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Quantitative Modeling of Financial Resources in Knowledge-Based Small and Medium-Sized Enterprises

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A B S T R A C T

Knowledge-based small and medium-sized enterprises (SMEs) play a vital role in economic development, job creation, and innovation, yet they often face financial constraints and limited access to optimal resources. The present study was conducted with the aim of designing and validating a quantitative financing model for these enterprises. This research employed a mixed-methods approach. In the qualitative phase, data were collected through semi-structured interviews with 10 senior managers and financial experts of knowledge-based ICT companies, and analyzed based on grounded theory to extract key indicators and components. In the quantitative phase, 384 managers of knowledge-based companies with more than five years of work experience were studied as the statistical population, and data were gathered using a questionnaire. The validity and reliability of the constructs were examined through confirmatory factor analysis (CFA), and the relationships among variables were tested using structural equation modeling (SEM). The findings indicated that the set of indicators demonstrated high validity and reliability, and that their structural relationships could be modeled predictably. Results also revealed that the selection of appropriate financing methods, access to financial resources, innovation capacity, and technical infrastructure all play key roles in the success and sustainable development of knowledge-based SMEs. This model can assist managers and policymakers in designing optimal financing strategies and enhancing innovation, growth, and competitiveness of knowledge-based SMEs.

Keywords: *Knowledge-based small and medium-sized enterprises, financing, confirmatory factor analysis, structural equations, sustainable development*

1. Introduction

Small and medium-sized enterprises (SMEs) are widely recognized as critical drivers of economic growth, innovation, and social development. They contribute significantly to employment, industrial diversification, and the overall competitiveness of national economies. Despite

this importance, SMEs face persistent and multi-faceted financing challenges, particularly in emerging and developing economies where institutional structures and financial markets are underdeveloped (Molosiwa et al., 2025). The complexity of SME financing has therefore become an important area of research, as scholars and practitioners attempt to understand barriers and identify innovative models that can address capital shortages and enable sustainable growth (Mansour Nouri et al., 2024; Shahrabi et al., 2024).

The financing environment for SMEs is shaped by a wide range of factors including access to capital markets, financial literacy, regulatory frameworks, technological advancements, and macroeconomic uncertainties. In Europe, for example, the dynamics of entrepreneurial finance have been deeply affected by geopolitical tensions such as the Russian war against Ukraine, which altered investor confidence and reshaped the flows of venture and private equity (Kraemer-Eis et al., 2024). In the context of developing economies like Iran, knowledge-based SMEs encounter even more profound difficulties due to restrictive legal frameworks, weak capital markets, and insufficient institutional support (Erfai Jamshidi et al., 2024; Habibi et al., 2024). These constraints highlight the urgent need for innovative financing mechanisms that are adapted to the unique conditions of SMEs in knowledge-driven sectors.

Recent scholarship has emphasized that SMEs increasingly rely on hybrid and innovative financing tools such as crowdfunding, venture capital, trade credit, Islamic financing, securitization, and green bonds (Deng et al., 2024; Ekechi et al., 2024; Rao et al., 2023; Tanhaei & Mohibi, 2023). Crowdfunding, in particular, has emerged as a transformative mechanism, enabling small firms to bypass traditional intermediaries while also signaling credibility to investors (Amoozad Mahdiraji et al., 2023). Similarly, securitization has been applied in various sectors such as agriculture to mobilize idle assets and reduce risks (Ghorashi, 2019). Trade credit remains an important financing tool in international commerce, enabling firms to extend their operational cycles without immediate liquidity pressures (Zhang & Dou, 2017).

However, the financing barriers confronting SMEs remain extensive. Research in the Iranian context demonstrates that obstacles span across legal, structural, and managerial dimensions, constraining firms' ability to secure adequate funding (Padash et al., 2023). Globally, systematic reviews show that SMEs frequently suffer from limited collateral, information asymmetry, and high transaction costs, which collectively raise the risk perception of financial institutions (Rao et al., 2023). For knowledge-based SMEs, the situation is even more complex because intangible assets such as patents or intellectual property are difficult to use as collateral, reducing the effectiveness of conventional bank lending (Ogutu et al., 2023).

Financial literacy and managerial capacity are increasingly recognized as critical factors influencing SME financing outcomes. Firms with higher levels of financial literacy are more successful in acquiring funding and managing financial risks (Molosiwa et al., 2025). In addition, financing decisions within specific firm types, such as family businesses, are influenced by ownership structures and behavioral preferences that do not always align with conventional pecking-order theories (Jansen et al., 2023). These findings reinforce the importance of considering firm-specific and contextual variables when examining SME financing models (Shahrabi et al., 2024).

Technological innovations, particularly in financial technologies (fintech), have fundamentally reshaped the financing landscape for SMEs. Fintech platforms reduce transaction costs, increase transparency, and offer alternative investment channels (Barberis & Chist, 2016; Lee & Shin, 2018). By creating new ecosystems for digital lending, peer-to-peer financing, and mobile banking, fintech has expanded access to underserved SMEs (Agustin, 2017). Moreover, digital platforms embody the logic of networked markets, where scalability and efficiency can be leveraged to transform financing systems (Parker et al., 2016). Yet, this transformation is not without risks, as financial technologies also introduce new dimensions of financing risk, particularly in the context of Islamic banking and regulation-sensitive sectors (Budianto, 2023).

The vulnerability of SMEs to external shocks also demonstrates the importance of macroeconomic stability for financing. Evidence shows that economic policy uncertainty can significantly alter financing structures, pushing firms toward more conservative or short-term financial strategies (Tabash et al., 2022). Banking sector regulations, asset quality, and systemic stability further determine the cost and availability of financing (Gong & Wei, 2022). In the Iranian context, managerial obstacles at both firm and national levels exacerbate financing difficulties, constraining the ability of knowledge-based SMEs to expand (Dehghani et al., 2022). Similarly, cultural and organizational dynamics influence financing; for example, employee voice and organizational trust in knowledge-based firms shape the

climate of decision-making, which indirectly impacts financial sustainability (Hosseini et al., 2022).

Financing models for SMEs therefore need to be designed with sensitivity to both internal and external determinants. Nguyen (Nguyen & Canh, 2021) highlights the interplay of formal and informal financing, suggesting that hybrid models can better serve the needs of small firms in uncertain environments. Mohammadzadeh Kazemi (Mohammadzadeh Kazemi et al., 2021) argues for empowerment-based models that strengthen managerial capacity, while Molkiamiri (Molkiamiri et al., 2021) emphasizes the role of firm-specific characteristics in shaping financing choices. Collectively, these studies demonstrate that no one-size-fits-all model exists, and effective financing requires contextually grounded approaches (Jihadi et al., 2021).

The capital market dimension further complicates financing decisions. Aggarwal (Aggarwal, 2023) describes the variety of secondary market options available to firms, while Gahng (Gahng et al., 2021) explores the rise of SPACs as new financing vehicles. Bibliometric analyses of small business research confirm that SME financing remains one of the most active areas of academic inquiry (Baker et al., 2021). In addition, innovative mechanisms in sectors such as education finance show that lessons from one domain can be adapted to others, offering novel pathways for SME financing (Joynes, 2019).

Empirical research in Iran underscores the dependence of knowledge-based SMEs on external financing and the importance of diversifying funding techniques (Bakhardi, 2023). Tailored models have been proposed to address productivity management and to systematically analyze financing barriers (Erfai Jamshidi et al., 2024; Mansour Nouri et al., 2024). These insights are consistent with findings in global contexts, where audit quality, corporate governance, and capital management are found to significantly influence financing outcomes (Ahmadi et al., 2019; Eghbali & Moridi, 2018).

The institutional and regulatory environment plays a decisive role in shaping financing models. Noor (Noor et al., 2014) demonstrates how Malaysia strategically positioned itself as a global hub for Islamic finance through regulatory design. Similarly, Flohr Nielsen (Flohr Nielsen, 2002) highlights the role of internet technologies in transforming customer engagement in Nordic banking. These cases illustrate that financing models are deeply embedded within broader institutional and technological ecosystems.

Firm-level governance and transparency are also essential to financing. Hasanaj (Hasanaj & Kuqi, 2019) stresses the importance of financial statement analysis in reducing information asymmetry, while Giaretta (Giaretta & Chesini, 2021) shows that fintech start-ups require unique debt financing determinants that diverge from traditional models. Li (Li et al., 2020) provides further evidence that green bonds, when supported by credit ratings and corporate social responsibility initiatives, reduce interest costs for issuers—an insight relevant to SMEs seeking sustainable financing.

Finally, emerging literature underscores the connections between financing, innovation, and competitiveness. Deng (Deng et al., 2024) integrates supply chain perspectives into private equity financing, while Ogutu (Ogutu et al., 2023) connects knowledge management practices to SME competitiveness in the tourism sector. Tanhaei (Tanhaei & Mohibi, 2023) applies hybrid decision-making methods to select optimal financing models, demonstrating that structured approaches can help SMEs overcome uncertainty. Studies from Iran reinforce this perspective, showing that financial constraints and cash flow vulnerabilities significantly affect sensitivity to external financing (Fallah & Maranjory, 2016). Interpretive structural modeling has also been applied to identify the motivations of financial suppliers in crowdfunding platforms, providing insights into the incentives shaping alternative finance (Abrahimi & Cheitsazan, 2017).

Taken together, these findings suggest that SME financing is shaped by a complex interplay of firm-specific, institutional, technological, and macroeconomic factors. Addressing financing challenges therefore requires integrated models that combine insights from global best practices with local contextual realities (Ekechi et al., 2024; Gai et al., 2016; Jaffar & Musa, 2016). In particular, knowledge-based SMEs in Iran face compounded barriers due to regulatory inefficiencies and underdeveloped financial systems, making it critical to design financing models that both respond to local constraints and leverage emerging opportunities (Abrahimi & Ahmadi, 2021; Dehghani et al., 2020).

Accordingly, this study seeks to develop and validate a comprehensive financing model for knowledge-based SMEs in Iran.

2. Methods and Materials

This study employed an exploratory mixed-methods approach (qualitative–quantitative). In other words, the

dimensions and components influencing the financing of knowledge-based small and medium-sized enterprises (SMEs) in Iran were first identified through the qualitative grounded theory method, and subsequently, in the quantitative phase, the conceptual model derived from the first stage was tested and validated using advanced statistical methods. In the qualitative section, the main objective was to identify components and conceptual relationships. To this end, data were collected through in-depth semi-structured interviews with 10 experts, including 6 senior managers or financial managers of knowledge-based companies and 4 university professors specializing in fields related to the study. Participants were selected using purposive and snowball sampling, and interviews continued until theoretical saturation was achieved. Data analysis was conducted based on the grounded theory approach of Strauss and Corbin, using three-stage coding (open, axial, and selective) in Atlas.ti software. The output of this stage was a localized conceptual model that paved the way for the quantitative phase.

The quantitative phase was designed to test the extracted conceptual model and examine the relationships among the identified components. The statistical population included all ICT knowledge-based companies registered in the official database of the Vice-Presidency for Science and Technology. Based on the applied filters (minimum five years of activity and focus on ICT), the target population was estimated at about 1,000 companies. The sample size was determined using the Morgan table, and to enhance the accuracy of the results, 384 companies were randomly selected. The data collection tool was a researcher-developed questionnaire, designed based on qualitative findings and a review of the literature. The questionnaire was structured and employed a five-point Likert scale. Content validity was assessed through expert evaluation, and instrument reliability was measured using Cronbach's alpha.

For data analysis, the structural equation modeling (SEM) approach was applied using AMOS software. First, confirmatory factor analysis (CFA) was conducted to assess construct validity and measurement model fit. Then, the structural model was analyzed to test hypotheses and examine direct and indirect relationships among components. The use of SEM made it possible not only to test multiple causal relationships simultaneously but also to evaluate the overall model fit.

3. Findings and Results

The findings of the present study are presented based on the analysis of data collected from ICT knowledge-based companies. This research was designed with a mixed-methods approach. In the qualitative phase, the initial conceptual framework was developed through in-depth interviews with experts, aiming to identify and localize the main financing components of knowledge-based SMEs. Subsequently, this framework was tested in the quantitative phase, using a researcher-developed questionnaire administered to a sample of 384 managers of knowledge-based companies. In this phase, the demographic characteristics of respondents were first described, followed by the presentation of quantitative data analysis results. The quantitative analysis included assessing the reliability and validity of the research instrument, conducting confirmatory factor analysis, and finally testing the conceptual model using the structural equation modeling approach. The ultimate goal of the study was to validate the proposed financing model for knowledge-based SMEs and explain the relationships among its key components.

To identify the factors influencing the financing of knowledge-based SMEs, in-depth semi-structured interviews were conducted with financial experts and managers of knowledge-based companies. After transcription, data were processed in ATLAS.ti software and organized into main categories through open, axial, and selective coding. The results showed that the core phenomenon of the study was business financing, around which the other categories were structured. Among these, several groups of key conditions were identified:

- **Causal conditions**: lack of access to financial resources, conditions and interactions with the financial market, legal and environmental barriers, and challenges in human resource management.
- **Contextual conditions**: market conditions, employee management conditions, legal, political, and financial conditions, as well as technical and technological conditions.
- **Intervening factors**: government and private investment and the improvement of the support infrastructure.
- **Strategies**: three main strategies were identified—attracting new financial resources, strengthening communication and cooperation, and optimizing business digitalization.

- **Consequences**: business growth and development, increased productivity speed and continuous growth, successful management and financial independence, and reduced digital dependency.

These findings indicate that success in financing is not only the central challenge of knowledge-based companies but also a strategic factor in achieving sustainable development and strengthening the knowledge-based economy.

Therefore, the qualitative findings indicated that the financing issue in knowledge-based companies is influenced by a set of causal, contextual, and intervening conditions, with strategies and consequences shaped accordingly. These results provided a conceptual framework outlining the relationships among key financing components. However, to validate this model and evaluate its fit in a broader statistical population, it was necessary to test the identified components through quantitative data. For this purpose, a researcher-developed questionnaire, designed based on the qualitative categories, was distributed among 384 managers of ICT knowledge-based companies. The collected data enabled examination of the reliability and validity of the instrument, the implementation of confirmatory factor analysis, and the testing of the conceptual model using structural equation modeling. In the following sections, the demographic characteristics of respondents are described, and the quantitative data analysis results are presented to examine the relationships among the model components.

In the quantitative section, the statistical population included 384 managers of ICT knowledge-based companies. An examination of demographic characteristics showed that the majority of respondents were male (81 percent), with only 19 percent female. In terms of age, the largest share belonged to the 36–45 age group (39.5 percent), followed by the 25–35 age group (29.5 percent). Regarding educational level, most participants held a bachelor's degree (77 percent), while only 1.5 percent had a doctoral degree. These results demonstrate that the studied population mainly consisted of middle-aged managers with university education, which may reflect their work experience and familiarity with financing challenges in knowledge-based companies.

After extracting the conceptual model in the qualitative phase and identifying the main constructs, the questionnaire instrument was designed to measure the model's components. In this section, the instrument's validity and reliability were first examined, followed by confirmatory factor analysis to assess the measurement model fit.

To ensure the accuracy of the data collection instrument, the content validity of the questionnaire was evaluated using the Content Validity Ratio (CVR) and the Content Validity Index (CVI). The results showed that all items exceeded the threshold values suggested by Lawshe and Waltz & Bausell, indicating the adequacy of the questionnaire's content validity. Next, the reliability of the instrument was calculated using Cronbach's alpha. The obtained values for all components were above 0.7, confirming desirable internal consistency and reliability of the instrument. To assess factor structure, confirmatory factor analysis (CFA) was performed using PLS/AMOS software. Model fit indices including GFI = 0.91, AGFI = 0.90, NFI = 0.92, CFI = 0.95, and RMSEA = 0.07 were all within the acceptable range. These results confirmed the good fit of the measurement model and the adequacy of the questionnaire in measuring the study's constructs. Based on these findings, the research instrument demonstrated satisfactory content validity, internal reliability, and factorial validity. Therefore, the designed questionnaire could reliably be used to test the conceptual model within the framework of structural equation modeling (SEM). The following section presents the results of hypothesis testing and model fit evaluation.

To assess construct validity, confirmatory factor analysis (CFA) was conducted on the causal conditions scale. This scale consisted of 4 latent variables and 10 observed variables. The results showed that all factor loadings were greater than 0.3, and the t-value statistics were significant at the 95 percent confidence level (greater than 1.96). Therefore, the relationships between the latent variables and the observed indicators were statistically confirmed.

To evaluate model fit, the principal goodness-of-fit indices were used. The results showed that the chi-square to degrees of freedom ratio ($\chi^2/df = 1.44$) falls within the desirable range (between 1 and 3). In addition, the RMSEA was obtained as 0.07, which is lower than the threshold of 0.10 and confirms an acceptable model fit. Other fit indices—including NFI = 0.99, CFI = 0.94, GFI = 0.96, IFI = 0.99, and RFI = 0.95—were all reported above the standard value of 0.90. Accordingly, it can be concluded that the causal-conditions model has an appropriate fit, and the observed variables adequately explain the corresponding latent constructs.

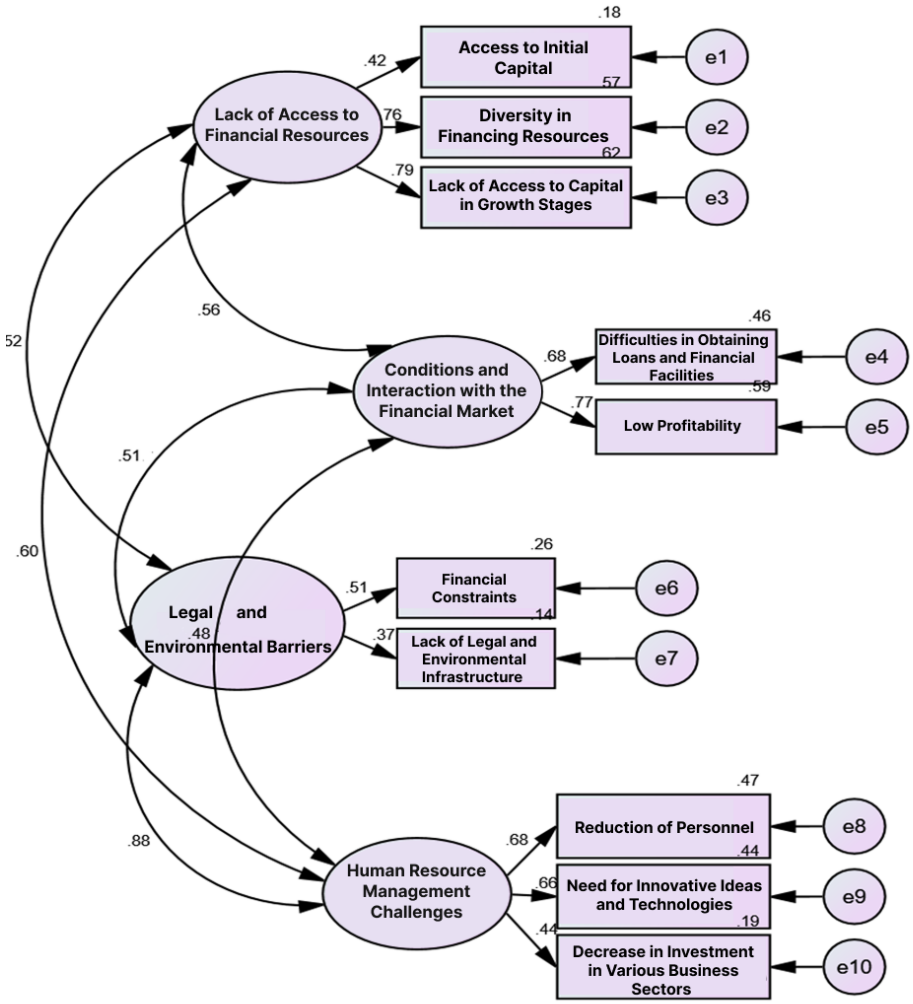
Table 1

Fit Indices for the Causal Conditions

Model	χ^2/df	RMSEA	NFI	CFI	GFI	IFI	RFI	SRMR	AGFI
Acceptable range	1–3	< 0.10	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90	< 0.09	> 0.80
Calculated	1.44	0.070	0.99	0.94	0.96	0.99	0.95	0.16	0.94

Figure 1

Factor Loadings of the Causal Conditions Variable



To examine the construct validity of the contextual conditions, confirmatory factor analysis was conducted on this scale. The scale comprised 4 latent variables and 10 observed variables. The results indicated that all factor loadings were greater than 0.30 and statistically significant at the 95% confidence level (t-value > 1.96). Therefore, the relationships between the observed indicators and the latent constructs are supported. To evaluate model fit, multiple indices were examined. The results showed that the chi-square to degrees of freedom ratio was 2.88, which lies within the acceptable range (1 to 3). The RMSEA = 0.026 was also below 0.10, indicating a desirable model fit. Other fit indices—including NFI = 0.99, CFI = 0.97, GFI = 0.97, IFI = 0.95, and RFI = 0.99—were all above the standard value of 0.90. Only the AGFI was reported as 0.83 which, although slightly lower than the others, is still within an acceptable level.

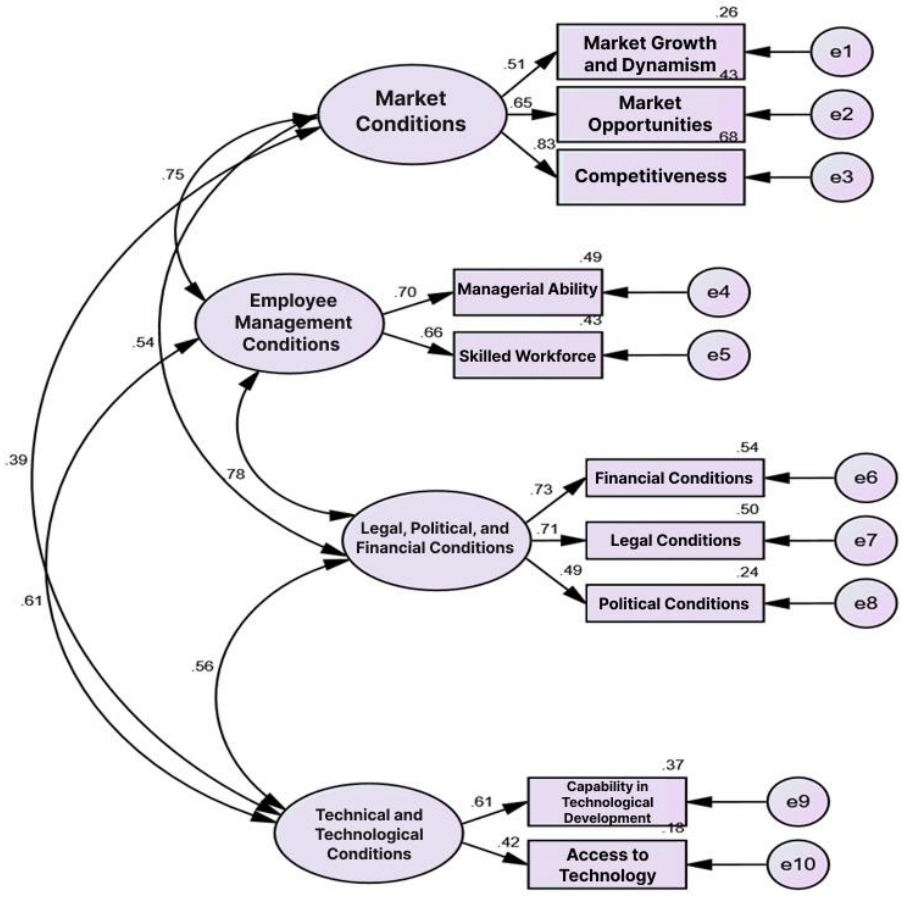
Table 2

Fit Indices for the Contextual Conditions Model

Model	χ^2/df	RMSEA	NFI	CFI	GFI	IFI	RFI	SRMR	AGFI
Acceptable range	1–3	< 0.10	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90	< 0.09	> 0.80
Calculated	2.880	0.026	0.99	0.97	0.97	0.95	0.99	0.22	0.83

Figure 2

Factor Loadings of the Contextual Conditions Variable



The results of the confirmatory factor analysis for the intervening-conditions scale are presented in Figure 3. This scale consists of 2 latent variables and 4 observed variables. As shown, all factor loadings of the observed variables exceed 0.30, indicating acceptable correlations between the latent variables and the observed indicators. After identifying the correlations, a significance test was performed to examine the validity of the relationships among variables. In this study, a significance level of 0.05 was adopted, and the t-value criterion was used for assessment. If the t-value exceeds the critical value of 1.96, the relationship is considered significant. According to the results, all t-values were greater than 1.96 at the 5% confidence level, demonstrating that the observed relationships are significant and valid. To assess model fit, multiple indices—including χ^2/df, RMSEA, NFI, CFI, GFI, IFI, RFI, SRMR, and AGFI—were used. The fit indices are reported in Table 3. As shown, all indices fall within the acceptable range, indicating good correspondence between the model and the data.

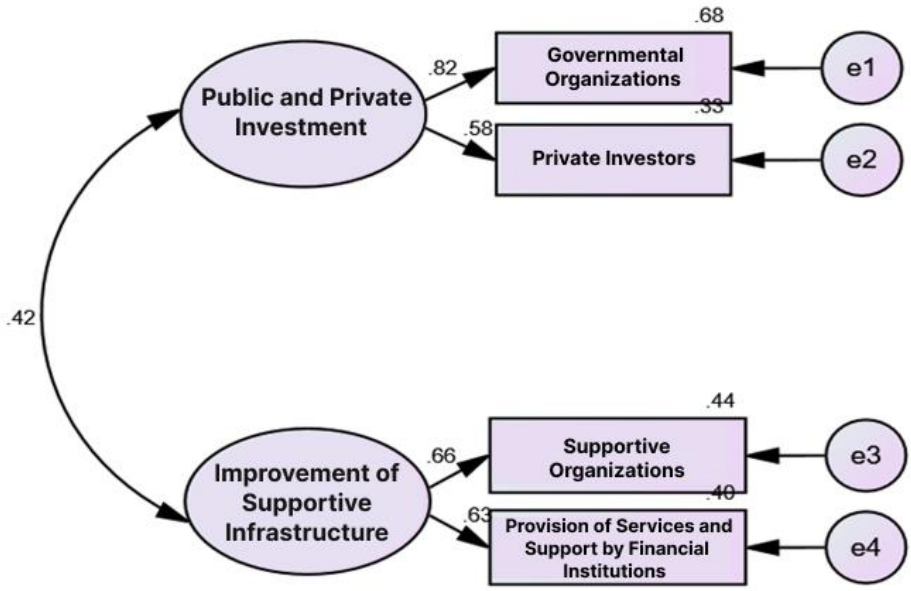
Table 3

Fit Indices for the Intervening Conditions Variable

Model	χ^2/df	RMSEA	NFI	CFI	GFI	IFI	RFI	SRMR	AGFI
Acceptable range	1–3	< 0.10	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90	< 0.09	> 0.80
Calculated	1.27	0.065	0.97	0.93	0.96	0.93	0.99	0.17	0.83

Figure 3

Factor Loadings of the Intervening Conditions Variable



The results of the factor analysis for the strategies variable are presented in Figure 4. This scale comprises 3 latent variables and 7 observed variables. In all cases, the factor loadings of the observed variables were greater than 0.30, indicating acceptable correlations between the latent variables (dimensions of each core construct) and the observed indicators. After identifying variable correlations, significance testing was conducted. The t-value statistic was used to examine the significance of the relationships. Given a significance level of 0.05, relationships with t-values greater than 1.96 were considered significant. Based on the measurement indices, all t-values exceeded 1.96 at the 5% confidence level, indicating that the observed correlations are statistically significant. To evaluate the overall acceptability of the model, various fit indices—including χ^2/df, RMSEA, NFI, CFI, GFI, IFI, RFI, SRMR, and AGFI—were calculated. As shown in Table 4, the indices lie within acceptable bounds: χ^2/df = 1.283, RMSEA = 0.038, NFI = 0.96, CFI = 0.97, GFI = 0.99, IFI = 0.95, RFI = 0.94, SRMR = 0.23, and AGFI = 0.96. These results indicate that the conceptual model for the strategies scale demonstrates an acceptable overall fit.

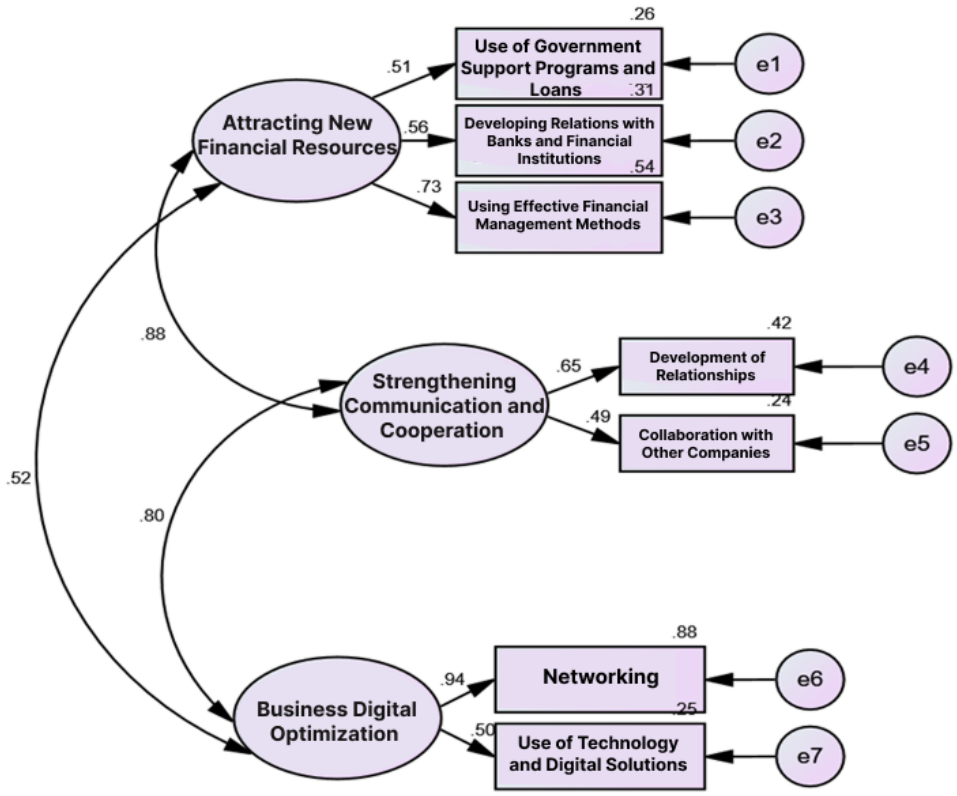
Table 4

Fit Indices for the Strategies Variable

Model	χ^2/df	RMSEA	NFI	CFI	GFI	IFI	RFI	SRMR	AGFI
Acceptable range	1–3	< 0.10	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90	< 0.09	> 0.80
Calculated	1.283	0.038	0.96	0.97	0.99	0.95	0.94	0.23	0.96

Figure 4

Factor Loadings of the Strategies Variable



The results of the factor analysis for the "Outcomes" scale are presented in Figure 5. This scale includes 4 latent variables and 10 observed variables. The factor loadings of the observed variables were all greater than 0.30, indicating acceptable correlations between the latent variables (dimensions of the core constructs) and the observed indicators. After determining the correlations, the significance of the relationships among variables was examined using the t-value statistic. With a significance level of 0.05, the critical t-value is 1.96, and all computed t-values exceeded this threshold, indicating that the observed correlations in the outcomes scale model are significant.

To evaluate the acceptability of the model, various fit indices—including the normed chi-square (χ^2/df), RMSEA, NFI, CFI, GFI, IFI, RFI, SRMR, and AGFI—were calculated. The results of the model fit analysis are shown in Table 5. As can be seen, all indices fall within acceptable ranges; specifically, χ^2/df = 1.17, RMSEA = 0.023, and other indices such as NFI, CFI, GFI, and IFI exceed 0.90. These findings indicate that the outcomes model possesses an adequate structural fit.

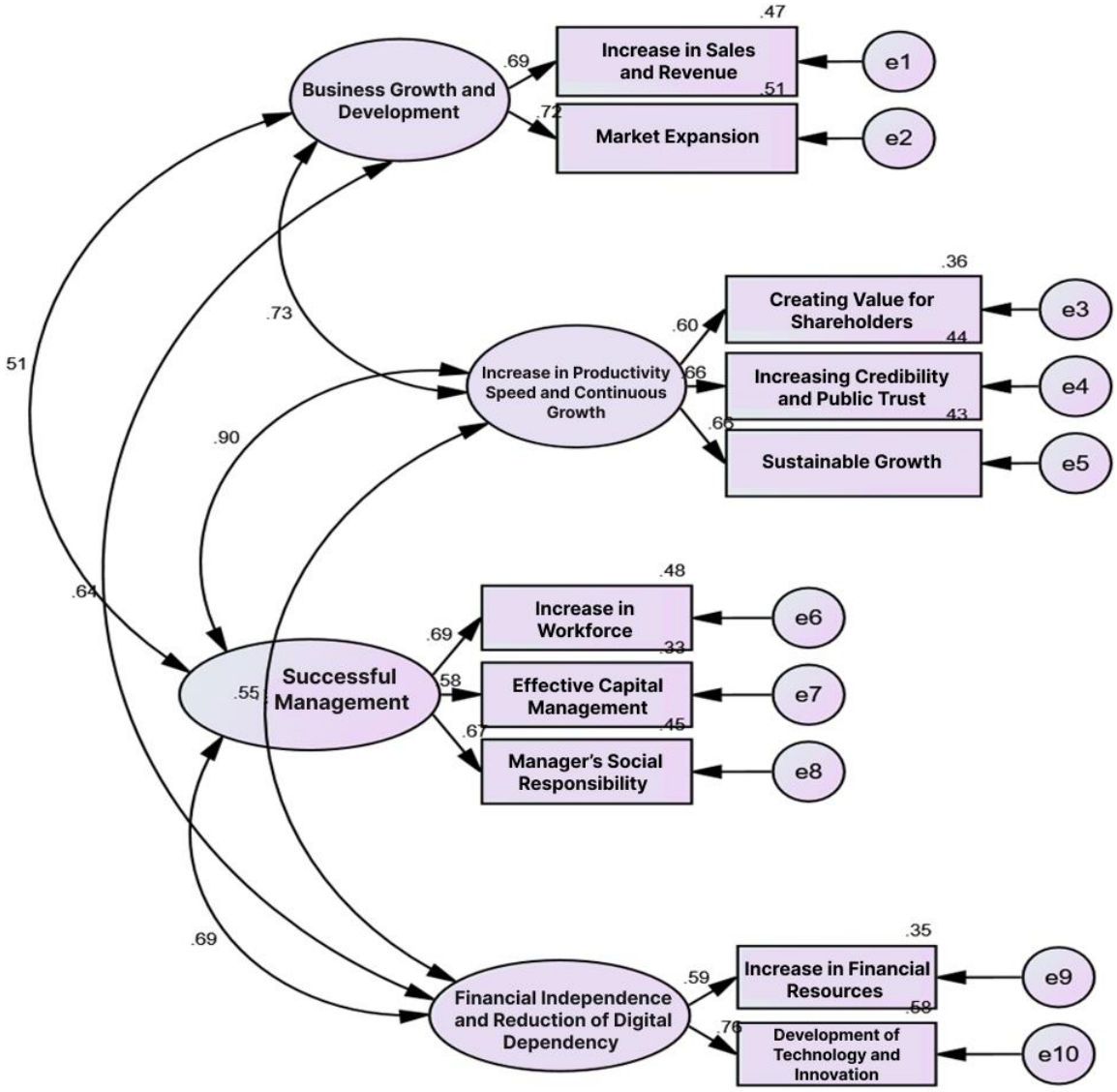
Table 5

Fit Indices for the Outcomes

Model	χ^2/df	RMSEA	NFI	CFI	GFI	IFI	RFI	SRMR	AGFI
Acceptable range	1–3	< 0.10	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90	< 0.09	> 0.80
Calculated	1.17	0.023	0.93	0.92	0.93	0.93	0.95	0.24	

Figure 5

Factor Loadings of the Outcomes



After confirming the factorial structure of the research constructs, structural equation modeling (SEM) was employed to examine the relationships among the variables. This model allows for the testing of the research hypotheses and analyzes the causal relationships between a set of latent constructs. The model is presented in Figure 6 and shows that all factor loadings in this model are greater than 0.30.

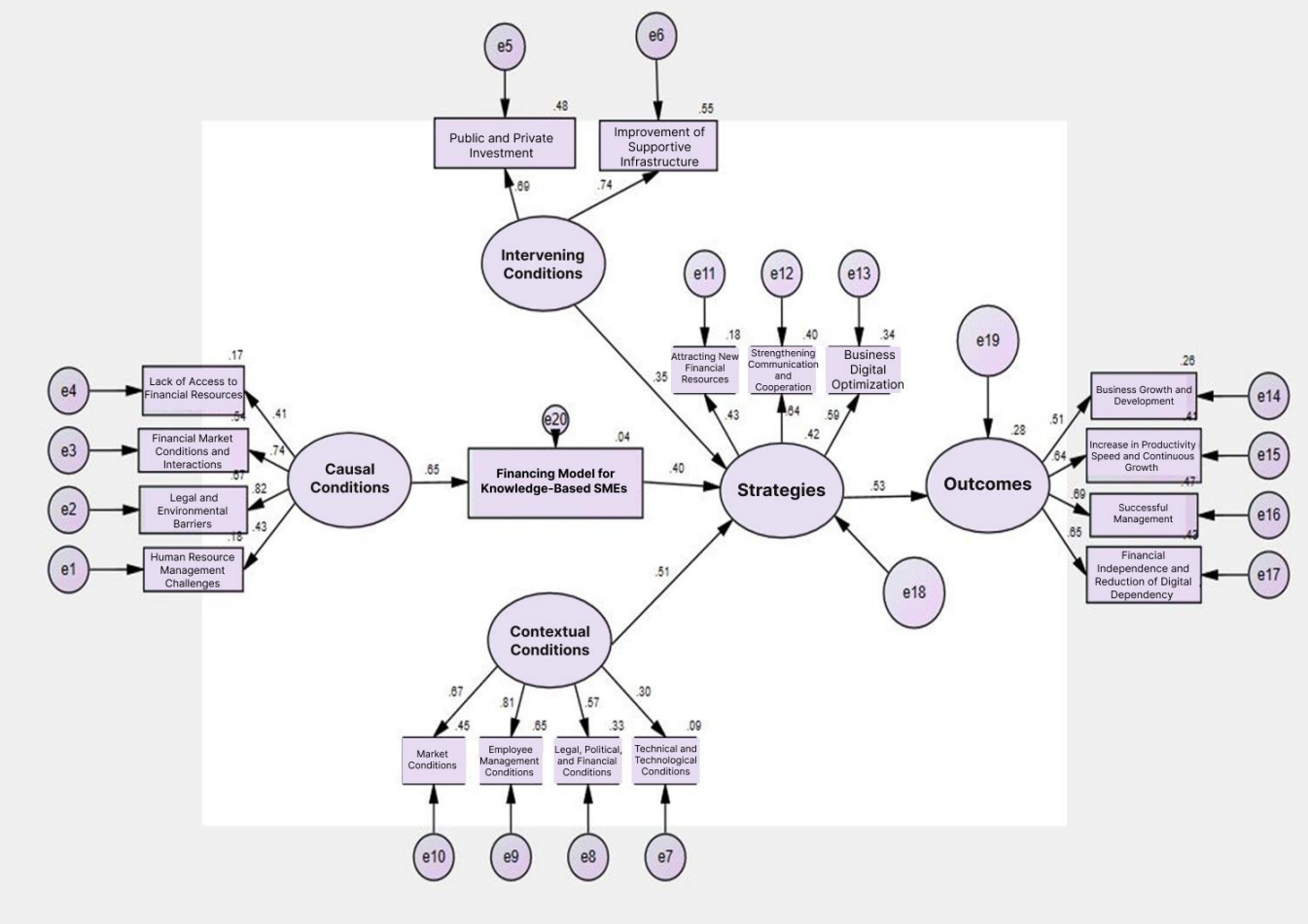
Table 6

Fit Indices of the Research Model

Model	χ^2/df	RMSEA	NFI	CFI	GFI	IFI	RFI	SRMR	AGFI
Acceptable range	1–3	< 0.10	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90	< 0.09	> 0.80
Calculated	1.16	0.019	0.95	0.95	0.96	0.97	0.99	0.21	0.89

Figure 6

Factor Loadings of the Research Model



The acceptability of the model is also displayed in Table 6. In the following, the effects of the identified factors on one another are examined, with the results presented in Table 7. According to this table, the factors identified in the grounded theory model influence one another. The factor loading of causal conditions on the core category was 0.65 with a t-value of 11.734. The factor loading of contextual conditions on strategies was 0.35 with a t-value of 8.076. The factor loading of intervening conditions on strategies was 0.51 with a t-value of 10.129. The factor loading of the core category on strategies was 0.40 with a t-value of 7.477. Finally, the factor loading of strategies on outcomes was 0.53 with a t-value of 10.384. Therefore, it can be concluded that the research model is supported.

Table 7

Examination of the Effects of Identified Factors in the Grounded Theory Model on One Another

Relationship	Factor Loading	t-value	Significance Level	Result
Causal conditions → Core category	0.65	11.734	0.000	Relationship confirmed
Contextual conditions → Strategies	0.35	8.076	0.000	Relationship confirmed
Intervening conditions → Strategies	0.51	10.129	0.000	Relationship confirmed
Core category → Strategies	0.40	7.477	0.000	Relationship confirmed
Strategies → Outcomes	0.53	10.384	0.000	Relationship confirmed

4. Discussion and Conclusion

The findings of this study provide an integrated perspective on the financing challenges, strategies, and outcomes of knowledge-based small and medium-sized enterprises (SMEs) in Iran. By applying a mixed-methods approach and validating the conceptual model through

structural equation modeling, the research confirmed that financing conditions are influenced by causal, contextual, and intervening factors that collectively determine the strategies SMEs pursue and the outcomes they achieve. Specifically, the results demonstrated that access to financial resources, market conditions, regulatory frameworks, human resource management, and institutional support are decisive elements shaping financing behavior. These findings align with prior scholarship on SME financing, which consistently emphasizes the multidimensional nature of financing challenges and the importance of context-sensitive models (Mansour Nouri et al., 2024; Molosiwa et al., 2025; Shahrabi et al., 2024).

One of the key findings of this research is that lack of access to financial resources remains a central obstacle for SMEs, consistent with global evidence that small firms often struggle with capital shortages due to limited collateral and high transaction costs (Nguyen & Canh, 2021; Rao et al., 2023). The results indicate that the inability to secure adequate financing at various stages of growth significantly undermines SMEs' ability to scale operations, innovate, and compete in domestic and international markets. This is particularly acute in knowledge-based enterprises, where intangible assets such as patents or intellectual property are difficult to use as collateral, thus creating a mismatch with traditional lending requirements (Molkiamiri et al., 2021; Ogutu et al., 2023). The structural barriers observed in Iran reinforce earlier findings that financing models for SMEs must go beyond conventional debt financing and embrace diversified approaches that reflect the unique characteristics of knowledge-based firms (Bakhardi, 2023; Padash et al., 2023).

The study also highlighted the role of contextual conditions, such as market dynamics, employee management, and regulatory environments, in shaping financing decisions. For example, market growth, competitiveness, and access to skilled labor were shown to influence SMEs' capacity to attract financing. This finding aligns with international research suggesting that firm-level performance indicators, market conditions, and governance structures directly affect the availability and cost of capital (Giaretta & Chesini, 2021; Hasanaj & Kuqi, 2019). In particular, the importance of employee management and human capital resonates with prior studies that emphasize the role of managerial capacity and organizational culture in financing success (Hosseini et al., 2022; Mohammadzadeh Kazemi et al., 2021). By linking contextual and managerial factors to financing outcomes, this study extends earlier work and underscores the necessity of integrating human resource strategies with financial planning in SMEs.

Another central finding concerns the intervening role of institutional support and investment. The model showed that government and private investments, as well as supportive infrastructures, positively influence financing strategies by reducing risks and broadening access to resources. This is consistent with the literature highlighting the importance of institutional arrangements and public policy in creating an enabling financial ecosystem for SMEs (Kraemer-Eis et al., 2024; Noor et al., 2014). In contexts such as Malaysia, institutional design has successfully positioned the country as a global hub for Islamic finance, illustrating how policy frameworks can reshape financing opportunities (Noor et al., 2014). Likewise, Iranian SMEs can benefit from supportive policies that integrate government initiatives with private investment, echoing earlier calls for hybrid financing models (Erfai Jamshidi et al., 2024; Mansour Nouri et al., 2024).

In terms of strategies, the study identified three primary pathways pursued by SMEs: attracting new financial resources, strengthening communication and cooperation, and optimizing business digitalization. Each of these strategies reflects broader global trends in SME financing. The attraction of new resources corresponds with the expansion of crowdfunding, venture capital, and capital market tools observed in many countries (Aggarwal, 2023; Amoozad Mahdiraji et al., 2023). Strengthening communication and cooperation resonates with studies that emphasize the role of networks, collaborations, and partnerships in accessing finance and sharing risks (Jansen et al., 2023; Ogutu et al., 2023). Digital optimization is directly aligned with the growing literature on fintech and platform economies, which highlights how digital technologies lower entry barriers and facilitate financial inclusion for SMEs (Agustin, 2017; Barberis & Chist, 2016; Lee & Shin, 2018; Parker et al., 2016). By empirically validating these strategies in the Iranian context, this research provides evidence that SMEs are indeed adapting to global financial trends, albeit within the constraints of local institutional environments.

The outcomes of successful financing, as validated in the model, included business growth, productivity improvements, successful management, and financial independence. These outcomes mirror the theoretical frameworks that link financing to innovation, competitiveness, and sustainability (Deng et al., 2024; Molosiwa et al., 2025; Ogutu et al., 2023). For instance, growth and market expansion are directly tied to access to

diverse financing tools (Aggarwal, 2023; Zhang & Dou, 2017). Productivity and continuous growth are associated with investment in technology, human capital, and innovation, as emphasized by recent scholarship (Bakhardi, 2023; Habibi et al., 2024). Financial independence and reduced digital dependency reflect a long-term orientation where SMEs are less reliant on unstable external resources, echoing prior findings on the strategic role of financing in achieving sustainability (Gong & Wei, 2022; Li et al., 2020).

The study's findings also resonate with broader macroeconomic and institutional research. For example, Tabash (Tabash et al., 2022) shows that uncertainty in economic policy influences financing structures across Asian economies, a finding mirrored in the Iranian context where regulatory instability increases risk perceptions. Similarly, Joynes (Joynes, 2019) documents innovative financing mechanisms in education, offering parallels to the need for innovative SME finance in Iran. In global capital markets, new tools such as SPACs and green bonds have reshaped financing opportunities (Gahng et al., 2021; Li et al., 2020), yet such innovations are only slowly diffusing into emerging markets. The Iranian case demonstrates that without strong institutional frameworks, the benefits of financial innovation may remain limited.

Importantly, the model validated in this study provides evidence that financing is not merely a transactional issue but a systemic phenomenon influenced by interrelated economic, institutional, and managerial variables. This perspective aligns with prior calls for holistic frameworks that integrate micro- and macro-level factors in analyzing SME financing (Baker et al., 2021; Nguyen & Canh, 2021; Rao et al., 2023). By situating financing within a systems approach, the study expands the understanding of how SMEs can achieve resilience and competitiveness in volatile environments.

Another noteworthy implication is the role of sustainability and innovation in shaping financing strategies. The outcomes observed in this research—particularly growth, innovation, and independence—echo the global trend toward sustainable financing (Gong & Wei, 2022; Li et al., 2020). Moreover, the emphasis on digital optimization highlights the increasing reliance on financial technologies to overcome structural constraints (Barberis & Chist, 2016; Lee & Shin, 2018). These findings suggest that Iranian SMEs, while constrained by regulatory inefficiencies, are aligning with global practices in leveraging technology and pursuing sustainability in financing.

Overall, the results of this study provide a robust framework for understanding SME financing in Iran, while also situating these insights within the global literature. The evidence demonstrates that financing challenges are multifaceted, strategies are adaptive to both local and global trends, and outcomes are directly tied to long-term sustainability and competitiveness.

Despite the contributions of this study, several limitations must be acknowledged. First, the sample was limited to knowledge-based SMEs in the ICT sector in Iran, which restricts the generalizability of the findings to other industries and regions. Financing dynamics may vary significantly in manufacturing, agriculture, or service-oriented SMEs, and future research should expand the scope to include a broader range of sectors. Second, the study relied on cross-sectional data, which limits the ability to capture temporal changes in financing strategies and outcomes. Longitudinal studies would provide deeper insights into the evolution of financing models over time. Third, while the study employed a robust mixed-methods approach, the reliance on self-reported data may introduce biases related to managerial perceptions. Finally, the contextual specificity of the Iranian financial system means that findings may not be directly transferable to other emerging economies without adaptation.

Future studies should address these limitations by expanding the sectoral and geographical coverage of SME financing research. Comparative studies across countries in the Middle East, Asia, and Africa could provide valuable insights into how institutional and cultural factors shape financing strategies. Additionally, future research should examine the role of digital technologies in greater detail, particularly the ways in which fintech innovations such as blockchain, peer-to-peer lending, and digital currencies are transforming SME financing. Longitudinal and experimental designs would also be valuable in assessing the causal impact of financing strategies on performance outcomes. Finally, integrating sustainability and environmental considerations into SME financing models is an area of growing importance that warrants further scholarly attention.

For practitioners, the findings highlight the importance of adopting diversified financing strategies that align with both local constraints and global opportunities. Policymakers should focus on creating supportive institutional frameworks that reduce financing barriers, encourage innovation, and promote collaboration between government and private investors. SME managers are encouraged to enhance their

financial literacy, strengthen communication networks, and embrace digital optimization to improve their financing outcomes. Financial institutions, meanwhile, should develop tailored products that address the unique needs of knowledge-based SMEs, recognizing the value of intangible assets and innovation potential.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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