The Role of Venture Capital Investment Trusts in Startup Financing: Financial Performance Analysis Using Entropy and TOPSIS Methods

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Abstract: This study assesses the financial performance of eight Venture Capital Investment Trusts in Türkiye over 2021-2024 using an Entropy-TOPSIS multi-criteria decision-making framework. Twelve financial ratios representing liquidity, profitability, leverage, and efficiency dimensions are used to construct annual decision matrices. Entropy results indicate that liquidity indicators carry the highest weights, while leverage-related measures are least influential; profitability maintains moderate importance, and efficiency gains greater prominence in 2023–2024. Using these objective weights, the TOPSIS analysis shows that Hub consistently achieves the highest performance, followed by Gözde VCIT, whereas Bulls VCIT and İş VCIT display weaker and more volatile results. The dataset is derived from independently audited annual reports retrieved from the Borsa Istanbul Public Disclosure Platform. Overall, the findings demonstrate the usefulness of the Entropy–TOPSIS approach for transparent, multidimensional performance assessment in a regulated emerging market and provide a practical quantitative framework for policymakers and investors.

Keywords: Venture capital investment trusts, Financial performance, Entropy method, TOPSIS method, Multi-criteria decision-making.

1. INTRODUCTION

Entrepreneurial activity and innovation-driven growth have become central themes in contemporary economic development. In emerging markets such as Türkiye, startups, newly established and innovation-oriented firms, play a crucial role in fostering technological transformation, competitiveness, and employment generation. However, the high uncertainty, limited collateral, and information asymmetries that characterize early-stage ventures often restrict their access to traditional financial instruments. This financing gap has prompted the emergence of specialized investment mechanisms such as venture capital and venture capital investment trusts (VCITs), which provide equity-based funding and managerial support to high-potential enterprises.

Over the past decade, the Turkish startup ecosystem has experienced rapid institutionalization, driven by government programs, technopark infrastructure, and increased participation of corporate and individual investors. Within this national context, the establishment of VCITs under the regulatory framework of the Capital Markets Board (CMB) represents a key institutional mechanism that aligns entrepreneurial finance with capital-market discipline.

Although research on startups and venture capital has expanded considerably, empirical studies that combine these areas, particularly within the framework of Türkiye's regulated capital market, are still scarce. Understanding how VCITs function as institutionalized intermediaries that finance startups and promote sustainable growth is therefore essential. The following section reviews the existing literature on startups, venture capital mechanisms, and VCITs, providing the theoretical foundation for the empirical analysis of Türkiye's innovation finance ecosystem.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Startup firms require external investment during their establishment and growth phases (Akın, 2020). In the early stages, expenditures on improvement, testing, and marketing typically exceed revenues, creating a financing gap that necessitates additional funding (Akkaya, 2020). Financial intermediaries and institutional investors that provide capital to startups differ significantly from traditional lending institutions. Since creditworthiness, an essential criterion for debt financing, depends on historical performance, newly founded startups with no prior financial record often face challenges in obtaining external capital. Moreover, startups are characterized by high risk, limited collateral value, and intensive technological investment needs, which further complicate their access to financial support. Traditional banks are generally reluctant to fund startups for these reasons, making the limited availability of conventional loans unsurprising (Moro Visconti, 2020).

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2.1. Venture Capital Investment Trusts and Startup Financing

The venture capital financing model has been widely utilized, particularly during critical stages of economic development, to promote individual entrepreneurship, reduce unemployment, and support productive capacity. Empirical evidence from the development trajectories of advanced economies such as the United States and European countries demonstrates the significant contribution of venture capital mechanisms to industrial expansion and innovation (Aktaş and İlgün, 2019a).

In this context, VCITs play an essential role in the financing of startup enterprises. Startups can obtain the funding they require during their establishment and growth phases through VCITs, which channel capital toward innovative and high-potential ventures. Conversely, VCITs can enhance their profitability by directing available financial resources to strategically selected and scalable startups, creating a mutually reinforcing relationship between entrepreneurial growth and investment performance.

Startups are newly established firms that emerge from innovative ideas and operate under conditions of high uncertainty. They typically evolve through three stages, namely bootstrapping, seed, and creation, each reflecting a progressive institutionalization of entrepreneurial activity (Salamzadeh and Kawamorita Kesim, 2015). During the bootstrapping phase, entrepreneurs rely on personal or family resources to test the feasibility of their ideas, while the seed stage involves prototype development, team formation, and engagement with accelerators or incubators that provide limited funding and mentorship. Once startups reach the creation stage, they begin to commercialize products, enter markets, and utilize formal financing channels such as venture capital.

Because startups generally lack stable cash inflows and tangible collateral, they face significant financing constraints. Their early operations are characterized by negative cash flows, as development and marketing costs exceed initial revenues (Moro Visconti, 2020). This structural imbalance renders conventional bank credit inaccessible and compels entrepreneurs to rely on equity-based instruments. Moro Visconti (2020) emphasizes that the valuation of such ventures is complex and relies on market multiples, discounted cash flow, or net-asset value approaches as outlined in the International Private Equity and Venture Capital Valuation Guidelines. These models adapt traditional corporate finance techniques to environments characterized by volatility and uncertainty.

Venture capital is the most prominent external funding source for startups. Akın (2020) explains that its high cost stems from the structural nature of venture funds and the low probability of success among portfolio companies. Only a small proportion of funded ventures achieve profitable exits, which raises the expected rate of return and results in significant ownership dilution for founders. In a typical ten-year fund, limited partners provide capital while general partners manage investments and receive both management fees and carried interest. Because investors anticipate long waiting periods and high risk, they demand equity shares that compensate for potential portfolio losses. This dynamic creates the "high-cost equity" paradox, where startups surrender substantial ownership for relatively modest cash inflows.

The Turkish startup ecosystem has undergone rapid institutionalization over the past decade, supported by government programs, technoparks, and an expanding investor base. The State of Turkish Startup Ecosystem 2020 reports an eightfold increase in accelerators between 2010 and 2019 and the establishment of sixty-one technoparks nationwide. Public institutions such as TÜBİTAK and KOSGEB have played central roles in providing grants to early-stage ventures, while the Ministry of Treasury and Finance introduced an angel investor accreditation system to expand the network of certified investors. By 2019, corporate venture capital units formed by banks and conglomerates had become key actors in early-stage investment. In 2020, 179 startups collectively raised 137 million USD, predominantly in software-as-a-service, artificial intelligence, and marketing technology ventures, reflecting a structural shift toward scalable digital business models (Turkey Destination for Early Stage Investments Report, 2021). The Turkish Startup Investments Review 2020 identifies fintech, logistics, and gaming as leading sectors, with Istanbul emerging as the central hub for entrepreneurial finance. Notable high-value exits such as Zynga's acquisitions of Peak Games and Rollic Games demonstrate the increasing maturity of Türkiye's startup landscape.

At the firm level, financial management and performance evaluation are crucial for startup sustainability. Bougoffa and Korichi (2020) highlight profitability, liquidity, and leverage ratios as key indicators of financial resilience, providing a quantitative framework applicable to early-stage ventures. Within this context, VCITs emerge as institutional mechanisms that bridge the financing gap faced by startups. Startups embody innovation and high risk (Gün and Karadağ, 2016), whereas VCITs serve as regulated investment vehicles channeling equity capital toward technologically promising but capital-constrained firms (Uygurtürk and Soylu, 2016).

Operating under the supervision of the Capital Markets Board (CMB), VCITs institutionalize venture capital principles within Türkiye's capital market, providing transparency, governance, and investor protection (Münyas, 2017).

The evolution of Türkiye's venture capital market dates back to the early 1990s, with major regulatory milestones such as the CMB Communiqué III-48.3 (2013), which defined the structure and governance of VCITs as publicly traded joint-stock companies (Münyas, 2017). These regulatory reforms enabled the establishment of institutional funds capable of mobilizing both corporate and individual savings toward innovative enterprises. Despite these advances, VCITs growth has been gradual, constrained by macroeconomic volatility and limited investor participation (Apan and Öztel, 2020). Empirical analyses highlight significant variation in VCITs performance. Uygurtürk and Soylu (2016) employed the COPRAS method to evaluate liquidity and profitability, finding Vturk superior in liquidity and Gözde in profitability. Apan and Öztel (2020) used the CRITIC-PROMETHEE approach to assess seven VCITs between 2012 and 2016, concluding that Gözde achieved the highest overall performance.

Further analyses by Aktaş and İlgün (2019a, 2019b) reinforced these findings through their comparative evaluation of Turkish VCITs. Their findings confirmed that profitability, capital utilization, and venture investment intensity were the most influential variables shaping market valuation. Collectively, these studies underscore that venture capital mechanisms, whether private, corporate, or institutionalized through VCITs, serve as catalysts for innovation, employment, and technological advancement. Davila, Foster, and Gupta (2003) demonstrated the positive influence of venture capital on startup employment growth, whereas Dushnitsky and Lenox (2006) showed that strategically oriented corporate venture capital enhances firm value by fostering technological spillovers. Türkiye's experience aligns with this global pattern, as VCITs integrate the logic of venture capital into a transparent and regulated framework that links financial performance to innovation-driven growth. Although challenges such as limited participation and long-term capital shortages persist (Gün and Karadağ, 2016; Münyas, 2017), the increasing methodological sophistication through tools such as COPRAS, PROMETHEE, and TOPSIS reflects a maturing financial ecosystem capable of supporting sustainable entrepreneurial development. This institutional perspective establishes a foundation for the quantitative evaluation of VCITs performance using multi-criteria decision-making methods.

2.2. Financial Performance Evaluation Using Entropy and TOPSIS

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is among the most widely applied multi-criteria decision-making (MCDM) methods in financial performance analysis. Based on the principle that the chosen alternative should have the shortest distance from the positive ideal solution and the farthest from the negative ideal, TOPSIS provides an objective ranking framework integrating multiple performance indicators into a single composite index. Early applications in the Turkish context, such as Saldanlı and Sırma (2016) for BIST-100 companies and Orçun and Eren (2017) for technology firms, validated its reliability and comparability with market-based measures. Similarly, Ömürbek and Kınay (2013) applied TOPSIS to the airline industry in Türkiye and Germany, confirming its flexibility across sectors.

In recent years, the integration of TOPSIS with weighting methods such as CRITIC and Entropy has enhanced the objectivity of financial performance evaluation. Özmerdivanlı (2024) applied the CRITIC-TOPSIS model to VCITs in Türkiye for the 2019-2023 period, identifying the current ratio as the most influential determinant of performance and highlighting Hedef and Vturk as the strongest performers. Sun *et al*. (2021) developed a comprehensive TOPSIS-based index to evaluate China's venture capital industry between 2006 and 2016, demonstrating that the method effectively captures both structural and performance dimensions of sectoral development. These findings confirm TOPSIS's adaptability across institutional and market contexts.

Advanced studies have expanded the methodological scope of TOPSIS into fuzzy and behavioral domains. Lu, Tian, and Buitrago (2021) combined the Analytic Hierarchy Process (AHP) with Intuitionistic Fuzzy TOPSIS (IFS-TOPSIS) to evaluate government venture capital projects in China, improving transparency and fairness in public funding decisions. Likewise, Afful-Dadzie *et al*. (2015) applied an Intuitionistic Fuzzy TOPSIS framework to startup selection in government-led venture capital programs in developing countries, emphasizing its ability to minimize political bias and enhance decision accuracy under uncertainty. Zhu *et al*. (2023) further extended the model through a *prospect theory-based TOPSIS* approach, integrating venture capitalists' psychological and risk-perception factors into decision-making. Aliyeva (2024) applied fuzzy group decision-making based on TOPSIS to investment evaluation, demonstrating the method's capability to aggregate diverse expert judgments. Sallum *et al*. (2018) also

confirmed its versatility by employing a DEMATEL-TOPSIS-WINGS hybrid to classify multimarket investment funds in Brazil, illustrating conceptual parallels with venture capital fund evaluation.

Overall, the literature illustrates the evolution of TOPSIS from a general performance analysis tool into a strategic evaluation framework for venture capital and fund management. When coupled with objective weighting methods such as Entropy or CRITIC, TOPSIS enhances both the precision and interpretability of financial analysis. Within the context of VCITs, this integrative approach enables a multidimensional understanding of performance by simultaneously accounting for liquidity, profitability, leverage, and efficiency indicators. Consequently, the Entropy-TOPSIS model provides a rigorous, data-driven foundation for evaluating the role of VCITs in channeling venture capital toward high-potential startups, thereby linking institutional investment performance to broader innovation-led growth objectives.

Building on this theoretical framework, the next section presents the data set and methodological approach used to analyze the financial performance of Turkish Venture Capital Investment Trusts. The Entropy method is employed to determine the objective weights of performance indicators, while the TOPSIS model ranks the VCITs according to their relative proximity to the ideal financial profile. This combined approach allows for a systematic and quantitative evaluation of how effectively VCITs allocate venture capital resources to support innovative startups within Türkiye's regulated capital market environment.

Building on this foundation, the next section details the dataset and methodological procedures adopted in the empirical analysis.

3. DATA AND METHODOLOGY

3.1. Data Set and Variables

This study analyzes the financial performance of eight VCITs traded in Borsa Istanbul (BIST) over the period 2021-2024: Bulls, Gözde, Hedef, Hub, Icu, İş, Pardus, and Vturk. Table **1** presents the VCITs examined in the research.

Table **2** presents the twelve financial ratios used in the study, categorized under liquidity, profitability, leverage, and efficiency dimensions.

This study evaluates the role of VCITs in startup financing by examining their financial performance using the Entropy-TOPSIS approach. The following section describes the Entropy-TOPSIS-based methodological framework used to evaluate the financial performance of VCITs.

3.2. Methodology

The methodological framework of this study integrates the Entropy weighting method with the TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) model to objectively assess the financial performance of VCITs. The TOPSIS method, a multi-criteria decision-making (MCDM) technique, provides a systematic approach for ranking alternatives based on their proximity to the ideal solution (Hwang and Yoon, 1981). The Entropy method determines the significance levels (weights) of the financial ratios used as evaluation criteria (Bakır and Atalık, 2018). The analysis is based on audited annual reports obtained from the Borsa Istanbul Public Disclosure Platform (KAP), which include independently audited financial statements of the firms. All analyses were conducted and verified for internal consistency using Microsoft Excel. Based on these data, the Entropy method was applied to obtain the criterion weights of the selected

Table 1:   Venture Capital Investment Trusts Examined in the Research

No	Abbreviation	Venture Capital Investment Trust	Year of Establishment
1	Bulls	Bulls Venture Capital Investment Trust Inc.	2021
2	Gözde	Gözde Venture Capital Investment Trust Inc.	2015
3	Hedef	Hedef Venture Capital Investment Trust Inc.	2013
4	Hub	Hub Venture Capital Investment Trust Inc.	2014
5	Icu	IcuVenture Capital Investment Trust Inc.	2004
6	İş	İş Venture Capital Investment Trust Inc.	2010
7	Pardus	Pardus Venture Capital Investment Trust Inc.	2021
8	Vturk	Verusatürk Venture Capital Investment Dant Trust Inc.	2016
Note: All entities are publicly listed on BIST and subject to CMB regulation.			

Table 2: Financial Ratios Used for Measuring Financial Performance

Code	Financial Ratio	Direction (+/−)	Formula
C1	Current Ratio	+	Current Assets / Short-Term Liabilities
C2	Cash Ratio	+	(Cash + Marketable Securities) / Short-Term Liabilities
C3	Return on Equity (ROE)	+	Net Profit / Equity
C4	Return on Assets (ROA)	+	Net Profit / Total Assets
C5	Equity Ratio	+	Equity / Total Assets
C6	Current Assets Ratio	+	Current Assets / Total Assets
C7	Net Working Capital Turnover	+	Net Sales / (Current Assets - Short-Term Liabilities)
C8	Equity Turnover	+	Net Sales / Equity
C9	Asset Turnover	+	Net Sales / Total Assets
C10	Leverage Ratio	−	(Short + Long-Term Liabilities) / Total Assets
C11	Debt-to-Equity Ratio	−	(Short + Long-Term Liabilities) / Equity
C12	Operating Expense Ratio	−	Operating Expenses / Net Sales

Note: '+' denotes benefit criteria and '−' denotes cost criteria. Ratios follow KAP reporting definitions and are computed from independently audited annual statements.

financial ratios, and the subsequent TOPSIS analysis was performed to rank the financial performance of the VCITs. The four-year analysis (2021-2024) employed the Entropy-derived weights within the TOPSIS model to generate annual performance rankings. The decision matrices were first normalized and multiplied by the respective criterion weights to obtain the weighted decision matrix. Then, the positive and negative ideal solutions were identified, the Euclidean distances to these reference points were calculated, and the relative closeness coefficients were derived to rank the firms based on their financial performance. Finally, the Entropy-TOPSIS procedure was implemented in four main steps, which together constitute the analytical framework of the study. Formulations adapted from Hwang and Yoon (1981); Entropy weighting applied as in Bakır and Atalık (2018).

Step 1. Normalization

All financial ratios were normalized using the min-max transformation to standardize the data scales:

$$r_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)}$$

Step 2. Entropy Weight Calculation

Entropy values (E_j) and the degree of diversification (d_j) for each criterion were computed as follows:

$$E_j = -k \sum_{i=1}^{m} p_{ij} \ln(p_{ij}), \quad \text{where } k = \frac{1}{\ln(m)}, \quad p_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}}$$

$$d_j = 1 - E_j, \quad w_j = \frac{d_j}{\sum_{j=1}^{n} d_j}$$

Step 3. Weighted Decision Matrix

Each normalized value was multiplied by its respective entropy weight (w_j):

$$v_{ij} = w_j \times r_{ij}$$

Step 4. TOPSIS Evaluation

The ideal (A^+) and anti-ideal (A^-) solutions were defined as:

$$A^+ = \{\max(v_{ij})|j \in J_+\} \cup \{\min(v_{ij})|j \in J_-\},$$

$$A^- = \{\min(v_{ij})|j \in J_+\} \cup \{\max(v_{ij})|j \in J_-\}$$

The Euclidean distances from the ideal and anti-ideal points and the relative closeness coefficients (C_i) were then calculated using the following formulas:

$$S_i^+ = \sqrt{\sum_{j=1}^{n}(v_{ij} - A_j^+)^2}, \quad S_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - A_j^-)^2}$$

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

The relative closeness coefficient (C_i) ranges between 0 and 1, where values closer to 1 indicate stronger financial performance. Table **3** presents the entropy-derived weights of the twelve financial ratios (w_j) for VCITs during the period 2021-2024, indicating the relative importance of each financial indicator in the overall performance evaluation framework.

Figure **1** visualizes the distribution of Entropy-derived weights across twelve financial ratios from 2021 to 2024, emphasizing the dominance of

Table 3: Entropy Weights of Financial Ratios (2021-2024)

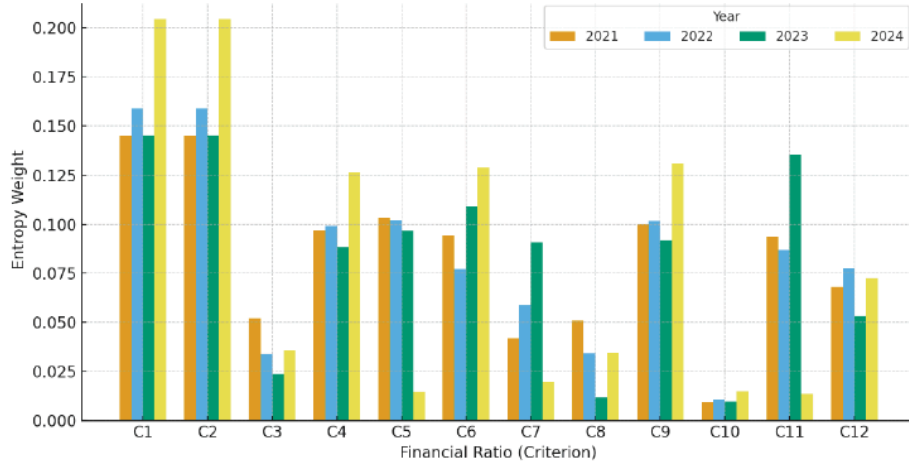| Year	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
2021	0.1449	0.1449	0.0518	0.0970	0.1036	0.0939	0.0420	0.0509	0.1000	0.0094	0.0934	0.0681
2022	0.1590	0.1590	0.0337	0.0992	0.1021	0.0772	0.0588	0.0342	0.1019	0.0106	0.0869	0.0773
2023	0.1451	0.1451	0.0236	0.0883	0.0969	0.1090	0.0906	0.0118	0.0915	0.0096	0.1355	0.0530
2024	0.2044	0.2044	0.0357	0.1266	0.0146	0.1289	0.0196	0.0345	0.1308	0.0147	0.0135	0.0724

Figure 1: Entropy-Based Weights of Financial Ratios (2021-2024).

liquidity indicators and the declining role of leverage ratios.

These weight dynamics serve as inputs to the subsequent TOPSIS ranking. Overall, the evolution of weights indicates a gradual shift from profitability-based to liquidity- and efficiency-oriented performance drivers. The Entropy analysis revealed substantial variation in the relative importance of performance indicators across years. Liquidity-based ratios, particularly the Current Ratio (C1) and Cash Ratio (C2), consistently received the highest weights, ranging between 0.14 and 0.20, highlighting the dominant role of liquidity in differentiating the financial stability of VCITs. This finding suggests that short-term solvency and cash management were the most decisive factors influencing financial performance throughout the period. In contrast, leverage-related indicators such as the Leverage Ratio (C10) and Debt-to-Equity Ratio (C11) exhibited the lowest weight values, often below 0.02, implying that variations in capital structure among VCITs had relatively minor effects on overall performance. Profitability ratios, particularly the Return on Assets (C4) and Return on Equity (C3), showed moderate significance, with the weight of ROA increasing from 0.097 in 2021 to 0.127 in 2024, indicating that profitability regained relative importance in the most recent year. Efficiency-oriented ratios, including the Current Assets Ratio (C6) and Asset Turnover (C9), became more influential in 2023

and 2024, reflecting a growing emphasis on asset utilization efficiency within the venture capital investment trust sector. Meanwhile, the Equity Ratio (C5) and Net Working Capital Turnover (C7) fluctuated across years, suggesting that equity strength and operational turnover had context-dependent impacts on performance.

Overall, the evolution of Entropy weights indicates a gradual shift from profitability-based to liquidity-oriented performance drivers. These weight dynamics served as inputs for the subsequent TOPSIS performance ranking. The financial performance scores of VCITs for the 2021-2024 period, obtained through the TOPSIS analysis, are presented in Table **4**.

Table 4: TOPSIS Scores of Venture Capital Investment Trusts (2021-2024)

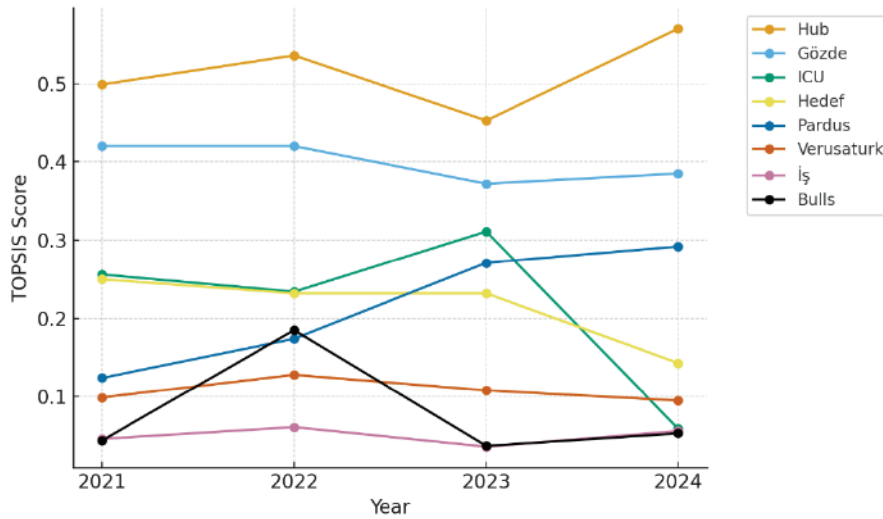| Company	2021	2022	2023	2024
Bulls	0.0443	0.1853	0.0367	0.0529
Gözde	0.4201	0.4204	0.3722	0.3851
Hedef	0.2496	0.2318	0.2323	0.1426
Hub	0.4987	0.5356	0.4532	0.5696
Icu	0.2565	0.2341	0.3108	0.0585
İş	0.0460	0.0612	0.0365	0.0562
Pardus	0.1236	0.1739	0.2708	0.2919
Vturk	0.0985	0.1276	0.1084	0.0950

Figure 2: Trends in TOPSIS Scores of VCITs (2021-2024).

Table **4** reports annual TOPSIS scores; Figure **2** depicts the corresponding trajectories over 2021-2024. Figure **2** illustrates also the annual evolution of financial performance scores for VCITs based on the TOPSIS results, highlighting the relative trends across the 2021-2024 period.

Hub consistently achieves the highest scores across all years, with Gözde forming a stable second tier. Pardus shows a steady improvement toward 2024, while Icu's pronounced decline in 2024 aligns with weaker liquidity signals. Bulls and İş follow lower and more volatile paths. The pattern suggests a stable hierarchy with selective mid-tier mobility. Table **5** summarizes the overall performance trends of VCITs across the 2021-2024 period, providing a concise interpretation of directional changes observed in Figure **1**.

Table 5: Summary of VCIT Performance Trends (2021-2024)

Company	Trend Direction	Interpretation
Hub	→	Maintained top performance consistently
Gözde	→	Stable profitability and efficiency
Icu	↓	Decline in 2024 due to lower liquidity
Hedef	→	Moderate and stable performance
Pardus	↑	Significant improvement by 2024
Vturk	↑	Gradual upward trend
İş	→	Weak but steady
Bulls	↓	Unstable and volatile

The annual financial performance rankings of VCITs, based on the TOPSIS scores, are presented in Table **6**.

Table 6: Annual Performance Rankings of VCITs (2021-2024)

Company	2021	2022	2023	2024
Bulls	8	5	7	8
Gözde	2	2	2	2
Hedef	4	4	5	4
Hub	1	1	1	1
Icu	3	3	3	6
İş	7	8	8	7
Pardus	5	6	4	3
Vturk	6	7	6	5

Figure **3** provides a comparative overview of annual performance rankings of VCITs during 2021-2024, offering a visual summary of changes in relative positions among firms. To complement the score-based perspective, Figure **3** compares annual rankings of VCITs over 2021-2024.

The heatmap reveals consistent top-tier stability, with Hub leading and Gözde following each year, while mid and lower tiers display divergent patterns. Pardus shows upward momentum in 2023-2024, whereas Icu experiences a notable decline in 2024. Vturk improves gradually; İş remains weak but steady. The C_i values represent the relative closeness coefficients to the positive ideal solution, where a higher C_i value indicates better financial performance (Ayçin, 2019). According to the results obtained through the TOPSIS method, Hub consistently achieved the highest C_i scores during the 2021-2024 period, ranking first in all four years. This finding highlights Hub's stable and superior financial performance compared to other VCITs included in the analysis.
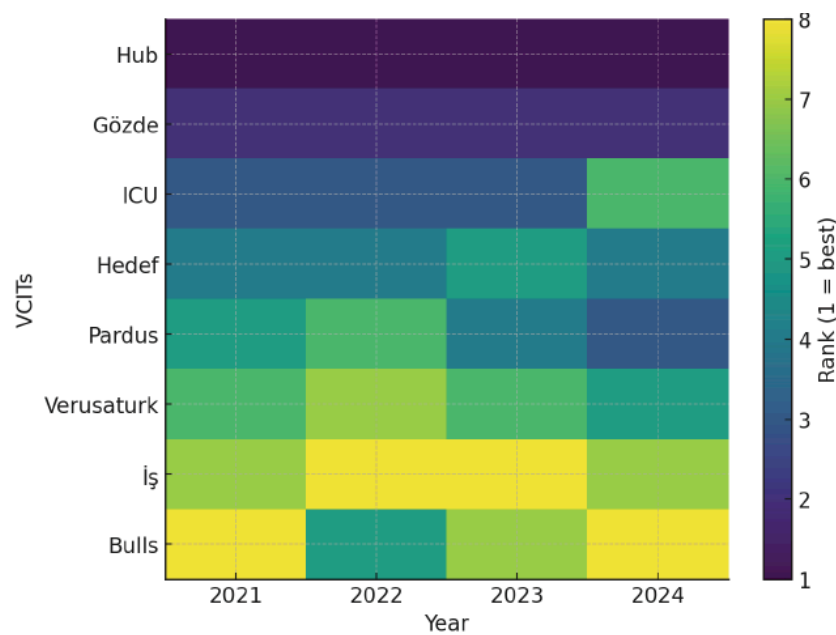
Figure 3: Annual Performance Rankings of VCITs (2021-2024).

In 2021, Hub recorded the highest performance score (0.4987), followed by Gözde and Icu in second and third place, respectively. In 2022, Hub again maintained its leading position (0.5356), while Gözde ranked second and Icu remained third. The 2023 results reflected a similar trend, with Hub (0.4532) and Gözde (0.3722) retaining the top two positions, whereas Icu continued to occupy third place.

By 2024, Hub further strengthened its financial performance with a C_i value of 0.5696, the highest recorded during the entire observation period. Gözde once again ranked second, while Pardus improved notably to third place, reflecting a relative rise in financial efficiency compared to previous years. The overall ranking pattern demonstrates that Hub and Gözde sustained superior financial positions throughout the study period, whereas smaller trusts such as Bulls, İş, and Vturk consistently exhibited lower C_i values, indicating weaker performance outcomes.

According to the results obtained from the TOPSIS analysis, Hub ranked first, Gözde second, and Icu third in 2021. A similar pattern was observed in 2022, with Hub maintaining its leading position, followed by Gözde and Icu in second and third place, respectively. In 2023, Hub once again achieved the highest financial performance, while Gözde and Icu retained their positions in second and third place. The results for 2024 show that Hub continued to hold the top position, Gözde ranked second, and Pardus rose to third place.

Overall, throughout the four-year period, Hub consistently exhibited the highest financial performance, demonstrating strong stability across years. Gözde maintained its position as the second-best performer, while Icu remained among the top three for most of the period. Pardus, on the other hand, showed a remarkable improvement in 2024. Conversely, Bulls, İş, and Vturk displayed relatively weaker financial performance scores over the observed period.

These findings provide a clear overview of the relative financial positions of VCITs during the 2021-2024 period. The consistent ranking pattern observed among the leading firms offers valuable insight into the structural stability of the Turkish venture capital market. The following section discusses these results in greater depth, relating them to previous empirical evidence and the broader literature on venture capital performance.

5. DISCUSSION

The results of the Entropy-TOPSIS analysis reveal a consistent financial performance hierarchy among the analyzed VCITs. Hub maintained the leading position throughout the 2021-2024 period, indicating sustained operational efficiency, liquidity strength, and profitability. Gözde followed closely in second place across all years, suggesting robust financial management and a well-diversified investment portfolio. The persistent top-tier positions of these two institutions reflect the advantages of scale, experience, and structured governance mechanisms within Türkiye's regulated venture capital market.

The relatively stable performance of Icu and the notable improvement of Pardus in 2024 highlight the gradual strengthening of medium-sized investment trusts. This trend aligns with the broader development

of the Turkish startup ecosystem, where institutional investors have increasingly adapted modern portfolio management and risk assessment practices. Conversely, the consistently lower scores of Bulls, İş, and Vturk suggest limited diversification and weaker capital utilization efficiency, factors that may constrain their ability to sustain high returns under volatile market conditions.

These patterns are largely consistent with previous studies in the field. Apan and Öztel (2020) reported Gözde dominance under the CRITIC-PROMETHEE framework. The convergence of these independent results across methodological approaches reinforces the validity of the observed performance hierarchy. Moreover, the findings confirm that VCITs with stronger liquidity, profitability, and asset utilization ratios tend to achieve superior overall rankings, underscoring the multi-dimensional nature of financial sustainability in venture capital markets.

In a broader context, these findings emphasize the importance of institutional maturity, analytical transparency, and portfolio diversification in shaping VCIT performance. As Türkiye's venture capital ecosystem continues to evolve, performance-based evaluation models such as Entropy-TOPSIS provide valuable benchmarks for both investors and policymakers. Such models facilitate more efficient capital allocation but also contribute to the accountability and resilience of the innovation-driven financial system. However, the study is limited to quantitative financial indicators; non-financial performance dimensions were not included.

6. CONCLUSION

This study examined the financial performance of VCITs operating in Türkiye between 2021 and 2024 using the Entropy-TOPSIS multi-criteria decision-making approach. The analysis revealed that Hub consistently achieved the highest performance scores, followed by Gözde, while Icu and Pardus showed moderate yet improving results. These outcomes indicate that financial stability and sustained profitability in VCITs are closely linked to effective capital allocation, portfolio diversification, and governance structures.

The findings also demonstrate that the Entropy-TOPSIS framework provides a robust and transparent mechanism for evaluating complex financial entities such as VCITs. By integrating multiple indicators covering liquidity, profitability, leverage, and efficiency, the method allows for an objective assessment of performance that complements traditional financial ratios and market-based measures.

From a broader perspective, the results underscore the critical role of institutional venture capital mechanisms in supporting startup financing and innovation-led growth in emerging markets. Enhancing operational and analytical capacities of VCITs can enhance their contribution to entrepreneurial ecosystems by improving funding continuity, risk management, and investment accountability. Overall, the findings contribute to a deeper understanding of how institutional venture capital mechanisms drive innovation-oriented economic transformation in emerging markets.

Future studies could expand on these findings by incorporating qualitative dimensions such as governance quality, innovation intensity, and network effects among VCITs and startups. Comparative analyses with other emerging economies could also provide a deeper understanding of how institutional venture capital structures evolve under different regulatory and macroeconomic conditions.

The findings of this study hold several implications for practitioners, policymakers, and investors. For VCITs, the results emphasize the importance of strengthening portfolio diversification strategies, enhancing liquidity management, and adopting data-driven performance monitoring tools such as the Entropy-TOPSIS framework. Policymakers, particularly the Capital Markets Board (CMB) and related financial authorities, may consider incentivizing transparency, performance benchmarking, and sustainable investment practices among VCITs to improve market efficiency. Encouraging collaboration between VCITs and startup accelerators or technoparks could also foster a more integrated innovation finance ecosystem. Overall, performance-based evaluation models can guide capital allocation decisions, promote accountability, and reinforce the strategic alignment between venture funding and national innovation objectives.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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