

The third hypothesis: Company tax has an effect on venture investment in Tehran Stock Exchange.

The fourth hypothesis: Disclosure index has an effect on venture investment in Tehran Stock Exchange.

The fifth hypothesis: the rule of law index has an effect on venture investment in the Tehran Stock Exchange.

The sixth hypothesis: Diversification of industry has an effect on venture investment in Tehran Stock Exchange.

The seventh hypothesis: Diversification of different stages of the company's life cycle has an effect on venture investment in the Tehran Stock Exchange.

The eighth hypothesis: The type of ownership has an effect on venture investment in Tehran Stock Exchange.

Ninth hypothesis: The number of sections and subsidiaries has an effect on venture investment in Tehran Stock Exchange.

The tenth hypothesis: The company investment has an effect on venture investment in Tehran Stock Exchange.

The eleventh hypothesis: Company size has an effect on venture investment in Tehran Stock Exchange.

The twelfth hypothesis: the age of company has an effect on venture investment in the Tehran Stock Exchange.

Conceptual and operational definition of the variables used in the research (Table 1) shows the research variables along with their type and measurement method.

**Table 1.** Research variables along with their type and measurement method

measurement method	The variable type	Variable
It was measured by surveys of industry elites and activists. Accordingly, they were asked to give a score between zero (the minimum venture investment) and 100 (the maximum venture investment) regarding the level and intensity of venture investment in the industry they operate in. Finally, the mean score given by the elites and activists of each industry was determined as a single score for the venture investment variable.	Dependent	Venture investment
The proportion of investments that resulted in the merger or acquisition of ownership of subsidiary companies on total assets	Independent	M&A investment volume
Export = value of exported goods and services - (payment to employees and investment income and transfer payments)	Independent	export
It is measured by the effective tax rate on corporate income.	Independent	company tax (TAX)
$DSCORE_{it} = Dis_{it} / Dis_j$	Independent	Disclosure Index
It was measured by surveys of industry elites and activist. Accordingly, they were asked to give a score between zero (minimum venture investment) and 100 (maximum venture investment) regarding the level and intensity of the rule of law in the industry they operate in. do Finally, the mean score of the answers given by the elites and activists of each industry was determined as a single score for the rule of law index variable.	Independent	Rule of Law Index (LOW)
Industry diversification index = 1 – Herfindahl–Hirschman Index	Independent	Industry diversification variable
First, the value of each variable of sales growth, capital expenditures, and dividend ratio and company life is calculated for each year of the company. Years of companies are divided into five classes based on each of the four mentioned variables and using statistical quintiles in each industry. According to table 1, they get scores between 1 and 5 according to their placement in the desired quintile (class).  Then, for each year of the company, a composite score is obtained, which is classified in one of the stages of growth, maturity and decline according to the following conditions: If the total score is between 16 and 20, it will be in the growth stage. If the total score is between 9 and 15, it will be in the maturity stage.	Independent	The diversification of different stages of the company's life cycle (Stage Diversification)



If the total score is between 4 and 8, it will be in the declining stage.		
$AGE = CYEAR - FYEAR$	Independent	Age of the company (AGE)
$SG_t = ((SALES_t - SALES_{t-1}) / (SALES_{t-1})) * 100$	Independent	Corporate Growth (SG)
$CEV_t = (CE_t / VALUE_t) * 100$	Independent	Change in capital expenditure (CEV)
$DPR = (DPS_{it} / EPS_{it}) * 100$	Independent	dividend (DPR)
If the company is controlled by the government and state-owned companies, it will take a value equal to one, otherwise, it will take a value equal to zero.	dummy	Company ownership type (OWN dummy)
It is equal to the number of sections and subsidiaries of each company in year t	control	Number of sections and subsidiaries of each company (Section of professionals)
Average company investments per year	control	Company investment (Ln(investment size))
The natural logarithm of the company's total assets	control	Company size (Ln(fund size))

## Methods

The Soccer League Competition algorithm was first introduced in 2014 by Mousavian and Roodsari for the optimal design of water distribution networks. The soccer league competition algorithm is a population search method and is very similar to the colonial competition algorithm. The main idea of this method is derived from the professional soccer league and the search process is based on the competition among the teams and players. In the mentioned algorithm, the population is divided into two levels: 1-teams 2-players. Each of the two mentioned levels effectively directs the search process to find the global optimum. The stages of the soccer league competition algorithm are:

The first stage - Formation of league teams: In this stage, the operation of initialization of the parameters and the generation of the initial population is done. Each answer in the population of the soccer league competition algorithm is initialized according to the Equation 1.

$$P = X_{\min} + \text{rand}(0, 1) * (X_{\max} - X_{\min}) \quad (1)$$

In Equation 1,  $X_{\min}$  and  $X_{\max}$  represent the minimum and maximum possible value in each dimension, respectively.

The second stage - performing the competitions of one season of the league: in this stage, the operations related to the internal competition between the players of each team and also the intra-league competition among the league teams is done. In this stage, two matches are held between all the league teams, exactly according to a real league (intra-league competition).

In this stage, two matches are held between all the league teams, exactly according to a real league (intra-league competition). The competition is held in such a way that the two teams, selected for the competition, are determined according to their fitness and the probability of winning and losing. The fit of each team is calculated from the sum of the fit of its fixed players. The regular

players of each Kf team are the best players of that team. Here, Kf indicates the number of fixed players of the teams and Ks the number of substitute players of each team. These parameters are determined according to the magnitude of the problem. It is obvious that the total population of answers in the soccer league competition algorithm, considering that M represents the number of teams present in the league, is equal to  $M \times (Kf + Ks)$ . The probability of winning is higher for better teams. However, there is no reason why the stronger team always wins the game over the weaker team (exactly similar to soccer matches in the real world). At the end of each match, only the winning players are allowed to try to improve their fitness (intra-team competition).

This effort is modeled by applying two important operators in the soccer league competition algorithm. These operators include: imitation and provocation. In the imitation operator, the regular players of the winning team imitate the star players of their team, as well as the top star player of the entire league. Imitation of the team's star player in the soccer league competition algorithm is very similar to the tendency of the colonial countries towards the imperialist country in each colony in the colonial competition algorithm. However, imitating every answer from the top star

player of the entire league is the innovation of the soccer league competition algorithm compared to the colonial competition algorithm. In the provocation operator, this operator is responsible for updating the substitute players. In the soccer league competition algorithm, after each match, the substitute players of the winning team, as well as the fixed players of this team, can change their value in line with the best team answer (SP) and also the best answer in the league (SSP). This change is done with the hope that the substitute players can be selected as fixed players by the head coach in the next game. After each match, imitation and provocation operators are applied to the players of the winning team, and then fixed and substitute players are updated. Then, the new fit of the team is calculated for the next match. This stage ends after all the league matches are held.

The third stage - Doing transfers between two seasons of the league: In this stage, the operation of updating the league is done. In this regard, the strongest players move to the teams at the top of the table, the average players move to the teams in the middle of the table, and the weak players move to the teams at the bottom of the table. The pseudo-code of the soccer league competition algorithm is presented in (Figure 2).



Function SLCA (problem) returns a state that is a local maximum

Input: Population size, Problemsize, M, K<sub>f</sub>, K<sub>s</sub>

Output: Sbest

Population ← ∅

For I = 1 to Populationsize do

P<sub>I</sub>position ← RandomPosition (Problemsize);

Population ← P<sub>I</sub>;

end

Teams Formation (Population);

While ← StopCondition () do

Evaluate Population (Population);

LeagueTeams ← Make League Teams (Population, M, K<sub>f</sub>, K<sub>s</sub>);

SSP ← GetBestSolution (Population);

foreach Team<sub>i</sub> E league Teams do

    foreach Team<sub>n</sub> E league Teams – Team<sub>i</sub> do

        Team<sub>winner</sub> ← Do Match (Team<sub>i</sub>, Team<sub>n</sub>);

        SP ← Get Best Solution (Team<sub>winner</sub>);

        Foreach P<sub>J</sub> E Team<sub>winner</sub> do

            P<sub>j</sub> ← Imtation (P<sub>j</sub>, SSP, SPProblemsize);

            P<sub>j</sub> ← Provocation (P<sub>j</sub>, SSP, SPProblemsize);

    end

U pate Fix Sub Players (Team<sub>winner</sub>);

    end

end

end

EvaluatePopulation (Population);

Sbest ← Get Best Solution (Population);

Return Sbest;

**Figure 2.** The pseudo-code of the soccer league competition algorithm

In the next stage, we extract an optimal subset of features using the soccer league competition algorithm (SLCA) meta-heuristic method to obtain the highest accuracy with the smallest size of the feature set. The existing problem is that the dimensions of the solutions in a meta-heuristic method are usually fixed and the values are changed by the operators in it to gradually determine the optimal solution of the problem based on a fit function. In order

to not have problems with the existing problem as the optimal subset of features and the variable size of the solutions, we will use an additional binary feature vector called Been, which is multiplied by the initial solution vector. Accordingly, after removing the zero values, we will have solutions with different lengths. In other words, the values of cells corresponding to zero places are not considered. An example of this feature vector as a problem solution is shown in (Figure 3).

sol	3	5	1	6	4	2	8	7
been	0	1	0	1	0	1	1	0
n	5		6		2		8	

Figure 3. The solution in meta-heuristic methods

The soccer league competition algorithm creates new solutions for the optimization problem during different iterations, which must be determined by a fit function to determine the appropriateness of this solution, so that better solutions with better fit replace unsuitable solutions over time, and finally get the answer close to the optimal. To determine the suitability of the presented solutions, the accuracy of diagnosis will be used based on the MSE criterion, whose calculation formula is stated in equation 2:

$$fit(sol_i) = \frac{1}{MSE(sol_i)} \quad (2)$$

Where, MSE is the level of detection accuracy based on the mean squared error value using the feature vector.

The simulated annealing (SA) algorithm is a simple and effective meta-heuristic optimization algorithm in solving optimization problems. The origin of the simulated annealing algorithm is the research of Lirkpatrik and Cerney in 1983 and 1985. Lirkpatrik et al were experts in the field of statistical physics. They proposed a method based on gradual annealing to solve hard optimization problems. The gradual annealing method is used by metallurgists to reach a state where the solid matter is well-ordered and its energy is minimized. This method involves placing the material at a high temperature and then gradually reducing this temperature. Based on this method, in metallurgy, to anneal or temper, metals and glasses are heated to very high temperatures and then gradually cooled, allowing the



material to be transformed into a low-energy crystalline state.

## Results

### *Simulation environment, data and evaluation parameters*

The data set used in this simulation includes the investments made by companies listed in the stock exchange from 2014 to 2019, and the records of 500 investments were selected as samples. The data included two parts of training data and test data to evaluate the accuracy of the model in predicting. Among

the total organizations, the history of 350 investments will be used as training data and the data of 150 investments will be used as test data set to evaluate the performance of the plan. Each investment record is assigned a numerical value as the value of investment risk. The evaluation parameter of the plan is the mean square error (MSE) and the explanatory index (R<sup>2</sup>) of the presented hybrid clustering. The features of the system and the parameters used in the implementation are shown in (Table 2) and (Table 3).

**Table 2.** System features to implement the proposed algorithm

features	Value
CPU	Core i5
RAM	4 GB
OS	Windows 10

**Table 3.** Simulation parameters

Simulation parameter	Value
The total number of data records	500
Number of selected features	12
Training dataset size	350
Test dataset size	150, 120, 80, 60, 40
Type of training method	Soccer League

It should be noted that we have considered  $m$  in the soccer league equal to each row of the information table for each company. We tried to consider the best feature of each company as the star player for that row. Also, among the total 500 teams, the team that has won the highest score among the teams will be the top team.

## Discussion

To compare the proposed model with the existing tools, it is necessary to determine the accuracy of these tools on the data set. Thus, in this section, the soccer league is first used to predict the investment risk. In this step, we give the system 12 features of companies' investment records as features of each player. The output will also be the value of investment risk. Here, the soccer league must

provide conditions in the model training phase so that the predicted value of investment risk has the least difference with their real value. After training, the proposed method is evaluated with test data to examine the performance.

In this section, meta-heuristic models of simulated annealing (SA) and soccer league competition algorithm (SLCA) and their combination were used to determine the optimal subset of features that have high describing potential in identifying investment risk. Then, the accuracy of different designs including the model based on the proposed

category with SOM (Fuzzy-SOM), the model based on neural network (NN), feature extraction with simulated annealing (SA) algorithm, feature extraction using the soccer league competition algorithm (SLCA) and feature extraction using a combination of simulated annealing algorithm and soccer league competition algorithm (SLCA-SA) were evaluated. In the first scenario, in 5 simulation runs with different values of the number of test samples (40, 60, 80, 100, 120), the following results were obtained, as shown in (Figure 4), (Figure 5) and (Figure 6).

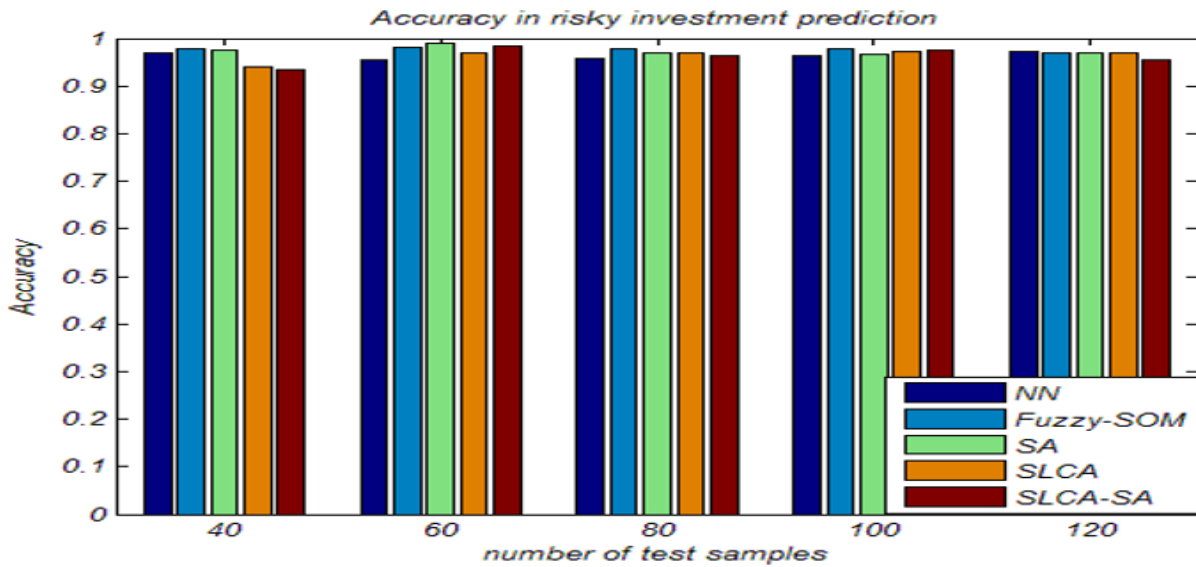


Figure 4. Comparison of investment risk detection accuracy



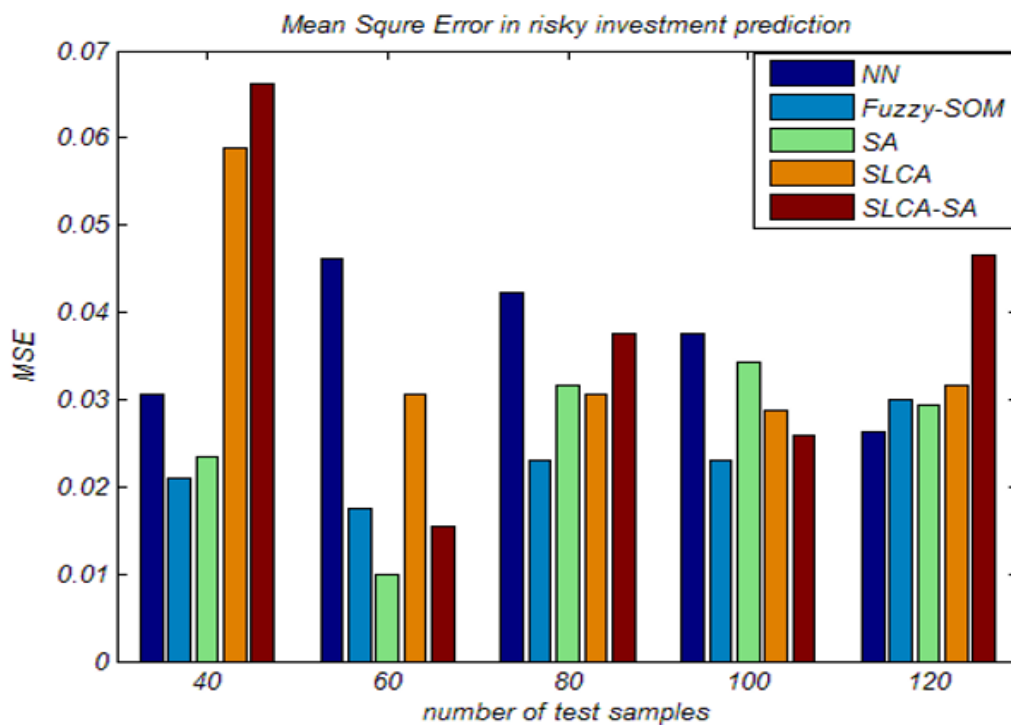


Figure 5. Comparison of mean squared error in identifying the amount of investment risk

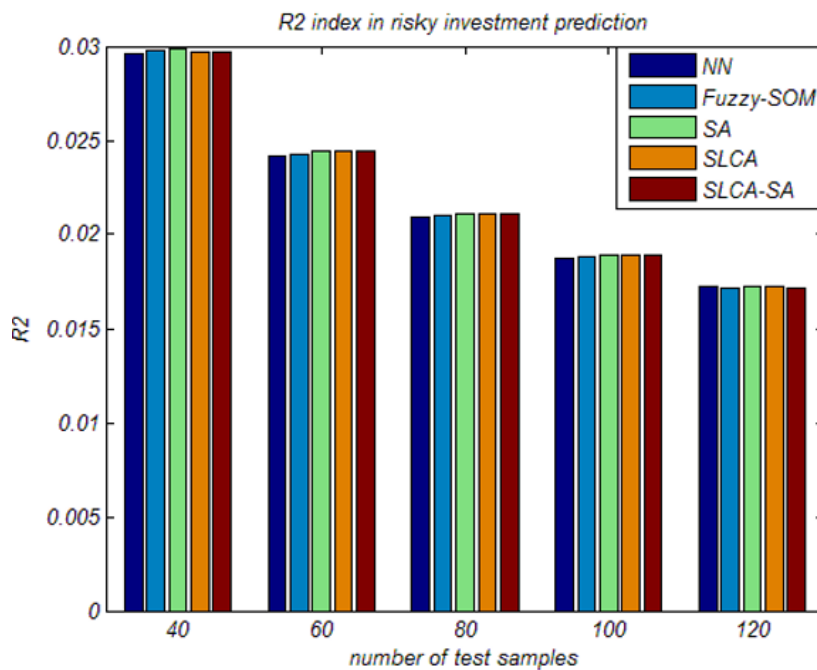


Figure 6. Comparison of explanation index in identifying the value of investment risk

As seen, the accuracy of the model (classification based on SOM clustering) is higher than the other four methods, so that we see improvement in most cases. The method based on simulated annealing (SA) ranks next in terms of investment risk detection accuracy. Therefore, the SOM neural

network method, by using an unsupervised method and using the flexibility of the fuzzy decision-making environment, could work better than feature extraction methods. These values are shown in detail in (Table 4), (Table 5) and (Table 6).

**Table 4.** Comparison of the accuracy of the proposed model with other investment risk detection methods

Criterion	Method	Number of test samples				
		40	60	80	100	120
Accuracy	NN	0.97	0.95	0.96	0.96	0.97
	Fuzzy SOM	0.98	0.98	0.98	0.98	0.97
	SA	0.98	0.99	0.97	0.96	0.97
	<b>SLCA</b>	<b>0.94</b>	<b>0.97</b>	<b>0.97</b>	<b>0.97</b>	<b>0.97</b>
	SA-SLCA	0.93	0.98	0.96	0.97	0.95

**Table 5.** Comparison of the MSE index of the proposed model with other investment risk detection methods

Criterion	Method	Number of test samples				
		40	60	80	100	120
MSE	NN	0.03	0.05	0.04	0.04	0.03
	Fuzzy SOM	0.02	0.02	0.02	0.02	0.03
	SA	0.02	0.01	0.03	0.04	0.03
	<b>SLCA</b>	<b>0.06</b>	<b>0.03</b>	<b>0.03</b>	<b>0.03</b>	<b>0.03</b>
	SA-SLCA	0.07	0.02	0.04	0.03	0.05

**Table 6.** Comparison of the R2 index of the proposed model with other investment risk detection methods

Criterion	Method	Number of test samples				
		40	60	80	100	120
R2	NN	0.029	0.024	0.021	0.019	0.017
	Fuzzy SOM	0.029	0.024	0.021	0.019	0.017
	SA	0.029	0.024	0.021	0.019	0.017
	<b>SLCA</b>	<b>0.029</b>	<b>0.024</b>	<b>0.021</b>	<b>0.019</b>	<b>0.017</b>
	SA-SLCA	0.029	0.024	0.021	0.019	0.017

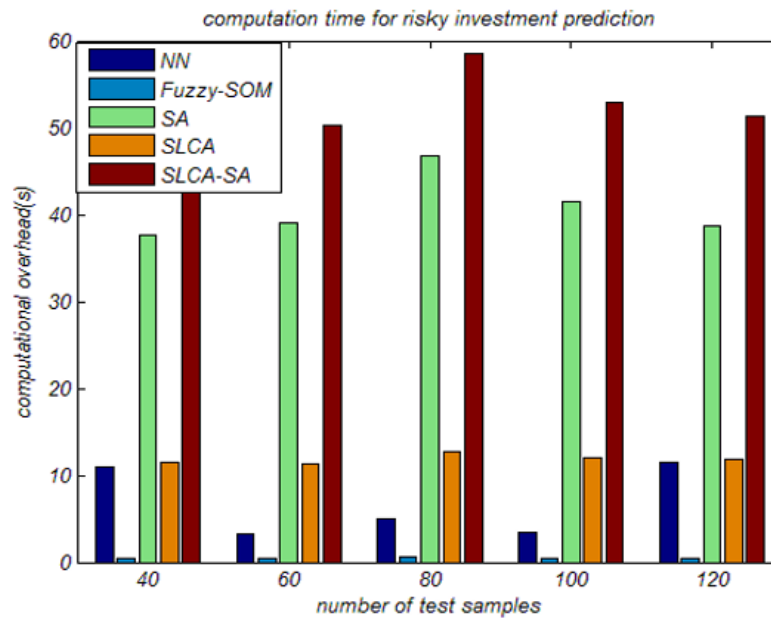
Based on using meta-heuristic patterns, we want to examine how much each of the investment risk detection methods creates computational time overhead. As shown in (Figure 7), the use of meta-heuristic methods has added significant overhead to risk detection plans. Therefore, considering that

the accuracy of the method (SOM-based classification) in different iterations of simulation is equal or more than the use of feature extraction designs based on meta-heuristic methods such as SA and SLCA. It also has less computational overhead. Therefore, it can be concluded that the SOM



neural network, even without using optimal feature extraction, can obtain a better

performance in terms of accuracy in less time.



**Figure 7.** Comparing the computational time overheads

As shown in (Table 7), the computational complexity of the simulation annealing

model is higher than that of the soccer league model.

**Table 7.** Comparison of the proposed model with other investment risk detection methods in terms of time complexity

Criterion	Method	Number of test samples				
		40	60	80	100	120
Computational overhead	NN	10.92	3.19	4.98	3.34	11.45
	Fuzzy SOM	0.48	0.36	0.57	0.53	0.48
	SA	37.67	38.85	46.69	41.42	38.61
	SLCA	11.46	11.33	12.75	12.08	11.83
	SA-SLCA	51.41	50.28	58.44	52.92	51.40

To know which features among the 12 features cause higher accuracy in the performance of venture investment detection, we recorded the optimal output of the meta-heuristic model of the soccer league. Then,

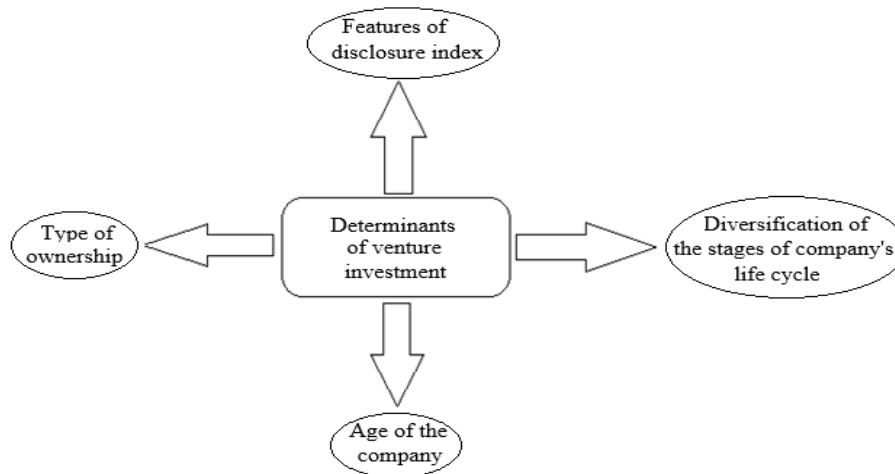
we calculated the number of iterations of each feature in the optimal solutions. As shown in (Table 8), the most iterated features are 4, 7, 8, and 12.

**Table 8.** The number of iterations of each feature in the optimal solution of the meta-heuristic algorithm

Feature	1	2	3	4	5	6	7	8	9	10	11	12
n	3	3	5	9	5	7	10	11	4	4	4	10

The features of the disclosure index, the diversity of the company's life cycle stages, the type of ownership and the age of the company have the greatest impact in

determining the exact value of investment risk. The proposed model for the determinants of venture investment is shown in (Figure 8).



**Figure 8.** Proposed research model

**Conclusion**

In this article, soccer league, soccer league plus stimulation annealing, neural network, neural network plus fuzzy logic, and stimulation annealing algorithms were used to decide on the value of investment risk. The output graphs of investment risk detection accuracy, the mean square error in investment risk detection, the explanation index in investment risk detection and the comparison of the time overheads in computing investment risk detection were extracted for the evaluation of the mentioned algorithms. According to the output results, it is observed that the accuracy of identifying

the value of investment risk in the classification method based on neural network clustering along with fuzzy logic, using a method without supervision and using the flexibility of the fuzzy decision-making environment is more than other methods. Also, the mean square error for the soccer league plus simulation annealing methods is higher than other methods. The neural network method is also higher than other methods for the explanation index of investment risk detection, and the time overhead of the combined algorithm of soccer league and simulation annealing is higher than other methods. The results of the



present study hypotheses showed the highest similarity and consistency to the results of studies conducted by Peter Groh & Wallmeroth, Bonini & Alkan, and Talebi et al., which modeled the determinants of venture investment in terms of indicators affecting the venture investment industry. They also consistent with the result of studies conducted by Bonini & Alkan, and Peter Groh & Wallmeroth, in terms of considering the tax as the factor affecting venture investment. The studies conducted by Ghazanfari et al., examined the factors affecting venture investment, but in these studies, corporate venture investment was identified as the main phenomenon and the causal, contextual, and intervening factors were described as factors that are related to this phenomenon. The results of this study are consistent with the results of the research conducted by Ghazanfari et al. in terms of the important of ownership type in venture investment. Also, in terms of importance of diversification, the results are consistent with the results of the study by Hegeman & Sørheim. Other studies such as Karim and Hain et al., examined these factors in developed economies, so the results are not consistent with the present study.

## References

- Abdolhaipour MS. (2018). Passing through the banking system. *Donya-e Eqtesad Newspaper*. 12-13. <https://donya-e-qtasad.com/>
- Sajjadi SM. & Esmail Hafezi M. (2014). Investigation of strategies for providing venture investment as a stimulus for the prosperity of the business ecosystem. The first international humanities conference with a vernacular-Islamic approach and emphasizing new studies.
- Asgharian E. & Sakhdari K. & Khodayi H. (2016). *Venture Investment Industry (Investment Process and Evaluation Tool)*. National Venture Investment Conference.
- Peter Groh A. & Wallmeroth J. (2016). Determinants of venture capital investments in emerging markets. *Emerging Markets Review*, 29(1): 104-132.
- Shams Sh. & Makouee B. (2014). The role of venture investment in financing entrepreneurial businesses. National Conference on Entrepreneurship and Sustainable Development.
- Karim M. (2019). Determinants of Venture Capital Investments: A panel data analysis across regions in the United Kingdom. Bachelor Thesis Within, Economics Number of Credits, 15 Programme of Study, International Economics, Bachelor Thesis in Economics.
- Askari Masooleh S. & Afshar M. (2015). Investigation of the feasibility of the venture investment industry in Iran: opportunities, challenges and pathologies. The first international conference on new paradigms of business and organizational intelligence management.
- Alinejad A. & Azar A. & Poorzarandi ME. (2019). Designing a prediction model and evaluating the innovation capacity of knowledge-based companies with the adaptive neural fuzzy inference (ANFIS) approach. *Public Management Research*, 13(47): 55-84.
- Ghazanfari H. & Khodadad Hosseini SH. & Kord Naej A. (2018). Corporate venture investment model in IT companies. *Strategic Management Thought (Management Thought)*, 13(1): 255-293.
- Dehghani Eshrat Abad M. & Albadavi A. (2017), valuation of start-up businesses by venture investors using real options approach in the first round of financing
- Talebi M. & Tavalaei RA. & Mortezaia H. (2017). Modeling the structural relationships of the main factors of risk assessment of venture investment in the resistance economy using the interpretive-structural modeling (ISM) approach. *Basij Strategic Studies*, 20(77): 113-140.

- Ekhlas A. & Ansari-Chaharsooghi SA. (2017). providing a brand strategic venture investment model for venture investment companies operating in the field of e-commerce (based on data-based theory). *Business Journal*, 86(1): 1-25.
- Hegeman PD. & Sørheim R. (2021). Why do they do it? Corporate venture capital investments in cleantech startups. *Journal of Cleaner Production*, 294(1): 126315-126324.
- Nguyen G. & VO V. (2021), Asset liquidity and venture capital investment. *Journal of Corporate Finance*, 69(1): 101963-73.
- Shuwaikh F. & Dubocage E. (2021). Access to the Corporate Investors' Complementary Resources: A Leverage for Innovation in Biotech Venture Capital-Backed Companies. *Technological Forecasting and Social Change*, 121374-86.
- Berger M. & Hottenrott H. (2021). Start-up subsidies and the sources of venture capital. *Journal of Business Venturing Insights*, 16(1): e00272.
- Cheng C. & Hua Y. & Tan D. (2019), spatial dynamics and determinants of sustainable finance: Evidence from venture capital investment in China. *Journal of Cleaner Production*, 232(1): 1148-1157.
- Hain D. & Johan S. & Wang D. (2018), Determinants of Cross-Border Venture Capital Investments in Emerging and Developed Economies: The Effects of Relational and Institutional Trust. *Journal of Business Ethics*, 138(4): 743-764.
- Razavi J. & Sharifi R. & Arabi SM. & Pirsahab E. (2017). Presenting a development strategy model of venture investments in the field of ICT. The second international conference and the fourth conference National studies of management and humanities in Iran.
- Bonini S. & Alkan S. (2017). The Macro and Political Determinants of Venture Capital Investments around the World. 16th November 201.