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Designing a Causal Model for Multi-Criteria Decision-Making in Financial Risk Analysis and Financing of IT-Based Startup Companies (BWM-DEMATEL) approach

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Abstract

This research uses a fuzzy Delphi approach to identify the dimensions and components of investor risk and financing for IT-based startup companies. The statistical population for this study consisted of 30 experts and university professors familiar with the research concepts surveyed to select the dimensions and components identified from the literature and prior research. The results from the fuzzy Delphi method showed that the financing and investor risk dimensions were selected in 9 dimensions and 29 components.

The weighting results for the research dimensions and components using the Best-Worst Method (BWM) prioritized each. The weighting results indicate that the industry status ranked first, followed by scientific factors and other components, ranked third to ninth in the LINGO software. Additionally, the intensity of relationships among the research dimensions was assessed using the Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique. The analysis of the intensity of relationships among the dimensions shows that the government factors dimension had the highest numerical value based on the row sum, making it the most influential dimension among those examined in financing startup companies using the DEMATEL technique. Conversely, based on the D-R analysis, the geographic factors dimension received the lowest value and was recognized as the most affected dimension. Using the fuzzy Delphi method, this research has identified specific and novel dimensions and components, such as governmental, geographical, and scientific factors, which have been less addressed in the existing literature.

Keywords: Risk Management, Financial Risk, Financing, Startup Companies, Fuzzy Delphi Technique, Best-Worst Method, Decision-Making Trial and Evaluation Laboratory (DEMATEL).

Introduction

Startups are emerging enterprises that leverage modern technologies to establish new business models. These entities often face numerous challenges and opportunities. On one hand, they possess the potential for rapid growth and high scalability; on the other hand, they encounter limited resources and significant uncertainties (Shahrabi et al., 2019). Financing refers to providing financial and fiscal resources to support various activities, projects, or operations of a company or organization. This process encompasses securing and attracting financial resources such as cash, loans, investments, and other financial means necessary to cover costs and achieve a company's or project's financial objectives. Financing can occur through internal sources (such as operational revenues) or external sources (via loans or attracting investments). This process is fundamental for the growth and survival of organizations and the development of various projects (Haghighi et al., 2019).

In today's global economy, new companies based on information technology, with a high level of investment in research and development, generating new knowledge (science and technology), and employing skilled scientists and professionals, serve as catalysts for transformation. These startups are the primary source of innovation, the backbone of the economy, and the driving force behind entrepreneurship, economic growth, and

sustainable development. In many countries, IT-based startups significantly contribute to growth and development, enhance innovation and new technologies, invigorate industries and markets, create new jobs, and strengthen the labor market (Golalizadeh et al., 2021). One critical and influential factor in enhancing the performance of various companies, including startups, is the constraints of financial resources and limited access to sufficient funding. This challenge hinders efficient, effective funding methods that align with their growth and developmental trajectories (Agustin, 2023). Research findings worldwide indicate that technology-based companies stimulate entrepreneurship and wealth creation. For instance, 75% of the gross domestic product (GDP) in the United Kingdom is generated by technology-based firms (ibid, 2023).

In Iran, the country's top-level documents, including the policies outlined in Article 44 of the Constitution, the Fifth, Sixth, and Seventh Development Plans, and the twenty-year national vision document, recognize the knowledge-based economy and startups as crucial and influential sectors. The development of this sector is prioritized in the country's developmental programs, which, in turn, necessitates the establishment and growth of startups and knowledge-based companies. Consequently, the government and public institutions strive to provide the necessary technical, financial, and legal infrastructures to facilitate the creation and development of new, technology-driven, entrepreneurial companies. One of the key infrastructures essential for the growth and development of these companies is the provision of financial aid, the facilitation of financing processes, and ensuring their access to sufficient financial resources efficiently and under favorable conditions, particularly during the early stages of their growth and development (Haghighi et al., 2019).

Analyzing financial risk and financing for IT-based startups can be a critical tool for successfully managing financial risks and achieving growth and sustainability in technological development and innovation. In light of current economic fluctuations and the depreciation of national currency compared to international currencies, sustaining any business, including startups, requires identifying effective financing strategies. Founders of startups, investors, stakeholders, educators, and researchers interested in financial risk analysis and financing have conducted extensive research on financing in various businesses, including knowledge-based enterprises. However, no research has focused on identifying the dimensions and components of financial risk assessment and analysis in financing IT-based startups in Iran. This study aims to identify the dimensions and components of risk assessment from the

investor's perspective and to understand the financing methods in IT-based startups to mitigate investment risks.

Given these considerations, the fundamental issue is what dimensions and components should be emphasized in the risk assessment from the investor's perspective and in recognizing the financing methods for IT-based startups. Consequently, the primary research question is: What are the dimensions and components of risk assessment from the investor's perspective and the financing methods for IT-based startups based on information technology?

The rationale for using the Best-Worst Method (BWM) and the DEMATEL approach in this research lies in their ability to provide a causal and multi-criteria model that offers a balanced perspective on investment opportunities and risks in startup companies, thereby improving strategic decision-making processes. Additionally, analyzing the intensity of influence and dependency among dimensions using DEMATEL enables a deeper understanding of how various factors impact each other, highlighting key influential and dependent dimensions for policymakers and investors.

The innovation and novelty of this research lie in its innovative combination of two well-established multi-criteria decision-making methods, namely the Best-Worst Method (BWM) and the Decision-Making Trial and Evaluation Laboratory (DEMATEL). This approach allows for simultaneous weighting of criteria and analysis of the relationships and interactions among them. Additionally, the research focuses on identifying and analyzing financial risks and financing in IT-based startup companies. This domain has been less studied due to this industry's unique complexities and challenges.

The following sections will briefly overview the theoretical foundations and literature review, introduce the initial dimensions and components of financing for startups derived from the existing literature, and then discuss the research methodology, findings, and results.

Literature Review

From a theoretical perspective, various political, economic, and legal regulatory elements influence managerial decisions regarding the optimal financing structure. Thus, determining a financing strategy is affected not only by macroeconomic variables such as inflation, interest rates, lending policies in the banking system, and taxation but also by factors like financing costs, financial and commercial risks of companies, asset composition, and contractual limitations on resource acquisition through debt, as well as

revisions in stock market regulations (Amelia, 2023). The following section discusses the classification of different sources of financing.

In financing projects and initiatives, companies' internal resources are prioritized due to their lower costs, reduced risk, and minimal expense. Managers must maximize the efficiency of available cash and short-term investments necessary to maintain current operations. However, sometimes, the cash available in a company is insufficient for expanding operational activities. Consequently, managers may need to propose capital increases, refrain from dividend distribution, create reserves, and seek loans from shareholders at the general assembly, considered the most cost-effective financing methods. This financing approach is particularly beneficial for young companies that are not yet widely recognized and face challenges securing bank loans (Asvinia, 2023).

Internal financing methods include capital and equity, retained earnings, payable dividends, legal and precautionary reserves, asset sales, partner loans, and current accounts. These methods are utilized for operational activities at the lowest capital costs. Typically, managers and shareholders of firms in their early years of operation, facing difficulties in obtaining loans and credit, prefer internal financing due to its cost-effectiveness over other financing methods. However, not distributing dividends for extended periods may lead to dissatisfaction among investors who expect profitability from their investments, ultimately decreasing their motivation to retain capital. Therefore, managers tend to gravitate towards external financing in the long term. Businesses consistently face financial constraints when seeking the necessary funding, and the severity of these constraints can vary based on economic and political conditions, the size of the firm, and the type of industry. For these reasons, businesses require external financing (Basht et al., 2022; Legowo & Juhartoyo, 2022).

Some of the most significant types of external financing methods include:

- Financing
- Refinancing
- Secured credit
- Purchase credit
- International loans
- Countertrade
- Bonds (participation)

- Borrowing from domestic banks (Islamic contracts)
- Accounts and payables
- Prepayments
- Off-balance-sheet financing
- Grants from the government

Financing, in its literal sense, refers to finance or funding and is considered a standard method for securing external financing for projects (Usanti, 2023; Zhang, 2023). Table 1 illustrates the various contracts involved in financing.

Table 1. Types of Contracts in the Financing Method of Economic Enterprises

Row	Name of contracts	Abbreviation
1	Build, Operate & Transfer	B.O.T
2	Build, Operate & Ownership	B.O.O
3	Build, Ownership, Operate & Sell	B.O.O.S
4	Build, Ownership, Operate & Transfer	B.O.O.T
5	Build, Lease & Transfer	B.L.T
6	Build & Transfer	B.T
7	Build, Lease & Operate	B.L.O
8	Design, Built, Operate & Maintenance	D.B.O.M
9	Rehabilitate, Operate & Transfer	R.O.T
10	Rehabilitate, Operate & Ownership	R.O.O
11	Modernize, Operate & Ownership	M.O.O.T
12	Build, Transfer & Operate	B.T.O
13	Design, Built, Finance & Operate	D.B.F.O

Several important studies have been conducted in the area of financing various companies and organizations:

Azad et al. (2025) conducted a study titled "Portfolio Optimization with Systemic Risk Approach." The results of empirical analysis of out-of-sample data (during 1198 days) show that based on all three mentioned criteria, the first proposed model shows the best performance among the three models. In addition, the performance of the second model is ranked second. In short, considering systemic risk in portfolio optimization leads to better performance than the Markowitz model.

Zarinjooei et al. (2025) conducted a study titled "Identifying and Prioritizing the Factors Affecting Enterprise Risk Management Implementation." The results demonstrated that five factors determine ERM effectiveness: 1. corporate governance indicators (monitoring the board of directors and ownership structure), 2. Financial indicators (return on assets (ROA), earnings volatility, merger and acquisition (M&A) activities, financial

deficiency, and capital opacity), 3. Environmental indicators (performance excellence, industry competition, audit firm credibility, environmental uncertainty, and industry), 4. Firm characteristics (financial leverage, size, and growth opportunities), and 5. Management indicators (management career and business diversity).

Jahan-Tigh and Taftian (2023) conducted a study titled "Identifying Factors Influencing Financing in Startup Companies through the Capital Market." This research aimed to identify the factors affecting financing for startups via the capital market. The statistical population included two groups: the first group consisted of ten experts selected from managers and specialists in startup companies. In contrast, the second group comprised 247 employees from these companies, determined using Cochran's formula. The results indicated that economic factors ranked first with the highest priority among the identified factors, followed by industry status with a normalized weight of 0.141, and scientific factors with a normalized weight of 0.125 in third place. Additionally, factors related to the location of companies were ranked last.

Khodjasteh et al. (2021) explored "The Effects of Social Media Advertising on Financing Small and Medium Enterprises." This study aimed to examine the impact of social media advertising on financing small and medium enterprises. The findings revealed that social media advertising outcomes for these businesses included market development and financing, value creation, branding, and long-term, two-way engagement with the audience. According to factorial analysis, the second-order factor loadings were 0.94 for market development and financing, 0.66 for value creation, 0.89 for branding, and 0.92 for long-term relationships and two-way interaction with the audience, indicating a moderate to high correlation between the components and their indicators.

Golalizadeh et al. (2021) identified and categorized the challenges of financing knowledge-based companies in Iran. One of the significant factors influencing these companies' performance, growth, and development, as well as a primary obstacle, is financial resource constraints. This research aimed to identify the challenges of financing knowledge-based companies in Iran using a mixed exploratory approach. The most notable innovations and findings from this study highlighted that knowledge, organizational, and professional weaknesses, aversion to risk, poor performance of existing funding institutions, lack of connections between these companies and larger firms for financial, investment, and marketing support, insufficient funds and guarantees, and sociocultural weaknesses for participation and investment, and finally infra-

structural issues (political, legal, executive, …) are among the most significant challenges facing the financing of knowledge-based companies.

Hosseini and Esmaeilpour (2020) examined the impact of financial performance on the financing methods of public companies in the defense sector and proposed a financing model through the capital market. In developing countries, the execution of defense projects is typically the responsibility of governments. Since the financial resources required for these projects are substantial, they constitute a significant portion of government budgets. Therefore, the issue of focusing on various methods and tools to attract the necessary financial resources becomes critical. The study investigated financing the defense sector through capital markets in EU member states and the USA, proposing a financing model for the defense-related industries and services of the Islamic Republic of Iran. The correlation analysis and Panel ARDL model were used to examine the relationship between financing methods and financial performance of defense-related public companies over the period from 2001 to 2018. Findings indicated that larger companies could secure more financial needs through equity and retained earnings. In contrast, more profitable companies demonstrated a greater capacity to attract financial resources through debt.

Haghighi et al. (2019) conducted a study titled "Examining the Impact of Western Sanctions on the Financing Strategies of New Technology-Based Companies in Iran." The main objective of this research was to analyze the impact of Western sanctions on the financing strategies of new technology-based companies in Iran. The statistical population consisted of new technology-based companies, with a sample size 384 determined using Krejcie and Morgan's Table. The research method was descriptive-applied, utilizing path analysis, correlation analysis, and structural equation modeling as data analysis tools. Overall, the findings indicated that the significance levels were below 5%, demonstrating the significance of the corresponding paths at a 95% confidence level. The results suggest that intra-company variables significantly influence both traditional and modern financing methods, considering the role of mediating variables; additionally, external variables, through intermediary variables, have a significant impact on both traditional and modern financing methods, as determined at a significant level. These results, in turn, highlight the importance of both internal and external factors in shaping the financing strategies of startup companies in Iran.

Manavar et al. (2023) explored the "Evolution of Financing Technology in Indonesia." The study employed library research and descriptive methods for data collection, utilizing descriptive and analytical statistical techniques for

data processing. Financial technology (Fintech) has its roots in industrialized countries with established infrastructures, modern technology, and societies inclined to utilize digital devices. However, this is not the case for developing countries. Fintech faces challenges entering impoverished nations and enhancing their financial engagement, even if this does not hold for emerging economies. This study aims to identify best global practices in Fintech and examine how they can improve the economic conditions of residents in poorer countries. The research categorized problems into three groups: lack of infrastructure, less digital-unorganized communities, and informal, unstructured cultures. It then examined three Fintech elements—microtaxes, crowdfunding, and digital payment systems—as the best representatives of these categories.

Xia et al. (2019) examined the impact of environmental factors on financing small and medium-sized enterprises (smes) in China. The financial environment, including governmental and credit environments, plays a significant role in financing SMEs. This study analyzed four environmental factors that can significantly influence SME financing. The researchers selected a principal component analysis method based on industry growth rates. The ratio of bank deposits to loans, financial budget revenue to financial expenditure, and non-performing loan rates were considered as factors influencing SME financing. Regression analysis revealed a significant relationship between financing and environmental factors affecting SMEs. The results indicated that the economic environment, financial environment, governmental conditions, and credit availability impact SME financing in descending order of significance. The identified influential dimensions in SME financing included the economic environment (with indicators such as the country's GDP, per capita GDP, income from residents, and secondary industry income growth); the financial environment (with indicators like bank loan growth rates, deposit loan rates, the number of financing institutions, and the increase in financing value for industries); the governmental environment (with indicators like the budget revenue to expenditure ratio, budget deficit to expenditure ratio, budget deficit to revenue ratio, and administrative costs to budget revenue ratio); and the credit environment (with indicators such as non-performing loan rates, the ratio of insured individuals to total personnel, unemployment costs to total insured costs, and the number of firms with credit ratings).

Ughetto et al. (2019) examined regional and geographical issues in financing and investment for small and medium-sized enterprises (SMEs). The results of this research showed that while financing these enterprises

contributes significantly to economic growth and brings about positive political and geographical outcomes, financing these enterprises plays a valuable role in securing funding for these industries, reinvestment, and obtaining financial resources through traditional options such as bank loans, attracting investors, and issuing shares, yet, the geographical location of these businesses can influence the financing process. Therefore, strong regional financial policies are needed to design and implement a systematic approach in policymaking to finance SMEs. Additionally, policymakers should focus on the local effects of financial ecosystem structure and health when allocating financial resources.

Cainelli and Giannini (2019) conducted a study titled "Small Enterprises and Bank Financing in Inopportune Times," comparing the extent of financing provided to small businesses dependent on business groups through the banking system with independent companies that sought financing without banking support. The research examined Italian manufacturing firms during the financial crisis and severe economic recession from 2010 to 2012. It explored two distinct methods for obtaining bank financing: assessing the dependency impact of bank-guaranteed securities and transferring financial resources through capital markets. Their findings confirmed the hypotheses, indicating that facilitating access to bank financing led to greater success than businesses obtaining financing through other means.

Research Methodology

The present research is applied in nature, as it will be used to assess risk from the perspective of investors and the financing of IT-based startup companies. The research approach is mixed-method (qualitative-quantitative). In the qualitative phase, the fuzzy Delphi method was employed to identify and screen dimensions and components derived from the literature and prior research. In the quantitative phase, the Best-Worst Method (BWM) and expert surveys were used to determine the weight and priority of each dimension and component and to examine the intensity of influence and impact among the financial dimensions of startup companies and their financial risk analysis.

The fuzzy Delphi method was used in the qualitative phase to identify the research dimensions and components. The statistical population consists of 30 experts and senior managers from 50 active startup companies in the information and communication technology sector, each with a minimum of 15 years of executive experience in IT-based services at the national level and university professors knowledgeable in corporate financing concepts. Their insights were used to respond to the fuzzy Delphi questionnaire and to validate

the reliability and validity of the questionnaires.

The sampling method for the experts was a census, meaning all 30 experts were invited to complete the fuzzy Delphi questionnaire. The characteristics of the experts are outlined in Table (2).

Table 2. General Characteristics of Experts in the Current Study

Row	Feature	Experience	Number
1	University professors proficient in financial concepts and startup companies	Over 15 years	5 people
2	Experts from startup companies with a bachelor's degree or higher	Over 10 years	10 people
3	Middle and senior managers of startup companies with a bachelor's degree or higher	Over 20 years	5 people
4	Senior managers of startup companies with a master's or PhD degree	Over 15 years	10 people
5	Total number of experts		30 people

Fuzzy Delphi Technique

The ability to make effective decisions in situations with insufficient information has led to adopting consensus or group agreement methods, such as brainstorming, nominal groups, and the Delphi technique. The Delphi method is particularly useful when a group of experts is geographically dispersed and cannot convene in one location. It serves as a tool for decision-making and qualitative forecasting by diverse specialists.

In the 1950s, Dalkey and his colleagues at the RAND Corporation undertook a project for the U.S. Army, which aimed to gather the perspectives of a group of experts using a questionnaire. This initiative led to the Delphi method, named after the ancient Greek oracle known for its prophecies. The Fuzzy Delphi method evolved from traditional Delphi techniques and fuzzy set theory. Traditional Delphi questionnaires often exhibited ambiguity and vagueness in questions and responses. Furthermore, significant challenges are related to the fuzziness of expert consensus within a group decision-making context.

Over the past three decades, researchers have revisited the Fuzzy Delphi method due to the importance of addressing the ambiguity among experts. This approach employs fuzzy numbers or fuzzy set theory, where each set has a value ranging from zero to one. Consequently, it reduces the cost and time

required to evaluate questionnaire items. This reduction in research frequency increases the rate of item retrieval, allowing experts to express their opinions without any ambiguous deviation, ultimately reaching a consensus without compromising their genuine views.

The Delphi technique is based on the perspectives of respondents. The traditional Delphi method has often suffered from low convergence of expert opinions, high implementation costs, and the potential exclusion of some individuals' views. To improve the traditional Delphi method, Murray and colleagues proposed integrating the traditional Delphi method with fuzzy theory in 1985. Ishikawa and colleagues (2012) further introduced the application of fuzzy theory in the Delphi method. They developed a fuzzy integration algorithm to predict the future penetration rate of computers in organizations (Feyzi et al., 2019).

In this study, the algorithm for implementing the Fuzzy Delphi technique was utilized to screen the dimensions and components of financing for information technology-based startups. The steps of the Fuzzy Delphi method can be summarized as follows:

- Identifying the desired range for fuzzifying verbal expressions
- Aggregating fuzzy values
- Defuzzifying the values
- Selecting threshold intensity and screening components

Table 3 presents triangular fuzzy numbers using a five-point Likert scale. The confirmed fuzzy numbers in Table 3 were calculated using Equation (1), where $\tilde{N}=(l,m,u)$. ($\tilde{N}$ represents a fuzzy number).

$$Crisp(\tilde{N}) = \frac{2m + l + u}{4} \quad (1)$$

Table 3. Triangular Fuzzy Numbers and Crisp Values of Linguistic Terms (Feizi et al., 2019)

Linguistic Terms	Triangular Fuzzy Numbers			Crisp Value
Very Low Importance	0/25	0	0	0/063
Low Importance	0/5	0/25	0	0/25
Medium Importance	0/75	0/5	0/25	0/5
Important	1	0/75	0/5	0/75
Very Important	1	1	0/75	0/94

Best-Worst Method

The Best-Worst Method (BWM) was proposed by Rezaei (2015). This technique is one of the most effective multi-criteria decision-making methods based on pairwise comparisons. BWM requires fewer pairwise comparisons than similar techniques while providing more reliable results (Rezaei, 2015).

Steps of the Best-Worst Method

Step 1: Define the Research Criteria

In the first step, the research problem must be identified, and the factors influencing the objective of the problem should be extracted. Finally, these factors need to be validated by experts in the field. Techniques such as the Delphi or Fuzzy Delphi methods can be used for this purpose, as they aim to confirm and screen research indicators. This study employed the Fuzzy Delphi technique to identify the dimensions and criteria for assessing credit risk in the banking industry.

Step 2: Compare the Best Criterion with Other Criteria (BO) and Other Criteria with the Worst Criterion (OW)

In this step, the most important and least important criteria must be identified among all indicators, referred to as the Best and Worst criteria. Subsequently, pairwise comparisons are made between the Best criterion and the other criteria, as well as between the other criteria and the Worst criterion, forming two matrices. These comparisons are addressed using a scale from 1 to 9.

Step 3: Create a Non-linear Programming Model

In this step, a non-linear optimization model for the BWM is developed using the following Equation:

$$\min \xi$$

$$s.t:$$

$$\left|\frac{W_b}{W_j} - a_{Bj}\right| \le \xi, for \to all \to j$$

$$\left|\frac{W_j}{W_w} - a_{jw}\right| \le \xi, for \to all \to j$$

$$\sum_{j=1}^{n} (W_j) = 1$$

$$W_j \ge 0, for \to all \to j$$

$$j = 1, 2, \ldots, n \qquad (2)$$

In Equation (2), W_b represents the weight of the Best criterion, W_w indicates the weight of the Worst criterion, W_j is the weight of the j-th criterion, a_{Bj} denotes the preference of the Best criterion over the j-th criterion, and a_{jw} shows the preference of the j-th criterion over the Worst criterion (Rezaei, 2015).

In order to calculate the inconsistency rate, the obtained ξ value and the consistency index (CI) reported for different aBW values are used in Equation (3). Table 4 shows the consistency indices specific to the BWM technique (Rezaei, 2015).

Table 4. Compatibility Indices Specific to BWM

a_{BW}	1	2	3	4	5	6	7	8	9
CI	0/00	0/44	1/00	1/63	2/30	3/00	3/73	4/47	5/23

$$IR = \frac{\xi^*}{CI} \qquad (3)$$

Decision Making Trial and Evaluation Laboratory (DEMATEL)

The DEMATEL technique was introduced by Fonetla and Gabus in 1971. This type of decision-making approach based on pairwise comparisons, utilizes expert judgment to extract factors from a system and systematically structure them using graph theory principles. It provides a hierarchical framework of the

factors present in the system along with their influence and interrelationships, quantifying the intensity of these relationships through specific numerical scores. DEMATEL is employed to identify and analyze the interrelationships among criteria and to map their network relationships.

Since directed graphs can better represent the relationships among system elements, the DEMATEL technique is based on diagrams that classify the involved factors into cause-and-effect groups, presenting their relationships in a comprehensible structural model. DEMATEL is generally used to address complex issues and is also applicable for structuring a sequence of presumed information. It assesses the intensity of relationships through scoring, investigates feedback along with their significance, and accepts non-transferable relationships. Steps of the DEMATEL Method include:

1. Designing the Questionnaire and Collecting the Information on the Relative Dependency of Dimension from Experts

2. Calculating the Direct Relationship Matrix (Z)

3. Calculating the Normalized Direct Relationship Matrix (S)

4. Calculating the Total Relationship Matrix (Direct and Indirect Dependency) (T)

5. Calculating the Normalized Total Relationship Matrix with Acceptance Threshold

6. Forming the Network Relationship Map Based on Two Vectors: D and R

The overall structure of the diagram illustrating the relationships among criteria is depicted in Figures 1-3. In this matrix, pairwise comparisons will be conducted to calculate the influence of the row factor on the column factor. The comparison scores include (1, 2, 3, and 4), representing very low to very high levels of influence, respectively. The elements of the matrix below, also referred to as the direct relationship matrix, will be shaped based on the influence of criterion i on criterion j.

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1j} \cdots & a_{1n} \\ \vdots & & \vdots & \vdots \\ a_{i1} & \cdots & a_{ij} \cdots & a_{in} \\ \vdots & & \vdots & \vdots \\ a_{n1} & \cdots & a_{nj} \cdots & a_{nn} \end{bmatrix}$$

Figure 1. Diagram of Direct Relationships among Criteria

Equations (4) and (5) normalize the direct relationship matrix.

$$S = m \,.\, AS = m \,.\, A \tag{4}$$

$$m = min\left[\frac{1}{max_i \sum_{j=1}^{n} |a_{ij}|}, \frac{1}{max_j \sum_{i=1}^{n} |a_{ij}|}\right]$$
$$m = min\left[\frac{1}{max_i \sum_{j=1}^{n} |a_{ij}|}, \frac{1}{max_j \sum_{i=1}^{n} |a_{ij}|}\right] \tag{5}$$

The total relationship matrix T is calculated using the matrix S through Equation (6), I a unit matrix.

$$T = S(I - S)^{-1}T = S(I - S)^{-1} \tag{6}$$

Two vectors, D and R, are used to determine the network relationship mapping, representing the sums of the rows and columns of the matrix T, respectively. The calculations for these vectors are provided in Equations (7) and (8).

$$D = [d_i]_{n\times 1} = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} \tag{7}$$

$$R = [r_j]_{n\times 1} = \left[\sum_{i=1}^{n} t_{ij}\right]_{1\times n} \tag{8}$$

d_i is the sum of the i-th row of matrix T, representing the total direct and indirect impacts of criterion i on other criteria. Similarly, r_j is the sum of the j-th column of matrix T indicates the total direct and indirect impacts that other criteria exert on criterion j.

$(d_i + r_i)(d_i + r_i)$ reflects the primary influence of factor i in the problem. If $(d_i - r_i)(d_i - r_i)$ itis positive, it implies that other factors are influenced by factor i. Conversely, when $(d_i - r_i)(d_i - r_i)$ itis negative, it indicates that other factors impact factor i. Thus, the mapping of network relationships is constructed.

Figure 2 illustrates the dependency relationship diagram among the criteria (Feizi & Javanmard, 2017).

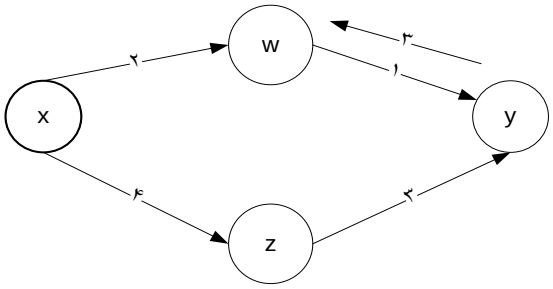

Figure 2. Example of the Dependency Relationship Graph among Criteria

Results

Results of Fuzzy Delphi Analysis

Based on the review of the theoretical foundations and prior research regarding the dimensions and components of financing information technology-based startups, a Fuzzy Delphi questionnaire was initially designed. After validating its reliability and validity in two phases, the questionnaire was distributed to experts. Subsequently, the results were compiled, as shown in Table 4, where criteria with a mean difference greater than 0.1 were eliminated, and the remaining criteria were selected. The screening analysis identified nine dimensions and 35 components related to the financing of startups, from which 29 components were selected through the Fuzzy Delphi technique and expert opinions. At the same time, those marked in gray in Table 5 were removed based on the Fuzzy Delphi results.

Table 5. De-fuzzified Mean Differences of Research Variables in the First and Second Phases of the Fuzzy Delphi

Row	Dimension	Component	First Round Average	Second Round Average	Difference Between Rounds	Result (Selected or Removed)
1	Administrative Factors	Governance of logic and justice in granting licenses for economic activities	0.330	0.279	0.051	Selected
2		Support for public safety and health by departments	0.388	0.310	0.078	Selected
3		Facilitation of starting activities for entrepreneurs in the investment field	0.310	0.312	0.02	Selected
4	Personal Factors	Innovation in investment	0.378	0.432	0.053	Selected
5		Confidence in investment	0.378	0.448	0.070	Selected
6		Optimism about the future	0.181	0.320	0.139	Removed
7		Investment experience	0.342	0.275	0.067	Selected
8		Risk-taking	0.379	0.369	0.01	Selected
9	Economic Factors	High security of investment	0.305	0.337	0.032	Selected
10		The balance between cost and risk	0.388	0.453	0.066	Selected
11		Low labor cost	0.185	0.342	0.157	Removed
12		Fairness of the tax system	0.188	0.320	0.132	Removed
13		Obtaining financial facilities	0.400	0.440	0.040	Selected
14		Clear and transparent tariffs	0.397	0.458	0.060	Selected
15		Stability of exchange rates	0.181	0.190	0.009	Selected
16	Governmental Factors	Development of equipment and industrial support	0.379	0.359	0.021	Selected
17		Presence of unified and coherent decision-making authorities	0.349	0.286	0.063	Selected
18		Suitable geographic and economic location for establishing startup companies by the government	0.330	0.279	0.051	Selected
19		Attention and proper enforcement of laws	0.344	0.450	0.106	Removed

Table 5. De-fuzzified Mean Differences of Research Variables in the First and Second Phases of the Fuzzy Delphi

Row	Dimension	Component	First Round Average	Second Round Average	Difference Between Rounds	Result (Selected or Removed)
		and regulations				
20		Proper policymaking in investment	0.310	0.312	0.02	Selected
21		Attention to the availability of sufficient facilities for investment	0.444	0.444	0.000	Selected
22	Industry Status	Lack of dependence of industry on uncontrollable external factors	0.344	0.346	0.002	Selected
23		High demand for products	0.364	0.364	0.000	Selected
24		Upward growth of the industry	0.378	0.891	0.513	Removed
25		Low systematic risk of the industry	0.353	0.356	0.003	Selected
26	Locational Factors	Creation of infrastructure to protect the company	0.378	0.380	0.003	Selected
27		Separation of units from each other	0.539	0.539	0.000	Selected
28		Suitable infrastructure (water, electricity, gas, sewage, roads, etc.)	0.555	0.557	0.002	Selected
29	Geographical Factors	Proximity to an optimal labor market	0.310	0.312	0.002	Selected
30		Access to natural resources	0.330	0.279	0.051	Selected
31		Proximity to the global economic center	0.555	0.920	0.365	Removed
32	Legal Factors	Laws and regulations to encourage investors	0.388	0.310	0.078	Selected
33		Clarity of laws and regulations related to attracting foreign investment	0.310	0.312	0.002	Selected
34	Scientific Factors	Conducting necessary research to identify obstacles and influential factors in startup company investment	0.417	0.421	0.004	Selected
35		Conducting feasibility studies and cost-benefit analysis of investments	0.362	0.362	0.000	Selected

Table 6 presents the dimensions and components of financing for information technology-based startups.

Table 6. Weights of Financing Dimensions for IT-Based Startups Using the BWM Technique

Row	Dimension	Component
1	Economic Factors	High investment security
2		The balance between cost and risk
3		Obtaining financial facilities
4		Clear and transparent tariffs
5		Stability of exchange rates
6	Governmental Factors	Development of equipment and industrial support
7		Presence of unified and coherent decision-making authorities
8		Suitable geographic and economic location for establishing startup companies by the government
9		Proper policymaking in investment
10		Attention to the availability of sufficient facilities for investment
11	Personal Factors	Innovation in investment
12		Confidence in investment
13		Investment experience
14		Risk-taking
15	Administrative Factors	Governance of logic and justice in granting licenses for economic activities
16		Support for public safety and health by departments
17		Facilitation of starting activities for entrepreneurs in the investment field
18	Industry Status	Lack of dependence of industry on uncontrollable external factors
19		High demand for products
20		Low systematic risk of the industry
21	Locational Factors	Creation of infrastructure to protect the company
22		Separation of units from each other
23		Suitable infrastructure (water, electricity, gas, sewage, roads, etc.)
24	Scientific Factors	Conducting necessary research to identify obstacles and influential factors in startup company investment
25		Conducting feasibility studies and cost-benefit analysis of investments
26	Legal Factors	Laws and regulations to encourage investors
27		Clarity of laws and regulations related to attracting foreign investment
28	Geographical Factors	Proximity to an optimal labor market
29		Access to natural resources

Results of Weighting Dimensions and Components Using the Best-Worst Method

After determining the dimensions and components of financial risk and financing for information technology-based startups based on expert opinions and screening using the Fuzzy Delphi technique, this section employs data from pairwise comparison questionnaires, utilizing a scale from one to nine, the average expert opinion, and the Best-Worst Method (BWM) to rank and weight each dimension and component of the study.

The mathematical model for minimizing each dimension and component was developed in Lingo software (Ver. 18). The results from solving the model are presented in the following, including the weights of the dimensions in Table 7 and the weights of the components for each dimension in Table 8.

The following demonstrates the coding conducted in Lingo software for financing dimensions for information technology-based startups.

```
Min=ξ;
@abs (w8/w1-4.4) <=ξ;
@abs (w8/w2-5.5) <=ξ;
@abs (w8/w3-1.5) <=ξ;
@abs (w8/w4-1.1) <=ξ;
@abs (w8/w5-1)   <=ξ;
@abs (w8/w6-2.5) <=ξ;
@abs (w8/w7-1)   <=ξ;
@abs (w8/w9-9)   <=ξ;

@abs (w1/w9-1.5) <=ξ;
@abs (w2/w9-1.5) <=ξ;
@abs (w3/w9-4.5) <=ξ;
@abs (w4/w9-5.5) <=ξ;
@abs (w5/w9-9)   <=ξ;
@abs (w6/w9-2.5) <=ξ;
@abs (w7/w9-9)   <=ξ;
@abs (w8/w9-9)   <=ξ;

w1+w2+w3+w4+w5+w6+w7+w8+w9=1;
w1>=0;
w2>=0;
w3>=0;
w4>=0;
w5>=0;
w6>=0;
w7>=0;
w8>=0;
w9>=0;

end model
```

Table 7. Weights of Financing Dimensions for IT-Based Startups Using the BWM Technique

Dimension	Wj (Weights for Each Dimension)	Rank
Economic Factors	0/044	7
Governmental Factors	0/039	8
Personal Factors	0/1	5
Administrative Factors	0/135	4
Locational Factors	0/067	6
Scientific Factors	0/195	2
Legal Factors	0/194	3
Industry Status	0/204	1
Geographical Factors	0/022	9
Value of ξ^*	0/427	
Consistency Index	5/23	
Consistency Ratio	0/081	

According to Table 7, the industry status dimension received a weight of 0.204, ranking first, followed by scientific factors with a weight of 0.195, and the remaining factors ranked third to ninth based on BWM calculations in Lingo software.

Additionally, the calculated consistency ratio was 0.081, which is less than 0.1, indicating that the results of this analysis can be trusted and that the questionnaire dimensions are reliable. Also, the value of ξ^* was 0.427, derived from calculations in Lingo. The consistency index, based on the consistency index table and considering the pairwise comparison of the most important (Best) dimension relative to the least important (Worst) dimension—namely, the industry status compared to geographic factors, which received a score of 9—yields a consistency index value of 5.23 for the numerical value of 9. It is also important to note that the consistency ratio is calculated by dividing the value ξ^* by the computed consistency index. The weights of the criteria for each dimension of financing information technology-based startups, determined using the Best-Worst Method, are presented in Table 8.

Table 8. Weights of Components for Each Financing Dimension and Financial Risk of Startups Using the BWM Technique

Row	Dimension	Component	Weights Wj	Rank	Value of ξ^*	Consistency Index	Consistency Ratio
1	Economic Factors	High investment security	0/257	2	0/378	5/23	0/072
2		The balance between cost and risk	0/259	1			
3		Obtaining financial facilities	0/234	3			
4		Clear and transparent tariffs	0/108	5			
5		Stability of exchange rates	0/142	4			
6	Governmental Factors	Development of equipment and industrial support	0/262	2	0/5	5/23	0/095
7		Presence of unified and coherent decision-making authorities	0/106	5			
8		Suitable geographic and economic location for startups by the government	0/219	3			
9		Proper policymaking in investment	0/267	1			
10		Attention to the availability of sufficient facilities for investment	0/146	4			

Row	Dimension	Component	Weights Wj	Rank	Value of ξ^*	Consistency Index	Consistency Ratio
11	Personality Factors	Innovation in investment	0/484	1	0/274	5/23	0/052
12		Confidence in investment	0/064	4			
13		Investment experience	0/380	2			
14		Risk-taking	0/072	3			
15	Administrative Factors	Governance of logic and justice in granting licenses for economic activities	0/517	1	0/216	5/23	0/041
16		Support for public safety and health by departments	0/058	3			
17		Facilitation of starting activities for entrepreneurs in the investment field	0/425	2			
18	Industry Status	Lack of dependence of industry on uncontrollable external factors	0/406	2	0/274	5/23	0/052
19		High demand for products	0/517	1			
20		Low systematic risk of the industry	0/077	3			
21	Locational Factors	Creation of infrastructure to protect the company	0/406	2	0/5	5/23	0/095
22		Separation of units from each other	0/531	1			

Row	Dimension	Component	Weights Wj	Rank	Value of ξ^*	Consistency Index	Consistency Ratio
23		Suitable infrastructure (water, electricity, gas, sewage, roads, etc.)	0/063	3			
24	Scientific Factors	Conducting necessary research to identify obstacles and influential factors in startup company investment	0/106	2	0/5	5/23	0/095
25		Conducting feasibility studies and cost-benefit analysis of investments	0/894	1			
26	Legal Factors	Laws and regulations to encourage investors	0/897	1	0/25	5/23	0/047
27		Clarity of laws and regulations related to attracting foreign investment	0/103	2			
۲8	Geographic Factors	Proximity to an optimal labor market	0/878	1	0/25	5/23	0/047
29		Access to natural resources	0/122	2			

Continuation of Table 8. Weights of Financial Risk Analysis Dimensions from the Investors' Perspective in Startups Using the BWM Technique

Row	Dimension	Weights Wj	Rank	Value of ξ^*	Consistency Index	Consistency Ratio
1	Market uncertainty	0/045	7	0/5	5/23	0/095
2	Financial and resource limitations	0/032	8			
3	Technological changes	0/113	5			
4	Inability to attract and retain a suitable team	0/121	4			
5	Economic and political changes	0/210	1			
6	Legal risk	0/068	6			
7	Operational risks	0/196	2			
8	Technical risks	0/193	3			
9	Managerial risk	0/022	9			

Analysis of Interrelationships Among Research Dimensions Using DEMATEL

After determining the weights and importance of the dimensions of risk analysis and financing for information technology-based startups, a pairwise comparison questionnaire was distributed to 30 experts (following validation) to assess the intensity of interrelationships among the dimensions using a scoring range from 0 to 4, where 0 indicates very low impact and 4 indicates very high impact. The DEMATEL technique follows an algorithm consisting of nine steps. Due to page limitations, only the research results are presented. Table 9 illustrates the influence hierarchy of the financing dimensions among information technology-based startups.

Table 9. Ranking the Influence of Financing Dimensions for Startups Based on DEMATEL Results

Order of Elements	From Highest Row Sum (D)	Order of Elements	From Highest Column Sum (R)	Order of Elements	Based on D+R	Order of Elements	Based on D-R
P2	1.156	P9	1.405	P4	1.486	P4	1.486
P3	0.667	P6	0.749	P9	1.436	P2	1.185
P6	0.319	P7	0.454	P6	1.068	P6	1.068
P8	0.298	P8	0.423	P2	1.127	P5	0.823
P5	0.240	P1	0.138	P5	0.823	P8	0.721
P4	0.117	P2	-0.029	P8	0.721	P3	0.702
P1	0.081	P3	-0.035	P3	0.632	P7	0.534
P7	0.080	P5	-0.583	P7	0.534	P1	-0.057
P9	0.031	P4	-1.369	P1	0.219	P9	-1.374

- Economic Factors (P1)
- Governmental Factors (P2)
- Personal Factors (P3)
- Administrative Factors (P4)
- Industry Status (P5)
- Locational Factors (P6)
- Scientific Factors (P7)
- Legal Factors (P8)
- Geographical Factors (P9)

Table 10. Ranking the Influence of Financial Risk Analysis Dimensions from the Investors' Perspective Based on DEMATEL Results

Order of Elements	From Highest Row Sum (D)	Order of Elements	From Highest Column Sum (R)	Order of Elements	Based on D+R	Order of Elements	Based on D-R
C1	0.953	C8	0.822	C4	1.393	C1	0.865
C4	0.887	C4	0.506	C8	1.359	C7	0.691
C8	0.537	C9	0.403	C1	1.041	C3	0.624
C7	0.409	C3	0.331	C3	0.624	C5	0.550
C5	0.388	C1	0.088	C2	0.542	C2	0.542
C6	0.322	C6	-0.041	C9	0.5	C4	0.381
C3	0.293	C5	-0.162	C6	0.281	C6	0.363
C2	0.130	C7	-0.282	C5	0.226	C8	-0.285
C9	0.097	C2	-0.412	C7	0.127	C9	-0.306

- Market Uncertainty (C1)
- Financial and Resource Constraints (C2)
- Technological Changes (C3)
- Inability to Attract and Retain the Right Team (C4)
- Economic and Political Changes (C5)
- Legal Risks (C6)
- Operational Risks (C7)
- Technical Risks (C8)
- Management Risks (C9)

To determine the intensity of relationships and the impact of risk dimensions from the perspective of investors and the financing risks of startups, the previous section discussed their evaluation using the DEMATEL technique. This section presents causal-effect diagrams based on the obtained values of (D + R) and (D - R). The (D + R) values indicate the overall impact of the factors, while (D - R) reflects the susceptibility of each factor. Generally, if (D - R) is positive, the variable is considered causal, whereas if it is negative, it is considered an effect.

The causal-effect diagrams are plotted on a Cartesian coordinate system, with the horizontal axis representing (D + R) and the vertical axis representing (D - R). The position of each factor is determined by the coordinates (D - R, D + R). Tables 11 and 12 display the dimensions of financing risk and financial risk analysis from the investors' perspective in information technology-based startups, illustrating these relationships within each dimension.

Table 11. Results of Causal Relationships Among Financing Risk Dimensions in Startups Using DEMATEL

Variable Type	Based on D-R	Order of Elements	Based on D+R	Order of Elements
Cause	1.486	P4 Administrative Factors	1.486	P4 Administrative Factors
Cause	1.185	P2 Governmental Factors	1.436	P9 Geographical Factors
Cause	1.068	P6 Locational Factors	1.068	P6 Locational Factors
Cause	0.823	P5 Industry Status	1.127	P2 Governmental Factors
Cause	0.721	P8 Legal Factors	0.823	P5 Industry Status
Cause	0.702	P3 Personal Factors	0.721	P8 Legal Factors
Cause	0.534	P7 Scientific Factors	0.632	P3 Personal Factors
Effect	-0.057	P1 Economic Factors	0.534	P7 Scientific Factors
Effect	-1.374	P9 Geographical Factors	0.219	P1 Economic Factors

Figure 3 presents the causal-effect diagram of the dimensions of financing risk in information technology-based startups, calculated using the DEMATEL technique.

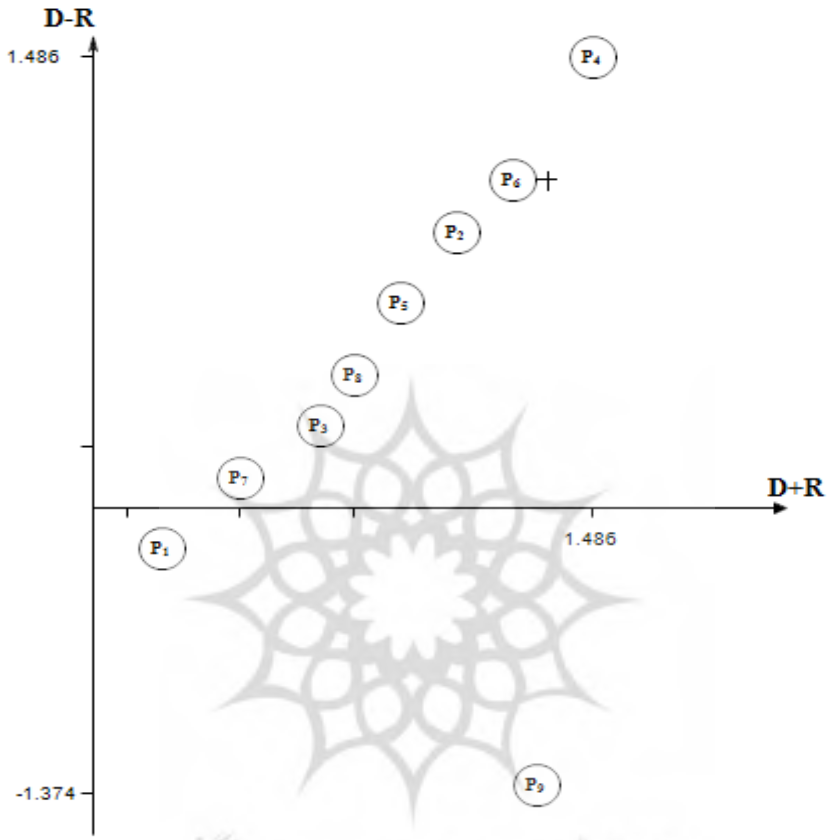

Figure 3. Causal-Effect Diagram of Financing Risk Dimensions in Startups Using DEMATEL

According to the results presented in Figure 1, the dimension of governmental factors (P2) has the highest numerical value based on the row sum (D), making it the most influential dimension among the financing dimensions analyzed for startups using the DEMATEL technique. Additionally, based on (D - R), the dimension of geographical factors (P9) received the lowest value, identifying it as the most susceptible dimension.

Table 12. Results of Causal Relationships Among Investor Risk Dimensions in Startups Using DEMATEL

Variable Type	Based on D-R	Order of Elements	Based on D+R	Order of Elements
Cause	0.865	C1 Market Uncertainty	1.393	C4 Inability to Attract and Retain Team
Cause	0.691	C7 Operational Risks	1.359	C8 Technical Risks
Cause	0.624	C3 Technological Changes	1.041	C1 Market Uncertainty
Cause	0.550	C5 Economic and Political Changes	0.624	C3 Technological Changes
Cause	0.542	C2 Financial and Resource Constraints	0.542	C2 Financial and Resource Constraints
Cause	0.381	C4 Inability to Attract and Retain Team	0.5	C9 Management Risks
Cause	0.363	C6 Legal Risks	0.281	C6 Legal Risks
Effect	-0.285	C8 Technical Risks	0.226	C5 Economic and Political Changes
Effect	-0.306	C9 Management Risks	0.127	C7 Operational Risks

Figure 4 illustrates the causal-effect diagram of investor risk dimensions in information technology-based startups, calculated using the DEMATEL technique.

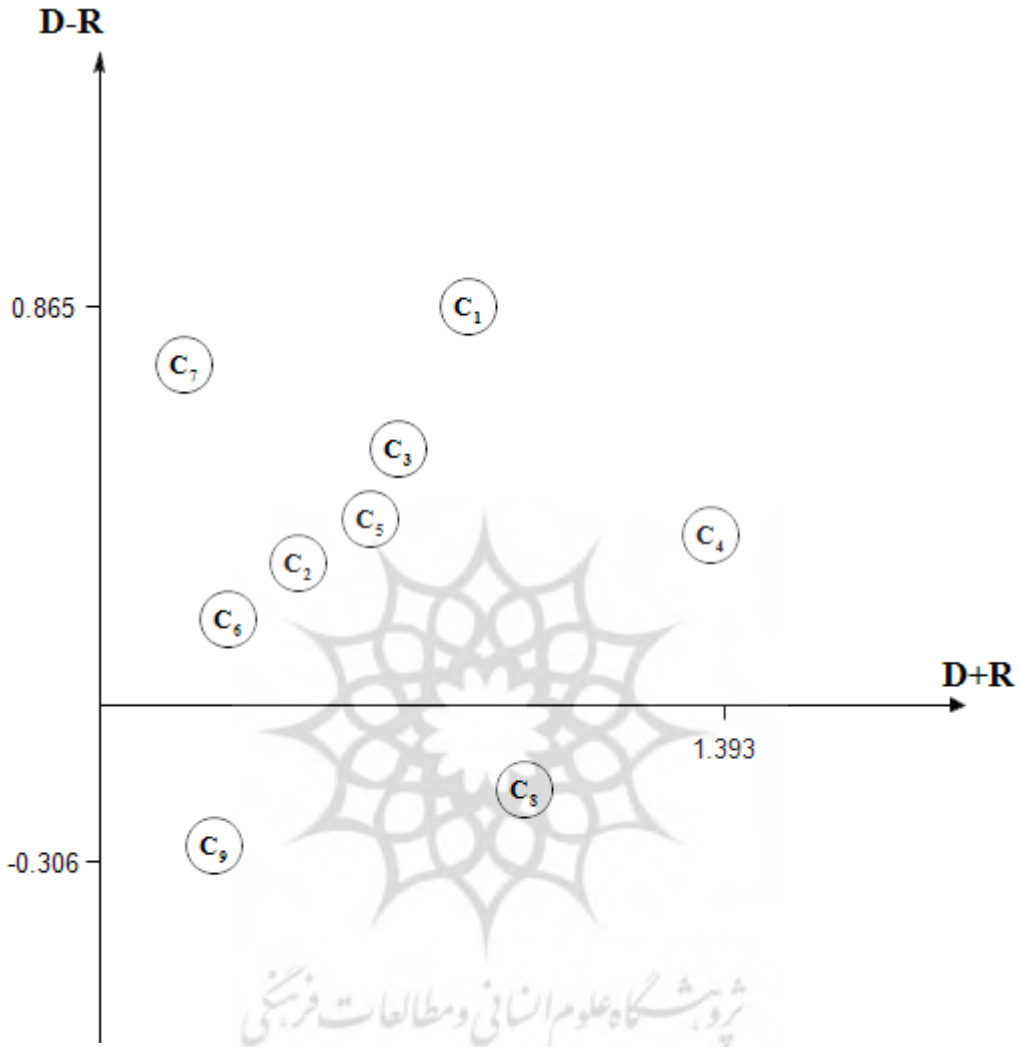

Figure 4. Causal-Effect Diagram of Investor Risk Dimensions in Startups Using DEMATEL

According to the results obtained from Figure 4, the dimension of market uncertainty (C1) has the highest numerical value based on the row sum (D), making it the most influential dimension among the financial risk dimensions analyzed from the investors' perspective in information technology startups. Additionally, based on (D - R), the dimension of management risk (C9) received the lowest value, identifying it as the most susceptible dimension.

Discussion and Conclusion

Analyzing financing for information technology-based startups is critically important. IT startups require significant investment in research and development. A thorough financing analysis helps investors and organizations mitigate the risk of capital loss in unsuccessful IT projects. Effective financing analysis can attract more investors, as they favor projects and companies with lower financial risks and a reduced likelihood of capital loss. Adequate financing enables IT startups to research and develop innovative and advanced technologies, which can contribute to company growth and competitive advantage in the market.

As economic engines, IT startups can promote job creation for many skilled young professionals in the technology sector. Job creation is a key factor in financing and supporting startups. Supporting IT startups contributes to the development and growth of the information technology industry in a country, which is viewed as a catalyst for innovation and technological advancement in the national economy. The increasing security risks in the technology sector further underscore the importance of financing analysis. Sufficient funding can help companies implement necessary security measures against cyber threats.

Financing analysis aids startups in achieving market stability, allowing them to operate longer in the technology sector and benefit from sustainable growth. For information technology-based startups, financing analysis can be a vital tool for effectively managing financial risks and achieving growth and sustainability in their path toward technological development and innovation.

Today, in light of economic fluctuations and the devaluation of national currencies compared to international currencies, it is essential for any business, including startups, to identify effective financing strategies for their operations.

This study identified the dimensions and components of investment risk analysis from the investors' perspective and financing risks in information technology-based startups using a combination of techniques (Fuzzy Delphi, BWM, and DEMATEL). The research delineated financing dimensions across nine dimensions (economic factors, governmental factors, personal factors, administrative factors, industry status, locational factors, scientific factors, legal factors, and geographical factors) and 29 components. It also examined investment risk dimensions from investors' perspectives across nine categories (market uncertainty, financial and resource constraints, technological changes, inability to attract and retain the right team, economic and political changes,

legal risks, operational risks, technical risks, and management risks) through Fuzzy Delphi and expert surveys in two phases. Subsequently, the Best-Worst Method was utilized to weigh and prioritize the research dimensions and criteria. Finally, the DEMATEL technique was applied to determine the intensity of interrelationships among the dimensions and the impact and susceptibility of each, resulting in a Cartesian diagram.

Research Limitations

1. Expert Bias:
2. The research relies heavily on the opinions and judgments of experts to identify dimensions and weighting criteria. This reliance may introduce subjective biases and personal influences, affecting the accuracy and impartiality of the findings.
3. Data Collection Challenges:
4. Obtaining accurate and comprehensive data, particularly in IT-based startups, is a primary challenge. The lack of access to suitable data or inconsistencies in data quality may impact the analysis and conclusions.
5. Model Adaptability Limitations:
6. Since the research is based on data and conditions specific to the IT industry, the proposed model may have limited applicability to other industries or contexts.
7. Dynamic and Complex Nature of Financial Data:
8. The dynamic and rapidly changing nature of financial data related to asset valuation, such as S&P500 and Bitcoin, challenges the accuracy and reliability of missing data imputation methods.
9. Resource Constraints:
10. Limited time and financial resources for comprehensively implementing the proposed methods may reduce the scope of analysis and feasibility assessments.

The limitations of the proposed model and framework can be explained as follows:

1. Dependence on Expert Judgments:

The model relies heavily on expert opinions to identify dimensions and weighting criteria, possibly introducing subjectivity and bias into the results.

2. Complexity in Application:

The combination of BWM and DEMATEL methods may require advanced technical skills and an understanding of both methodologies, making it challenging for practitioners without sufficient expertise.

3. Dynamic Nature of IT-Based Startups:

The framework may not fully capture the rapidly evolving nature of IT-based startup companies, as changes in technology, market conditions, and regulatory environments can quickly render the identified dimensions and criteria outdated.

4. Generalizability Issues:

Since the model is developed based on data and feedback specific to IT-based startups, its applicability to other industries or contexts might be limited.

5. Data Availability and Accuracy:

The model's effectiveness depends on accurate and comprehensive data, which may not always be accessible or reliable, particularly for startups with limited operational history.

6. Interdependence of Dimensions:

While DEMATEL addresses the relationships among dimensions, the linear approaches may not fully capture the potential non-linear interdependencies and feedback loops within the factors.

7. Limited Consideration of External Uncertainties:

The model focuses on internal and controllable factors, potentially overlooking external uncertainties such as economic downturns, global crises, or sudden technological disruptions.

These limitations provide opportunities for future research to refine and enhance the model for broader applicability and resilience.

Future Researchers

1. Exploring Alternative Methods:

Utilize advanced and innovative approaches like machine learning algorithms to identify, analyze, and impute missing data and compare them with traditional methods.

2. Expanding the Scope of Research:

Examine the applicability of the proposed model in other industries and sectors, particularly in emerging and complex fields, to evaluate its adaptability and effectiveness in various contexts.

3. Analyzing the Dynamics of External Factors:

Investigate the impact of external factors such as economic fluctuations, technological advancements, and government policies on the proposed model and framework and suggest appropriate solutions to enhance flexibility.

4. Improving Data Collection Methods:

Design more efficient mechanisms for collecting accurate and reliable data, including using credible databases and modern technologies such as blockchain.

5. Conducting Comparative Studies:

Perform comparative studies across different industries and geographical regions to identify similarities and differences in financing and investment risk dimensions and components.

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