

Modeling the Dynamics of Decentralized Finance (DeFi)-Based Crowdfunding Systems to Support Startups

Jafar. Jafarizadeh¹, Hamid Reza. Mollaei^{1*}, Ali. Raeispour Rajabali², Mohsen. Zayandehroodi², Zahra. Firoozi¹

¹ Department of Industrial Management, Ke.C., Islamic Azad University, Kerman, Iran

² Department of Economics, Ke.C., Islamic Azad University. Kerman , Iran

* Corresponding author email address: hrmollaei@iau.ac.ir

Article Info

Article type:

Original Research

How to cite this article:

Jafarizadeh, J., Mollaei, H. R., Raeispour Rajabali, A., Zayandehroodi, M., & Firoozi, Z. (2026). Modeling the Dynamics of Decentralized Finance (DeFi)-Based Crowdfunding Systems to Support Startups. *Journal of Resource Management and Decision Engineering*, 5(5), 1-13.

<https://doi.org/10.61838/kman.jrmde.313>



© 2026 the authors. Published by KMAN Publication Inc. (KMANPUB). This is an open access article under the terms of the Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0) License.

ABSTRACT

The present study aimed to identify the factors influencing crowdfunding systems in the DeFi environment and to develop a system dynamics model for supporting startup businesses. In terms of purpose, this study is applied-developmental, and in terms of nature, it is exploratory. Using the system dynamics approach and documentary modeling methodology, the key factors affecting the success of crowdfunding in the DeFi environment were first identified through a systematic review of the literature (42 validated sources). Subsequently, by analyzing the causal relationships and feedback loops among these factors, causal loop diagrams and stock-and-flow diagrams were designed. For model validation, data from 150 projects and 15 active platforms in this field were utilized. The influential factors were categorized into five main groups, including project-related factors (proposal quality, executive team, tokenomics), platform-related factors (system quality, transparency, security, governance mechanisms), investor-related factors (trust, experience, herd behavior, risk tolerance), institutional factors (regulatory quality, institutional trust, governmental support), and macroeconomic factors (economic competitiveness, macroeconomic stability, technological penetration). Key feedback loops, such as the “trust and participation loop,” the “success and project attraction loop,” and the “investor learning and maturity loop,” were identified within the model. Mechanisms such as milestone-based financing, liquidity pools, and decentralized autonomous organization (DAO) governance were incorporated as major structural elements of the DeFi model. The proposed model can contribute to a deeper understanding of the complex dynamics underlying decentralized crowdfunding systems. Simulation results under different scenarios indicate that platforms utilizing milestone-based financing and decentralized governance mechanisms increase project success rates by up to 41%. Furthermore, the interactive effect of transparency and investor participation in platform governance demonstrated the strongest impact on long-term capital accumulation.

Keywords: Crowdfunding, Decentralized Finance (DeFi), System Dynamics, Startup Businesses, Documentary Modeling, Blockchain.

1. Introduction

The rapid evolution of digital technologies has fundamentally transformed the architecture of financial systems and entrepreneurial financing mechanisms over the past decade. Emerging technologies such as blockchain, smart contracts, decentralized finance (DeFi), and distributed ledger systems have created new opportunities for reshaping traditional models of capital allocation, investment participation, and startup financing. Among these innovations, crowdfunding has emerged as one of the most influential alternative financing mechanisms, particularly for startups and small entrepreneurial ventures that often encounter barriers in accessing conventional banking systems and venture capital resources (Ehsanfar, 2025; Singh & Sharma, 2023). Crowdfunding platforms enable entrepreneurs to mobilize financial resources from a broad community of investors through digital infrastructures, thereby democratizing access to capital and reducing dependence on centralized financial intermediaries (J, 2024; Onunka et al., 2023).

Traditional crowdfunding systems, however, continue to face several structural limitations despite their growing popularity. These limitations include high transaction costs, lack of transparency, centralized governance structures, vulnerability to fraud, weak investor protection mechanisms, and inefficiencies in monitoring the utilization of collected funds (Aziz, 2024; Varun et al., 2024). In centralized crowdfunding ecosystems, investors frequently encounter information asymmetry regarding project quality, managerial competence, and the actual allocation of capital resources. Such limitations often weaken investor trust and increase the probability of project failure. Moreover, centralized platforms possess substantial discretionary authority over project selection, fee structures, and dispute resolution mechanisms, which may create governance inefficiencies and reduce platform credibility (Boreiko, 2024; Rodríguez-Garnica et al., 2025).

The emergence of blockchain technology has introduced a transformative paradigm capable of addressing many of these structural weaknesses. Blockchain systems provide decentralized, transparent, immutable, and auditable infrastructures that can significantly improve trust formation, transaction security, and accountability within crowdfunding ecosystems (Gupta et al., 2024; Viju, 2024). Smart contracts, which operate as self-executing agreements coded on blockchain networks, enable automated fund allocation, milestone-based payments, and decentralized

governance mechanisms without requiring traditional intermediaries (Aswale et al., 2024; Varun et al., 2024). Consequently, DeFi-based crowdfunding systems have gained considerable attention as innovative financial infrastructures capable of enhancing efficiency, transparency, and inclusiveness in entrepreneurial financing.

Decentralized finance refers to a blockchain-based financial ecosystem that eliminates centralized authorities and enables peer-to-peer financial interactions through programmable protocols and smart contracts. DeFi systems integrate multiple technological and economic mechanisms, including decentralized exchanges, liquidity pools, governance tokens, and decentralized autonomous organizations (DAOs), to create autonomous financial infrastructures (Naudts, 2023; Olaniyi et al., 2023). Within crowdfunding contexts, DeFi mechanisms enable startups to raise capital directly from distributed communities of investors while maintaining transparency in capital flows, governance decisions, and project execution. This decentralized architecture reduces reliance on centralized financial institutions and creates opportunities for broader financial inclusion and entrepreneurial empowerment (Puschmann & Khmarskyi, 2024; Singh & Sharma, 2023).

The integration of crowdfunding and blockchain technologies has also generated new forms of entrepreneurial financing models, including Initial Coin Offerings (ICOs), Security Token Offerings (STOs), governance-token fundraising systems, and creator coin ecosystems (Boreiko, 2024; Mehta, 2024). These financing mechanisms allow startups to issue digital assets representing utility rights, governance participation, or future economic benefits to investors. Such innovations expand the range of financing instruments available to startups and facilitate global investor participation beyond geographical and institutional constraints. Nevertheless, the rapid expansion of DeFi-based crowdfunding has simultaneously introduced new forms of complexity, volatility, and systemic risk (Kshetri, 2023; Xie et al., 2025).

One of the major challenges associated with decentralized crowdfunding systems concerns the dynamic interactions among technological, institutional, investor-related, and macroeconomic variables. Unlike traditional financial systems characterized by hierarchical governance structures and centralized regulation, DeFi ecosystems evolve through nonlinear feedback mechanisms involving investor trust, platform reputation, liquidity dynamics, governance participation, and network effects. Changes in one component of the system can trigger cascading

consequences across multiple interconnected dimensions. For instance, improvements in platform transparency may increase investor trust, which subsequently attracts additional capital and projects, thereby strengthening platform reputation and market liquidity. Conversely, governance failures, security breaches, or excessive token volatility may rapidly undermine investor confidence and destabilize the entire financing ecosystem (Rodríguez-Garnica et al., 2025; Xie et al., 2025).

Investor behavior represents another critical dimension influencing the success of crowdfunding systems. Existing research demonstrates that investment decisions in crowdfunding environments are strongly affected by signaling effects, herd behavior, project communication quality, and perceived legitimacy (Cumming et al., 2025; Rodríguez-Garnica et al., 2025). Project owners frequently attempt to influence investor perceptions through strategic language, optimistic narratives, and signaling mechanisms designed to enhance project credibility and reduce uncertainty. In reward-based crowdfunding environments, discretionary tone and communication style have been shown to significantly affect project success probabilities (Cumming et al., 2025). Similarly, herd behavior can generate reinforcing investment dynamics in which early investor participation signals project legitimacy and encourages additional investment activity (Rodríguez-Garnica et al., 2025). These behavioral processes become even more complex in DeFi environments due to the increased role of token economics, decentralized governance participation, and speculative market behavior.

The role of governance mechanisms in decentralized crowdfunding systems has also received increasing scholarly attention. Decentralized autonomous organizations (DAOs) represent one of the most innovative institutional structures within blockchain ecosystems, enabling distributed communities of token holders to participate collectively in decision-making processes (Naudts, 2023; Olaniyi et al., 2023). DAOs can improve transparency, reduce agency problems, and enhance collective monitoring of project performance. However, governance participation in decentralized systems may also create coordination challenges, voter apathy, unequal influence distribution, and legal ambiguities regarding accountability and regulatory recognition (Naudts, 2023). The absence of comprehensive legal frameworks governing decentralized governance structures continues to represent a major institutional challenge for the sustainable development of DeFi ecosystems (Aziz, 2024; Kshetri, 2023).

Regulatory uncertainty is widely recognized as another major obstacle affecting the expansion of decentralized crowdfunding systems. Since DeFi ecosystems operate across jurisdictions and frequently involve tokenized assets with ambiguous legal classifications, governments and regulatory institutions continue to struggle with establishing effective legal frameworks capable of balancing innovation with investor protection (Aziz, 2024; Kshetri, 2023). Some jurisdictions have adopted supportive regulatory approaches to blockchain innovation, while others impose restrictive or uncertain policies that may discourage investor participation and entrepreneurial adoption. Institutional trust and regulatory quality therefore play substantial roles in shaping the legitimacy and sustainability of DeFi-based financing systems.

In addition to institutional factors, technological infrastructure and economic conditions significantly influence the viability of decentralized crowdfunding ecosystems. Blockchain scalability, transaction speed, cybersecurity resilience, internet penetration, and digital wallet adoption collectively determine the accessibility and operational efficiency of DeFi platforms (Aswale et al., 2024; Gupta et al., 2024). Macroeconomic instability and cryptocurrency volatility may further influence investor confidence and funding behavior. During periods of high market volatility, investors may become more risk-averse and reduce participation in startup financing activities. Conversely, favorable economic conditions and strong digital infrastructure can stimulate broader adoption of decentralized financial technologies (Onunka et al., 2023; Puschmann & Khmarskyi, 2024).

The sustainability dimension of blockchain-enabled crowdfunding systems has also emerged as an important area of contemporary research. Blockchain technologies and green fintech infrastructures are increasingly being utilized to support sustainable development goals, environmental initiatives, and socially responsible entrepreneurial projects (Chalmeta et al., 2024; Puschmann & Khmarskyi, 2024). Transparent and decentralized crowdfunding systems can facilitate resource mobilization for sustainability-oriented ventures by improving accountability, reducing corruption risks, and enabling traceable financial flows. This integration of fintech innovation with sustainability objectives highlights the broader socio-economic implications of decentralized financial ecosystems beyond purely technological or financial considerations.

Despite the growing scholarly and practical interest in DeFi-based crowdfunding systems, existing research

remains fragmented and largely focused on isolated dimensions of the phenomenon. Previous studies have predominantly examined specific aspects such as blockchain implementation, investor behavior, governance structures, token economics, legal challenges, or platform transparency independently (Boreiko, 2024; Naudts, 2023; Viju, 2024). Limited attention has been devoted to understanding the dynamic interactions and feedback structures connecting these variables within an integrated systemic framework. Furthermore, many existing studies adopt static analytical approaches that are insufficient for capturing the nonlinear, evolving, and feedback-driven nature of decentralized crowdfunding ecosystems.

System dynamics provides an appropriate methodological framework for addressing these analytical limitations. Developed as a methodology for understanding complex systems characterized by feedback loops, delays, accumulations, and nonlinear relationships, system dynamics enables researchers to model the structural determinants of system behavior over time. This approach is particularly suitable for analyzing DeFi ecosystems because decentralized financial systems exhibit highly interconnected dynamics involving investor participation, liquidity accumulation, platform reputation, governance structures, and project performance. Through causal loop modeling and stock-and-flow simulation, system dynamics can reveal the underlying mechanisms generating growth, instability, sustainability, or collapse within decentralized crowdfunding environments.

Moreover, the use of system dynamics allows policymakers, platform designers, and entrepreneurs to evaluate the long-term implications of alternative governance structures, transparency policies, funding mechanisms, and investor participation models. Simulation-based analysis can facilitate scenario evaluation and policy experimentation in ways that traditional cross-sectional methods cannot achieve. By identifying reinforcing and balancing feedback loops, system dynamics models can also contribute to a more comprehensive understanding of systemic vulnerabilities and resilience factors within DeFi crowdfunding systems.

Given the increasing importance of decentralized finance in entrepreneurial ecosystems, the growing demand for transparent and inclusive financing mechanisms, and the lack of integrated dynamic models explaining the behavior of DeFi-based crowdfunding systems, there is a significant need for comprehensive research capable of identifying the key determinants and structural interactions underlying

these ecosystems. Therefore, the present study aims to identify the factors influencing decentralized crowdfunding systems in the DeFi environment and to develop a system dynamics model for supporting startup businesses.

2. Methods and Materials

The present study employed a system dynamics approach to investigate the dynamics of decentralized finance (DeFi)-based crowdfunding systems and their role in supporting startup businesses. System dynamics is recognized as an analytical methodology for understanding the underlying structural mechanisms governing the behavior of complex socio-economic systems. The emphasis of this approach on feedback structures and nonlinear interactions provides a comprehensive understanding of real-world systems and facilitates the identification of dynamic behavioral patterns within complex environments. In terms of purpose, the study was classified as an applied-developmental investigation because it sought both to address a practical problem in the real world, namely improving startup financing mechanisms, and to expand theoretical knowledge related to decentralized financial systems. From the perspective of methodological nature and implementation, the research was exploratory and conducted using a documentary modeling strategy within the framework of system dynamics.

Data collection was conducted through documentary and library-based methods. Consistent with the principles proposed by Jay W. Forrester, the founder of system dynamics, model construction can be based on mental models, written resources, and numerical data. In the present study, primary emphasis was placed on written sources and documented evidence for extracting system variables, identifying causal relationships, and conceptualizing the structural foundations of the model. The statistical population of the study consisted of crowdfunding projects, including both traditional crowdfunding initiatives and DeFi-based crowdfunding projects, whose documentation and operational information were accessible through published sources and technical reports. For more detailed analysis and model calibration, information related to 150 crowdfunding projects was extracted and organized into the research database. Among these projects, 100 represented conventional crowdfunding systems and 50 were associated with decentralized crowdfunding platforms operating within blockchain-based ecosystems. Furthermore, operational and financial data from 15 active crowdfunding platforms were employed to calibrate and validate the simulation model.

The primary data collection method in this study was documentary analysis. Information and conceptual variables were extracted from multiple categories of written and technical resources to ensure methodological comprehensiveness and triangulation of evidence. Scientific articles constituted the first major source of data collection. A total of 32 peer-reviewed articles indexed in Web of Science, Scopus, and ScienceDirect databases were systematically reviewed using keywords such as “Crowdfunding,” “Decentralized Finance (DeFi),” “System Dynamics,” and “Blockchain.” These articles were used to identify key constructs, theoretical relationships, influencing variables, and existing research gaps related to decentralized crowdfunding ecosystems.

The second category of resources included five specialized books in the fields of system dynamics, digital economics, blockchain governance, and financial innovation. These sources provided the theoretical foundations required for developing feedback structures and understanding the dynamic interactions among the variables embedded within decentralized financial systems. Industry reports formed another major source of data collection. Five reports published by reputable international platforms and analytics providers, including DeFi Llama, CoinGecko, Binance Launchpad, and Kickstarter, were analyzed to obtain quantitative insights regarding market growth, liquidity behavior, investor participation, token issuance mechanisms, and project performance indicators in crowdfunding ecosystems.

In addition, technical documentation and whitepapers from 10 DeFi-based crowdfunding projects, including BonDeFi and Bifrost, were examined in detail. These documents provided operational information related to decentralized governance structures, tokenomics, liquidity pool mechanisms, milestone-based financing procedures, investor incentive systems, and decentralized autonomous organization (DAO) frameworks. The extracted information was subsequently used to conceptualize the causal relationships and feedback loops underlying the proposed system dynamics model.

Data analysis was conducted using the system dynamics methodology based on the five-stage modeling process proposed by John Sterman. In the first stage, problem structuring was performed by defining the objectives of the model, identifying the central problem, determining the key variables, establishing the boundaries of the system, and specifying the simulation time horizon. The primary objective of the model was to simulate the dynamics of

decentralized crowdfunding systems and to evaluate the effects of alternative policy mechanisms on project success and capital accumulation. The central problem addressed in the study involved the high failure rate of startup projects and the severe fluctuations in capital attraction within decentralized financing environments. The simulation time horizon was established as 36 months with monthly time intervals. The system boundaries included interactions among startup projects, crowdfunding platforms, investors, and the broader macroeconomic environment, while individual micro-level investor behaviors, except for herd behavior effects, were excluded from the model boundaries.

In the second stage, dynamic hypotheses were developed using Causal Loop Diagrams (CLDs). These diagrams illustrated the causal relationships among variables and facilitated the identification of reinforcing and balancing feedback loops embedded within the system structure. Key loops identified in this stage included trust and participation loops, investor learning loops, and project success attraction loops. In the third stage, Stock and Flow Diagrams were constructed based on the causal structures identified in the previous phase. Mathematical equations governing the relationships among stocks, flows, auxiliary variables, and feedback structures were formulated. The modeling and simulation procedures were implemented using Vensim DSS version 9.0 software.

In the fourth stage, the developed model underwent several validation procedures to ensure structural consistency and behavioral reliability. Behavioral reproduction tests were conducted through comparisons between simulated outputs and historical data obtained from crowdfunding platforms. Extreme condition tests were performed to evaluate model stability under boundary scenarios and unusual parameter conditions. Sensitivity analysis was also conducted to assess the responsiveness of model outputs to variations in critical parameters such as investor trust, transparency levels, governance participation, and liquidity availability. In addition, forecasting accuracy was evaluated using the Mean Absolute Percentage Error (MAPE) index.

In the final stage, the validated model was employed for scenario simulation and policy analysis. Different policy scenarios, including milestone-based financing systems, decentralized governance mechanisms, and variations in platform transparency, were simulated to investigate their impacts on project success rates, investor participation, and long-term capital accumulation within DeFi-based crowdfunding ecosystems.

3. Findings and Results

The qualitative findings derived from the systematic review of 42 scientific and technical sources revealed that the success of decentralized crowdfunding systems in the DeFi environment is influenced by five major dimensions and 23 sub-factors. The identified dimensions included project-related factors, platform-related factors, investor-related factors, institutional factors, and macroeconomic factors. Among the project-level variables, executive team competence demonstrated the highest relative importance, with a recurrence frequency of 40 out of 42 sources. Variables such as LinkedIn background verification, Know Your Customer (KYC) certification, and prior relevant experience were consistently emphasized as determinants of project credibility and investor confidence. Proposal quality, including documentation transparency, roadmap clarity, and the presence of promotional videos, also showed a high level of importance with a frequency of 38 references. Social capital of the project team and tokenomics design similarly emerged as highly influential variables, whereas the existence of a minimum viable product (MVP) demonstrated a moderate level of significance.

At the platform level, transparency of information represented the most influential factor with a recurrence

frequency of 41 references. Open-source smart contracts, periodic reporting, and auditability were repeatedly identified as essential components for investor trust formation. System quality, including transaction speed, platform accessibility, and cybersecurity standards, also demonstrated substantial importance. Governance mechanisms such as decentralized autonomous organization (DAO) participation and voting structures showed moderate importance, while educational support and responsive customer service received comparatively lower emphasis in the literature. Within the investor dimension, trust emerged as the most critical factor across all identified variables, appearing in all 42 reviewed sources. Herd behavior and investor participation dynamics also demonstrated strong effects on funding success, while investor experience, risk tolerance, and motivational factors displayed moderate influence. Institutional variables, including regulatory clarity and legal protection of investors, showed moderate significance, whereas governmental support and institutional trust exhibited lower frequencies. At the macroeconomic level, technological penetration and economic stability demonstrated moderate importance, while entrepreneurial culture and national competitiveness showed relatively limited direct influence on decentralized crowdfunding success.

Table 1

Key Factors Influencing the Success of DeFi-Based Crowdfunding Systems

Dimension	Key Factor	Operational Variables	Frequency in Sources (n = 42)	Relative Importance
Project	Proposal Quality	Documentation transparency, project videos, detailed roadmap	38	High
Project	Executive Team Competence	LinkedIn background, KYC certification, relevant experience	40	Very High
Project	Tokenomics Design	Fair token distribution, long-term liquidity lock, sustainable fees	32	High
Project	Team Social Capital	Social media followers, previous collaborations	35	High
Project	MVP Availability	Demonstrable prototype, product demo	28	Moderate
Platform	System Quality	Transaction speed, audited security, accessibility	36	High
Platform	Information Transparency	Open-source smart contracts, regular reports, auditability	41	Very High
Platform	Governance Mechanisms	DAO structure, voting systems, investor participation	25	Moderate
Platform	Milestone-Based Financing	Capital release based on project progress	30	High
Platform	Fee Structure	Low investor fees, loyalty incentives	22	Moderate
Platform	Support and Education	Educational documentation, responsive support teams	18	Moderate-Low
Investor	Trust	Perceived risk, smart contract transparency, platform history	42	Very High
Investor	Herd Behavior	Number of early investors, funding speed	37	High

Investor	Experience and Knowledge	Blockchain familiarity, previous investment experience	26	Moderate
Investor	Risk Tolerance	Willingness to invest in high-risk projects	20	Moderate
Investor	Motivation	Expected profit, belief in project idea, community support	29	Moderate
Institutional	Regulations and Laws	Token regulation clarity, investor legal protection	24	Moderate
Institutional	Institutional Trust	Support from banks and financial institutions	15	Low
Institutional	Governmental Support	Economic zones, tax exemptions	12	Low
Macroeconomic	Economic Stability	Inflation rate, cryptocurrency volatility	19	Moderate
Macroeconomic	Economic Competitiveness	Ease of doing business, innovation	14	Low
Macroeconomic	Technological Penetration	Digital wallet adoption, internet penetration	21	Moderate
Macroeconomic	Entrepreneurial Culture	Societal attitudes toward startups and risk-taking	16	Low

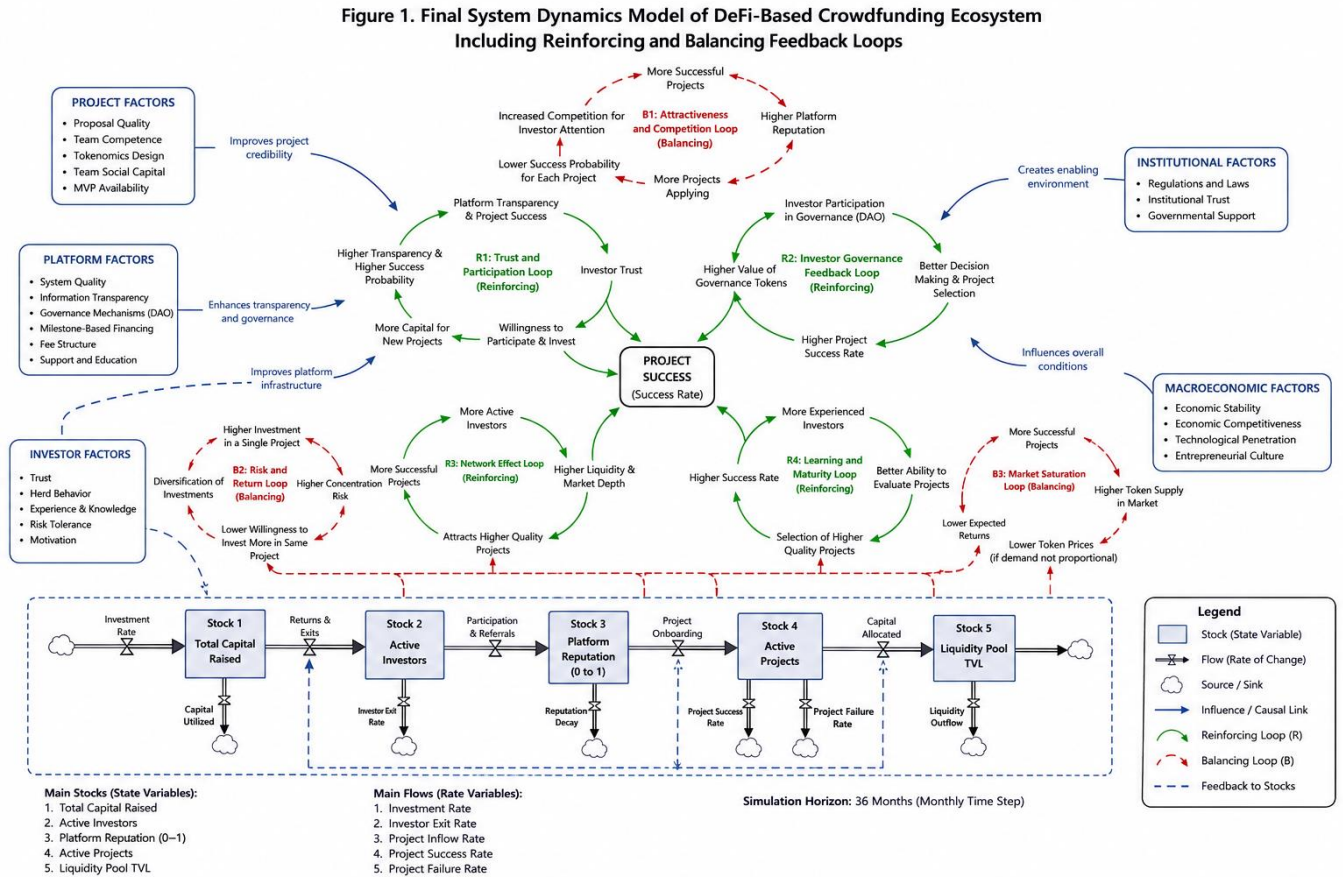
Based on the identified factors and their causal interactions, the causal loop diagram (CLD) of the system was developed. The model included several reinforcing and balancing feedback loops that collectively explained the dynamic behavior of decentralized crowdfunding ecosystems. Four major reinforcing loops were identified. The first reinforcing loop (R1), labeled the “trust and participation loop,” illustrated how increased platform transparency and project success enhance investor trust, which subsequently increases participation and investment flows, ultimately strengthening project success and transparency over time. The second reinforcing loop (R2), referred to as the “investor governance feedback loop,” demonstrated that active investor participation in decentralized governance structures improves project selection quality and decision-making effectiveness, thereby increasing project success rates and governance token value. The third reinforcing loop (R3), termed the “network effect loop,” reflected the positive relationship between investor growth, market liquidity, attraction of higher-quality projects, and subsequent platform expansion. The fourth reinforcing loop (R4), identified as the “learning and maturity loop,” showed how investor experience improves project evaluation capability, leading to higher-quality investment decisions and enhanced platform performance.

Three balancing loops were also identified within the system structure. The first balancing loop (B1), the “attractiveness and competition loop,” indicated that increasing numbers of successful projects attract more applicants to the platform, intensifying competition for investor attention and ultimately reducing the success probability of individual projects. The second balancing loop (B2), the “risk and return loop,” demonstrated that excessive investment concentration in a single project increases concentration risk and eventually reduces additional investment incentives. The third balancing loop (B3), the “market saturation loop,” showed that excessive growth in successful projects increases token supply in the market, leading to price reductions and declining investor incentives if demand does not increase proportionally.

The quantitative system dynamics model was subsequently developed through stock-and-flow formulation. The main stock variables included Total Capital Raised, Active Investors, Platform Reputation, Active Projects, and Liquidity Pool Total Value Locked (TVL). Corresponding flow variables consisted of Investment Rate, Investor Exit Rate, Project Inflow Rate, Project Success Rate, and Project Failure Rate. These variables collectively represented the structural and behavioral dynamics of DeFi-based crowdfunding systems over the 36-month simulation horizon.

Figure 1

Final System Dynamics Model of DeFi-Based Crowdfunding Ecosystem Including Reinforcing and Balancing Feedback Loops



The developed model was validated using behavioral reproduction, extreme condition, and sensitivity testing procedures. In the behavioral reproduction test, the simulated output for the “Total Capital Raised” variable was compared with historical data obtained from 10 major

crowdfunding platforms, including Bifrost, BonDeFi, and Binance Launchpad. The Mean Absolute Percentage Error (MAPE) of the model was calculated at 7.2%, indicating excellent predictive accuracy and strong behavioral consistency between the simulated and observed data.

Table 2

Behavior Reproduction Test Results

Month	Actual Data (Million USD)	Model Output (Million USD)	Percentage Error
6	45.0	42.8	-4.9%
12	82.0	85.3	+4.0%
18	115.0	110.2	-4.2%
24	148.0	156.7	+5.9%
30	176.0	168.5	-4.3%
36	205.0	219.6	+7.1%
MAPE	—	—	7.2%

The extreme condition tests demonstrated that when the trust variable approached zero, the investment rate also converged toward zero, which was logically consistent with the theoretical assumptions of the model. Additionally, when the number of projects increased excessively, the probability

of project success gradually approached zero due to investor attention saturation. The removal of milestone-based financing mechanisms resulted in significantly higher volatility in capital accumulation trajectories. Sensitivity analysis further indicated that $\pm 20\%$ changes in key

parameters, including transparency, network effects, and governance participation rates, resulted in less than 15% variation in total capital accumulation, demonstrating acceptable structural stability of the model. The most sensitive parameter was investor trust, where a 20% variation generated approximately 18% changes in total capital accumulation outcomes.

Following model validation, the system dynamics model was used to simulate four policy scenarios and evaluate their impacts on project success rates and total capital accumulation over a 36-month period. The baseline scenario (S0), representing the continuation of existing conditions with moderate transparency, absence of milestone-based financing, and 20% governance participation, produced a final project success rate of 52% and total accumulated capital of 124 million USD. Scenario S1, which focused on improving transparency through regular audits and quarterly reporting, increased project success rates to 68% and total capital accumulation to 178 million USD. Scenario S2, involving the implementation of milestone-based financing across five development stages, demonstrated even stronger

performance with a success rate of 81% and accumulated capital of 205 million USD. Scenario S3, emphasizing enhanced decentralized governance and increased investor participation in DAO decision-making structures, generated a project success rate of 74% and total capital accumulation of 196 million USD.

The combined scenario (S4), integrating transparency enhancement, milestone-based financing, and strengthened decentralized governance, produced the strongest outcomes among all simulated conditions. Under this integrated policy framework, project success rates increased to 93%, representing a 41% improvement compared with the baseline scenario. Total accumulated capital reached 253 million USD, reflecting a 104% increase relative to the baseline condition. These findings demonstrated that the simultaneous implementation of transparency mechanisms, decentralized governance participation, and staged financing structures creates synergistic effects capable of substantially improving the long-term sustainability and performance of DeFi-based crowdfunding ecosystems.

Table 3

Simulation Results of Different Policy Scenarios

Scenario	Description	Final Success Rate (After 36 Months)	Change Compared with Baseline	Total Capital Raised (Million USD)	Change Compared with Baseline
S0: Baseline Scenario	Existing conditions (Transparency = 0.6, no milestone-based financing, governance participation = 20%)	52%	—	124	—
S1: Transparency Improvement	Increasing transparency to 0.9 through regular audits and quarterly reporting	68%	+16%	178	+44%
S2: Milestone-Based Financing	Implementation of five-stage capital release mechanisms	81%	+29%	205	+65%
S3: Strengthening Decentralized Governance	Increasing investor participation in DAO governance to 50% through incentive mechanisms	74%	+22%	196	+58%
S4: Combined Scenario	Transparency improvement + milestone-based financing + governance strengthening	93%	+41%	253	+104%

4. Discussion and Conclusion

The present study aimed to identify the factors influencing decentralized crowdfunding systems in the DeFi environment and to develop a system dynamics model capable of explaining the dynamic interactions among these variables in support of startup businesses. The findings demonstrated that the success of DeFi-based crowdfunding systems is shaped by a multidimensional structure consisting of project-related, platform-related, investor-related,

institutional, and macroeconomic factors. Among these dimensions, investor trust, platform transparency, executive team competence, herd behavior, and decentralized governance mechanisms emerged as the most influential determinants affecting long-term capital accumulation and project success rates. The simulation results further revealed that policy mechanisms such as milestone-based financing, enhanced transparency, and decentralized governance participation substantially improve crowdfunding performance, particularly when implemented simultaneously within an integrated governance framework.

One of the most significant findings of the study was the central role of investor trust in shaping the sustainability and performance of decentralized crowdfunding systems. The sensitivity analysis showed that changes in trust levels produced the largest variation in total capital accumulation compared with other system parameters. This finding is theoretically consistent with the nature of decentralized financial systems, where the absence of centralized intermediaries increases the importance of transparency, perceived legitimacy, and technological credibility. In blockchain-based environments, trust is transferred from centralized institutions toward technological infrastructures such as smart contracts, distributed ledgers, and decentralized governance systems. The findings align with studies emphasizing the importance of transparency and secure blockchain architectures in strengthening investor confidence and reducing uncertainty in crowdfunding ecosystems (Aswale et al., 2024; Gupta et al., 2024; Viju, 2024). Similarly, research on investor protection and legal safeguards in crowdfunding systems has highlighted that trust remains one of the most decisive variables affecting investment participation and long-term ecosystem sustainability (Aziz, 2024).

The findings also demonstrated that transparency significantly influences project success rates and overall capital attraction. Platforms implementing high levels of transparency through regular auditing, open-source smart contracts, and periodic reporting achieved substantially higher investment performance than platforms operating under baseline conditions. This result supports prior literature indicating that blockchain-enabled transparency reduces information asymmetry and increases investor willingness to allocate financial resources to entrepreneurial projects (Chalmeta et al., 2024; Varun et al., 2024). Transparency is particularly important in decentralized systems because investors frequently rely on publicly available digital signals rather than direct institutional guarantees. The present findings are also consistent with research suggesting that transparent communication and signaling mechanisms positively affect crowdfunding performance and investor participation behavior (Cumming et al., 2025; Rodríguez-Garnica et al., 2025). In reward-based and token-based crowdfunding environments, the perceived credibility of project communication plays a crucial role in shaping investor perceptions regarding project viability and managerial competence.

Another important finding concerns the effectiveness of milestone-based financing mechanisms in improving project

success rates and stabilizing capital accumulation. The simulation scenarios revealed that staged capital release mechanisms generated significantly higher project success rates compared with conventional unrestricted financing structures. This finding can be explained by the role of milestone-based financing in reducing agency problems, increasing accountability, and enhancing investor monitoring capabilities. By linking capital release to verified project progress, milestone-based systems reduce the probability of opportunistic behavior and improve resource allocation efficiency. These results correspond with previous studies emphasizing the capacity of blockchain and smart contract systems to automate financial governance and improve transactional accountability (Gupta et al., 2024; Viju, 2024). Furthermore, the findings are aligned with research highlighting that decentralized financing structures can improve entrepreneurial resource management through programmable financial controls and transparent execution protocols (Sadeghi et al., 2023).

The study also revealed that decentralized governance mechanisms, particularly investor participation through decentralized autonomous organizations (DAOs), positively influence project selection quality, platform reputation, and long-term ecosystem sustainability. Increasing investor participation in governance structures generated substantial improvements in project success and capital accumulation across the simulation scenarios. These findings support theoretical perspectives suggesting that decentralized governance can reduce agency conflicts and improve collective decision-making processes in digital financial ecosystems (Naudts, 2023; Olaniyi et al., 2023). The reinforcing governance feedback loop identified in the model demonstrated that active participation strengthens governance token value, improves project evaluation quality, and enhances investor commitment to the platform ecosystem. This finding also reflects broader discussions in blockchain governance literature concerning the transition from centralized financial authority toward community-driven governance structures (Kshetri, 2023).

The network effect loop identified in the system dynamics model represented another critical contribution of the study. The findings showed that increases in active investor participation generate greater market liquidity and attract higher-quality projects, which subsequently reinforce platform growth and ecosystem expansion. This result reflects the self-reinforcing dynamics characteristic of many digital platform economies and decentralized financial ecosystems. The existence of strong network effects in

crowdfunding systems has been highlighted in previous studies examining investor behavior and market participation dynamics (Rodríguez-Garnica et al., 2025). In decentralized environments, network effects become even more influential because platform value depends heavily on user participation, token utility, and liquidity depth. Therefore, attracting and retaining active investors represents a strategic priority for DeFi-based crowdfunding platforms seeking sustainable growth.

The identified investor learning and maturity loop further demonstrated that increasing investor experience improves project evaluation capabilities and contributes to higher-quality investment decisions. As investors accumulate knowledge regarding blockchain technologies, tokenomics, and startup evaluation processes, they become more capable of distinguishing viable projects from speculative or low-quality ventures. This process increases overall project success rates and strengthens ecosystem stability. These findings align with prior research emphasizing the importance of financial literacy, technological familiarity, and digital inclusion in fintech adoption and entrepreneurial financing participation (Onunka et al., 2023; Singh & Sharma, 2023). The role of investor education is especially critical in DeFi environments due to the technological complexity and financial volatility associated with blockchain-based assets.

The balancing loops identified in the model also provided important insights into the structural limitations and vulnerabilities of decentralized crowdfunding ecosystems. The market saturation loop demonstrated that excessive growth in successful projects may increase token supply beyond proportional market demand, thereby reducing token prices and weakening investor incentives. Similarly, the attractiveness and competition loop illustrated that platform success may generate intensified competition among projects for investor attention, ultimately reducing the probability of success for individual ventures. These findings suggest that although DeFi ecosystems possess strong growth potential, they are simultaneously vulnerable to structural instability, speculative excess, and resource fragmentation. Such dynamics are consistent with previous studies identifying volatility, regulatory ambiguity, and speculative behavior as major risks within blockchain-based financing systems (Mehta, 2024; Xie et al., 2025).

The findings regarding regulatory quality and institutional trust also deserve attention. Although institutional factors demonstrated lower direct influence compared with investor trust and platform transparency, they

nonetheless played a meaningful role in shaping ecosystem stability and legitimacy. Regulatory uncertainty remains one of the primary obstacles limiting the widespread adoption of decentralized crowdfunding systems. Legal ambiguity concerning token classifications, investor rights, and decentralized governance accountability may discourage institutional participation and increase systemic uncertainty. These findings correspond with research arguing that supportive legal frameworks and institutional recognition are essential for the long-term sustainability of DeFi ecosystems (Aziz, 2024; Kshetri, 2023; Naudts, 2023). Therefore, while decentralized systems seek to reduce reliance on centralized institutions, institutional legitimacy and regulatory clarity continue to play important roles in facilitating broader ecosystem adoption.

The study additionally highlighted the broader economic and developmental implications of decentralized crowdfunding systems. By reducing barriers to capital access and enabling peer-to-peer financing structures, DeFi-based crowdfunding can significantly improve financial inclusion for startups and small entrepreneurial ventures. This finding aligns with research emphasizing the transformative role of fintech ecosystems in expanding access to financial resources for underserved businesses and entrepreneurs (Ehsanfar, 2025; Singh & Sharma, 2023). Decentralized crowdfunding platforms may be particularly valuable in emerging economies and financially constrained regions where traditional banking infrastructures are insufficient or exclusionary. Furthermore, blockchain-enabled transparency and accountability mechanisms can support sustainability-oriented projects and socially responsible entrepreneurial initiatives, thereby contributing to broader sustainable development objectives (Chalmeta et al., 2024; Puschmann & Khmarskyi, 2024).

Another important implication of the findings concerns the methodological value of system dynamics for analyzing decentralized financial ecosystems. Traditional linear analytical approaches are often insufficient for understanding the nonlinear interactions, delays, feedback structures, and accumulation processes characteristic of DeFi systems. By integrating causal loop diagrams, stock-and-flow structures, and simulation-based policy analysis, the present study provided a more comprehensive understanding of the structural dynamics underlying decentralized crowdfunding systems. The low MAPE value obtained during model validation further confirmed the robustness and behavioral consistency of the developed model. Therefore, the findings support the suitability of

system dynamics as an effective analytical methodology for investigating complex digital financial ecosystems characterized by adaptive interactions and evolving governance structures.

The most significant finding of the study was related to the combined policy scenario integrating transparency enhancement, milestone-based financing, and strengthened decentralized governance. This integrated scenario generated the highest project success rate and more than doubled total capital accumulation relative to the baseline condition. The synergistic effects observed in this scenario indicate that the effectiveness of decentralized crowdfunding systems depends not on isolated interventions but rather on the coordinated interaction of governance quality, technological transparency, investor participation, and financial accountability mechanisms. This finding reinforces the systemic perspective underlying the study and highlights the importance of adopting integrated policy frameworks in the design and regulation of DeFi-based entrepreneurial financing systems.

One limitation of the present study concerns the reliance on documentary analysis and secondary data sources for model construction and calibration. Although the use of multiple scientific articles, technical reports, and platform data improved the comprehensiveness of the model, direct empirical observations from investors, entrepreneurs, and platform managers were not incorporated into the analysis. In addition, the model focused primarily on macro-level structural dynamics and did not include detailed psychological or behavioral heterogeneity among individual investors. The rapidly evolving nature of blockchain technologies and DeFi protocols may also limit the long-term stability of some model assumptions. Furthermore, the study concentrated mainly on crowdfunding ecosystems operating in relatively open digital markets and did not explicitly model country-specific regulatory differences or geopolitical constraints affecting DeFi adoption.

Future research can expand the present study in several directions. Subsequent studies may integrate behavioral economics and agent-based modeling approaches to capture individual-level investor decision-making processes within decentralized crowdfunding environments. Comparative studies across countries with different regulatory structures could also provide deeper insights into the influence of institutional frameworks on DeFi ecosystem development. Future investigations may additionally examine the role of artificial intelligence, predictive analytics, and automated governance systems in improving project selection and risk

management within decentralized crowdfunding platforms. Longitudinal empirical studies based on real-time blockchain transaction data may further improve the predictive accuracy and practical applicability of system dynamics models in digital finance research.

From a practical perspective, the findings suggest that DeFi crowdfunding platforms should prioritize transparency mechanisms, decentralized governance participation, and milestone-based financing structures to improve investor trust and long-term sustainability. Platform developers should implement auditable smart contracts, transparent reporting systems, and participatory governance infrastructures that actively involve investors in strategic decision-making processes. Startup founders seeking decentralized financing should focus on strengthening project credibility through detailed roadmaps, transparent communication, and robust tokenomics design. Policymakers and regulatory institutions should also develop adaptive legal frameworks capable of balancing innovation promotion with investor protection and systemic stability. Finally, educational institutions and fintech organizations should invest in blockchain literacy and investor education programs to improve the quality of participation and decision-making within decentralized crowdfunding ecosystems.

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.

Acknowledgments

We would like to express our gratitude to all individuals helped us to do the project.

Declaration of Interest

The authors report no conflict of interest.

Funding

According to the authors, this article has no financial support.

Ethics Considerations

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were considered.

References

- Aswale, M. P. S., Vyawahare, M. N., Patange, A., Hargude, P., Gadkari, G., & Patil, S. (2024). Transparent Charity Application and Crowdfunding Using Blockchain. *Int Res J Adv Engg Hub*, 2(05), 1221-1230. <https://doi.org/10.47392/irjaeh.2024.0168>
- Aziz, M. T. (2024). Ensuring Investor Security and the Future of Crowdfunding: Exploring Legal Protection and Innovations in Indonesia. 602-608. https://doi.org/10.2991/978-2-38476-218-7_101
- Boreiko, D. (2024). Introduction to Initial Coin Offerings. 1-7. <https://doi.org/10.4337/9781803921587.00007>
- Chalmeta, R., Cabezas-Hernando, D., & Silva, J. d. S. (2024). Framework for Crowdfunding Sustainable Development Goals Projects Using Blockchain. *Sustainable Development*, 33(2), 2740-2758. <https://doi.org/10.1002/sd.3260>
- Cumming, D., Lan, Y., Shan, Y. G., & Zhang, J. (2025). Discretionary tone in reward-based crowdfunding: Do project owners talk their way to success? *The British Accounting Review*, 57(3), 101433. <https://doi.org/10.1016/j.bar.2024.101433>
- Ehsanfar, S. (2025). The Role of Fintechs and Crowdfunding Platforms in Improving Access to Financial Resources for Small and Medium Enterprises. *9th International Conference on Management, Accounting, Economics, and Banking in the Third Millennium*. <https://civilica.com/search/paper/k-%D8%AA%D8%A7%D9%85%DB%8C%D9%86%20%D9%85%D8%A7%D9%84%DB%8C%20%D8%AC%D9%85%D8%B9%DB%8C-o-Title-ot-desc/>
- Gupta, R., Gupta, S. G., Gangwar, L. G., Gupta, A. G., & Shinde, V. (2024). Easy-Starter : An Online Crowdfunding Website Using Blockchain. *International Journal of Scientific Research in Computer Science Engineering and Information Technology*, 10(2), 232-241. <https://doi.org/10.32628/cseit2410214>
- J, M. K. (2024). Rise Together: A Crowdfunding Platform. *Interantional Journal of Scientific Research in Engineering and Management*, 08(04), 1-5. <https://doi.org/10.55041/ijssrem31331>
- Kshetri, N. (2023). The Nature and Sources of International Variation in Formal Institutions Related to Initial Coin Offerings: Preliminary Findings and a Research Agenda. *Financial Innovation*, 9(1). <https://doi.org/10.1186/s40854-022-00405-x>
- Mehta, A. (2024). Assessing Economic Feasibility of Creator Coins. <https://doi.org/10.32920/26052613>
- Naudts, E. (2023). The Future of DAOs in Finance - In Need of Legal Status. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.4605627>
- Olaniyi, O. O., Olabanji, S. O., & Okunleye, O. J. (2023). Exploring the Landscape of Decentralized Autonomous Organizations: A Comprehensive Review of Blockchain Initiatives. *Journal of Scientific Research and Reports*, 29(9), 73-81. <https://doi.org/10.9734/jsrr/2023/v29i91786>
- Onunka, T., Raji, A., Osafiele, A. N. O., Daraojimba, C., Egbokhaebho, B. A., & Okoye, C. C. (2023). Banking: A Comprehensive Review of the Evolution and Impact of Innovative Banking Services on Entrepreneurial Growth. *Economic Growth and Environment Sustainability*, 2(2), 66-78. <https://doi.org/10.26480/egnes.02.2023.66.78>
- Puschmann, T., & Khmarskyi, V. (2024). Green Fintech: Developing a Research Agenda. *Corporate Social Responsibility and Environmental Management*, 31(4), 2823-2837. <https://doi.org/10.1002/csr.2675>
- Rodríguez-Garnica, G., Gutiérrez-Urtiaga, M., & Tribo, J. A. (2025). Signaling and herding in reward-based crowdfunding. *Small Business Economics*, 64(3), 889-916. <https://doi.org/10.1007/s11187-024-00933-z>
- Sadeghi, M., Mahmoudi, A., Deng, X., & Naeni, L. M. (2023). Enterprise Blockchain Solutions for Vibrant Construction Ecosystem: Grey Ordinal Priority Approach. *Grey Systems Theory and Application*, 14(1), 115-143. <https://doi.org/10.1108/gt-07-2023-0060>
- Singh, A., & Sharma, L. M. (2023). Fintech and Financial Inclusion: Transforming Underserved Access to Financial Services. *International Journal of Tourism and Hotel Management*, 5(2), 07-11. <https://doi.org/10.22271/27069583.2023.v5.i2a.71>
- Varun, M., Devi, S., Jaiswal, U., & Pratap, V. (2024). Decentralized Crowdfunding Platform Using Blockchain Technology. *International Research Journal of Modernization in Engineering Technology and Science*. <https://doi.org/10.56726/irjmets49574>
- Viju, A. (2024). Crowdfunding Using Blockchain. *Ijrasnet*, 12(4), 2099-2101. <https://doi.org/10.22214/ijrasnet.2024.59996>
- Xie, C., Hou, C., Sun, Y., & Sugumaran, V. (2025). Exploring Risks and Challenges in Crowdfunding Performance Using Text Analytics and Deep Learning. *International Journal of Software Science and Computational Intelligence*, 17(1), 1-31. <https://doi.org/10.4018/ijssci.370002>