

Research Article

A Fuzzy Ecosystem Benchmarking for Crowdfunding in Transport Sector

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Received 12 May 2022; Revised 19 May 2022; Accepted 1 August 2022; Published 16 September 2022

Academic Editor: Elżbieta Macioszek

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The global crowdfunding (CF) market was valued at 10.2 billion US\$ in 2018 and is expected to almost triple in size by 2025. The CF is evolving as a major and easy source of fundraising methods for various industries. Still, this acceptability is not widely accepted in transportation activities due to various limitations and low awareness among policymakers. The present research analyzes the factors contributing to the growth of market acceptability of CF, divided into three different research phases: identifying barriers from the literature, interviews with transport industry experts at two stages, and designing an ISM model in a fuzzy environment. The identification phase led to selecting 16 factors from the past literature and suggesting industrial experts. The Interpretive Structural Modelling (ISM) analysis was used to understand the impact and linkage of identified barriers on seven levels of the fuzzy scale. The factors are classified into four major categories based on the fuzzy matrix's drive and dependence power using Fuzzy MICMAC. The sixteen identified growth factors for CF have been distributed in 5 levels in the ISM designed model. All the factors had fallen in only two quadrants of MICMAC based on the fuzzy scale matrix. Except for No or Low in regulation, the selected fifteen factors fall in the linkage quadrant, with high dependency and driving power. Such relation of all variables is the precise reason for storm growth in the field. "No or Low in regulation" is one of the most significant factors to the growth and acceptance of this innovative fundraising method by common investors but cannot be controlled directly by the associated crowdfunding members in the transport industry.

1. Introduction

In recent years, crowdfunding has become an important elective funding source looking for outside financing. Crowdfunding is a term portraying a new twist on generally old fundraising methods. Existing empirical investigations report huge growth in fundraising volume through crowdfunding (CF) worldwide. The success story of CF in the transportation industry is well known; in a recent year, a Germany based start-up launched a high-speed train, Locomore, with the help of CF sources. The company

sourced over €231,000 in the first phase and €460,000 in the second phase of fund sourcing in 2016 to launch its Stuttgart-Berlin rail service. Through crowdsourcing, Commuter Club, UK's independent train season ticket retailer and finance provider, has raised more than £2.2 m in 2019 (source: rail technology). The current condition of the COVID pandemic has created a very conducive environment for the growth of CF. Many of us used the CF platform for help with medical bills, funeral expenses, lost wages, small business support, food assistance, and other needs. COVID-related fundraising activities increased exponentially after March

2020 on platforms such as GoFundMe [1]. The Ph.D. thesis work of Soto [2] highlights various aspects of crowdfunding-based transportation infrastructural projects along with their implementation and policies.

Crowdfunding is an umbrella term that refers to an increasingly widespread form of fundraising where individuals pool their money, usually smaller contributions by individuals to achieve a particular goal. However, attention toward crowdfunding by many investors, policymakers, founders, and regulators has increased its mechanisms and dynamics in general, and equity crowdfunding, in particular, is not yet well understood [3].

The concept of crowdfunding can be traced back to the nearer broader concept of crowdsourcing, which uses the crowd to get the solution, ideas, and feedback concerning the progress of corporate activities [4, 5]. The primary motive of crowdfunding is to collect funds for some specific projects or functions, typically by using social networks online, usually, a small sum of individual contributions, to provide financial support to an effort by a fundraiser to attain a specific goal. Such investment may create different forms of obligations, like equity, loan, donation, and even advance payment of an order for future buying [6–9]. Crowdfunding provides unparalleled efficiency of capital creation, mainly to start-ups.

Because CF differs from standard fund sourcing methods, it can help businesses raise financing at an early stage of development. Even if the company is liquidated, CF creates a differential right on its assets. Unlike traditional fundraising approaches, even very successful crowdfunding fundraising does not necessitate the involvement of a financial institution as underwriters, which further reduces the related fees involved in the fundraising. Therefore, fundraising expenses in CF become lower than conventional fundraising methods in the absence of cumbersome regulatory procedures, constraints, and paperwork. The crowdfunding market is relatively new and complex for average business houses. The global crowdfunding market was valued at \$12.27 billion in 2021 and is expected to almost triple in size by 2025. Possibly, the crowdfunding approach is going to be the future of fundraising in finance markets. Also, the cost of raising funds through IPOs is comparatively much higher. It differs from other funding sources due to varied relationships between funders and fundraisers by goals, context, and fundraising efforts [10].

Although CF has piqued the interest of academics and professionals, there are relatively few structural works of the literature on the subject, primarily to examine the facilitators and determinants in the rise of CF in the transportation industry. This paper is one of the early attempts to investigate growth determinants and the different fundamental features of the potential underlying structure of CFs, known as their “detailed investment realities.” Developing economies, such as India, are still battling to recover from the financial shocks caused by the 2008 global crisis. Any errors in fundraising methods such as crowdfunding may raise concerns about sustainability. Sustainability is one of the major areas of concern in such a high growth economy. An increasing flow of finance from national and foreign sources

is the key to achieving such economic sustainability. Crowdfunding (CFs) is evolving as one of the most preferred vehicles of fund mobilization.

It becomes crucial to study the factors and their importance contributing to the growth of CF. Many of these factors and their association with management education have been studied mainly in isolation. The research methodology is the backbone of a research study; the methodology explains the structured way of solving problems, achieving objectives and the validity of the result. The current study falls under the quantitative domain of research [11]. Hence, this study is designed to determine the factors affecting the growth of CF in the long run. This paper is one of the preliminary attempts to study the mutual relationship among all the elements in the development of CF. The primary objective of this paper is to rank the barriers based on their dominance. Then, an analysis would attempt to understand the mutual imperative relationship of all selected factor barriers to developing a sustainable market for CF. The Interpretive Structural Modelling (ISM) model in the FUZZY environment designed on expert opinions has been used as a research methodology. The study is an attempt to make some incremental contributions which are as follows:

- (i) Defines the impact of each factor in the system of elements on CF.
- (ii) Applies the in-depth understanding of the judgmental sample of experts and generates an acceptable framework for the academics, policymakers, and industry.
- (iii) Uses the mathematical explanation of Interpretive Structural Modelling (ISM) and “Matrices d’Impacts Croises Multiplication. Appliqué a UN Classement” (cross-impact matrix multiplication applied to classification) (MICMAC) in a fuzzy environment to attain new perceptions about the factors on CF.

Accordingly, the research objectives (RO) and research questions of this study are as follows:

- RO1: to explore and identify the enablers of crowdfunding (CF), mainly in the transport sector
- RO2: to propose an integrated fuzzy ISM-MICMAC decision-making framework to assess and benchmark the CF

The following research questions (RQ) have been framed to achieve the above-cited objectives:

- RQ1: what are the critical dimensions and enablers of the CF?
- RQ2: how does the mutual interaction of enablers of CF play a significant role in industry and business houses?
- RQ3: how can a systematic framework help assess the severity of each enabler in a fuzzy environment?

The main purpose of the research is to highlight the factors of CF, a technology-driven financing activity, in the growth of the transportation industry. The CF is evolving as

a major and easy source of fundraising methods for various industries. Still, this acceptability is not widely accepted in transportation activities due to various limitations and low awareness among policymakers.

The paper is divided into the following sections: Section 1 provides an introduction and understanding of crowdfunding, including the risk and economy of CF, Section 2 provides a review of previously published literature related to the study, and Sections 3 and 4 provide an outline of the research structure. Sections 5 and 6 describe the questionnaire and ISM application construction, followed by fuzzy computation. Section 7 has a discussion of the findings. Section 8 addresses recommendations and applications, while Section 9 discusses limitations and future research opportunities.

2. Literature Review

2.1. Literature on the Enablers of CF. The study domain of CF is relatively new in finance, so it is no surprise that the associated literature is only in the emerging stage. The government's lack of support and incentives is the main reason behind the lack of awareness about crowdfunding in India. Mass research, transparency, feasibility, convenience, goal orientation, and reward lead to investment in crowdfunding [12]. Non-investor-friendly, low trust, credibility, transparency, and awareness are some challenges for crowdfunding in India [13]. Underlying project quality and personal networks are the critical components associated with the success of crowdfunding and the projects which are geographically related to both types and have successfully raised funds [14]. Investors who have a personal connection with friends and family have more driven the geographic effect. However, the online platform has eliminated the distance-related problems like data gathering information, and the social-related frictions are still not eliminated by the technology [15]. Referring to the economic model of "multi-side platforms," a theoretical framework for crowdfunding websites was proposed, classifying projects according to the objectives of crowd funder and initiator. Four different typologies such as business, cooperation, patronage, and donation were pointed out by them [16]. Three types of investment opportunities, that is, donations, passive investment, and active investment, are offered to potential investors to finance a project under crowdfunding. Active investments are more related to equity than passive investments related to debt [17].

The early schema of the inner working of crowdfunding is presented, and the social entrepreneurship context was discussed, which shows the matchmaking process between the venture, offering debt or equity investments, and the crowd [18]. Currently, crowdfunding is an infant [9].

To reach the target fund, individual social capital has a significant positive effect, whereas geolocalized capital has no significant effect [19]. Portals prefer fewer disclosure requirements and fewer restrictions on the free trading of crowd-funded shares, whereas start-ups prefer fewer restrictions on the ability to crowdfund. However, more disclosure, limits on amounts entrepreneurs can raise, and

lower thresholds for audited financial statements are demanded by investors [20]. The entrepreneur's reputation affects capital formation outcomes favourably in terms of both degree and speed. The capital formation depends on the entrepreneur's reputation rather than on funder characteristics, project characteristics, or timing of backing. This becomes important as more financial institutions rely on nontraditional social media data to make funding decisions [21]. Projects in the field of transport and transport support are creating huge funds by CF across the globe, which is better than other traditional sources of funds [2]. Crowdfunding is becoming an easier source of fundraising for big and capital intensive transport-related projects and infrastructure [22].

2.2. Literature on the Traditional Fundraising Methods. IPOs investment is generally treated as low-hanging fruits by the investors. If investors get allotment in IPOs and sell these stocks on the listing, they get returns better than the going market. Generally, IPOs are underpriced compared to their listed peer group companies [23]. The uninformed retail investors might undergo a "winner's curse problem" by making all their allocation in IPOs [24]. IPOs are used as a short-term investment avenue to get maximum return, as they are generally available at a comparatively low price [25]. IPOs can be a good source of return, as generally, they are underpriced, as observed using a signalling model with two signals and attributes [26, 27]. Investment in IPOs in the period 1970-1990 failed to give an expected return in the long run [28]. IPOs are preferred investment tools due to their guideline and transparency of book building [29].

Many kinds of literature support different reasons for IPO pricing under various market conditions (Baron [30]; Muscarella and Vetsuypens [14]; Welch [31, 32]; Allen and Faulhaber [33]; Chemmanur [34]; Michael and Shaw [35]; Koh and Walter [36] Hughes and Thakor [37]; Drake and Vetsuypens [38]; Lowry and Shu [39]; Boehmer and Raymond Fisher [40]; Krigman et al. [41]; Ellis et al. [42]; Booth and Chua [43]; Bubna and Prabhala [44]; and many more).

3. Literature on the Suitability of Methodology

Interpretive Structural Modelling (ISM) is a ranking system of directly or indirectly connected factors in a complete methodical model. The model shows the systematic ranking of factors in a multilevel structured pattern of graphs and statements using opinions from various experts. The structural model inflicts relative direction and ranking of selected factors even for a multifarious system to provide a clear insight to regulators and policymakers [45, 46].

The ISM technique is used to study inter-relationships among identified factors on vendor selection in supply chain management [47-49]. The ISM ranking method has been used to classify factors to execute knowledge management schemes in manufacturing and other production-based industries [50]. The study used the ISM technique to form a multilevel, hierarchy process model for factors required to implement an optimal waste management project [51]. The

concept of ISM methodology has been used to establish a relationship matrix of selected elements for the conservation and management of energy in the cement manufacturing plants [52]. The ISM methodology is used to select and offer a relative position of the factors for the reverse logistics selection process in SCM of the hardware business. The study suggested a relative ranking of barriers [53]. The ISM technique has been used to rank 11 selected key barriers and establish a relative matrix in the implementation of reverse logistics in the automotive industry [54]. The hybrid ISM and ANP are used to find interdependence and feedback relationships in subsystems by multidimensions and scaling techniques in the Chinese industry [55]. The ISM methodology has been used to address issues in green suppliers in the automobile sector [56, 57]. The ISM was applied to established relations among the elements influencing the supplier selection for the built-in-order industry [58]. Further, the ISM ranking model is upgraded by an amalgamation of fuzzy TOPSIS (the Technique for Order of Preference by Similarity to Ideal Solution) as a fusion approach for ranking factors in the area to identify the third-party reverse logistics suppliers [59]. The ISM is also used to sort out problems in the knowledge management system [60]. The ISM is also used to sort out problems in the healthcare sector [61]. The research-based is on a structured ISM method to get the mutual involvement of identified enablers in implementing a flexible manufacturing process [62]. The ISM is also used in finance and investment decisions, an article to sort out problems in retirement planning [63]. ISM model is used to identify the factors of knowledge management [50, 60, 64], literature surveys, [65–67], and many more that have summarised the works of literature published based on ISM model and other hybrid ISM models in different industries.

Many kinds of literature studies based on ISM and hybrid ISM are available related to the studies in different disciplines. However, there is a lack of work carried out on applying this method to evaluate crowdfunding enablers. With the growth of CF and other similar fundraising methods, the industry's sustainability and transparency are critical issues before regulators. The regulators have to understand the factors of the growth of such a new virtual financial system for the betterment and safety of the investors. Very few pieces of the literature have studied accelerators in the area. This study aims to fill the gap and analyze mutual relationships among all the factors in the way of the growth of the CF market. The sixteen factors based on available literature and views from the experts from industry and academia are found as shown in Table 1. The selected decision-making methodology has been used on these identified factors to rank them as per their importance.

4. Research Methodology

The current section is based on paradigm, sampling, and instrument development process to solve the identified problem in a structured way [72]. Due to start-ups' high demand for capital in recent years, CF has received a high concentration level in the last few years. Many existing companies have also joined the race of CF to raise additional funds for their running

business. Dint of not much support from regulatory bodies of many countries, the growth rate in the segment has been more than 80% in the last 4 years. Identification and ranking of factors in the growth of CF are the study's central problems.

The ISM in a fuzzy environment has been used to rank the identified accelerating factors. Below mentioned steps are involved in the ISM methodology as explained by Reference [59].

The following steps are shown in the form of the flow chart in Figure 1. The growth of CF involves factors of micro as well as macro levels. The major factors include no geographic restrictions, low cost of issue, high finance literacy, and many more. As shown in Table 1, sixteen factors for study are gathered from past published works of the literature and opinions from experts; Algorithm 1 shows the ISM in a fuzzy environment.

5. Formation of the Questionnaire

The growth path of CF is way different from other traditional capital market tools, as they have different mechanisms from traditional funding. The major objective of the study is achieved by ISM, a tool for better communication in such complex situations. We have selected 12 factors from previous works of the literature, and 4 are added by discussion from the experts. These experts are senior professionals and persons in academia from various colleges with expertise in technology-driven fundraising activities in the capital market. These experts were chosen in the individual capacity of researchers from various locations across India with a minimum experience of 10 years in academics and at least 7 years in the industry. Initially, 35 experts were selected and approached, but only twenty participated after regular communication. The twelve experts were from academia, and eight experts were from the transportation and logistics industry.

All individual responses were collected from experts at two stages and sent to two experts, one from academia and the other from industry, in a consolidated form to get the final response. Finally, one consolidated response matrix has been formed based on all these collected responses and brainstorming sessions.

6. Application of ISM

The ISM methodology starts with creating SSIM (structural selfinteraction matrix). This matrix is a planned presentation of contextual connection of selected factors based on expert opinion.

We use four symbols to show the pairwise directional relationship between the factors, say I and j ; symbol “ V ” is used to indicate factor I will support to achieve factor j , symbol “ A ” indicates factor j will support in the achievement of factor I , symbol “ x ” indicates factor j and I will help to achieve each other, and “ o ” symbol indicates no relation between both factors. The SSIM for the selected factors in the growth of CF is given in Table 2.

The reach-ability matrix is formed from data collected in SSIM, by changing the information of each cell into either 1 or 0 in the matrix, according to the rules as follows:

TABLE 1: Description of CF barriers.

Sr.no.	Barrier	Description	Supported pieces of the literature
1	No or Low time requirement	CF can collect money in less time, even less than an hour, in many cases	By expert
2	No or Low in regulation (NLR)	CF neither fall under income tax law nor the security act in most of the countries	[13]
3	Low in cost	Issue costs are significantly less in comparison to traditional fundraising methods	[13]
4	No geographic restrictions	There is no restriction on a country as work on the digital platform. CF can get investment from anywhere	Agrawal et al. [68]
5	Usage of unaccounted money	Some platforms do allow investing unaccounted money into the cryptocurrency channel	By expert
6	Lack of access to funding for start-ups	Start-ups cannot raise funds in the form of an IPO	Sanchez [69]; Cumming et al. [70]
7	Inability to generate funds through IPOs or any other traditional route	Many companies and firms are not fit for generating funds through IPOs because of their long business history	Cumming et al. [70]
8	High level of competition in the traditional financial market	Traditional markets are well known to everyone, so there is a massive rush in the market for fundraising	Cumming et al. [70]
9	Heavy dependence on banks and other investment bankers to raise funds from public	Banks and networks of financial institutions dominate the traditional method of fundraising	Kuppuswamy and Bayus Barry [9]
10	High growth of IT and digital awareness	Digital awareness acts as a platform for the spread of such avenues	Sanchez [69]; Cumming et al. [70]
11	Supportive external environment	Current external factors are supportive enough to digest such innovative ideas	Sanchez [69]; Cumming et al. [70]
12	High level of financial literacy	Financial literacy has increased by many folds in the last few years, mainly in the urban population	Sanchez [69]; Turan [71]
13	The innovative structure of CF	CF under a regulatory environment is backed by certain tangible assets and increases the confidence of investors	Sanchez [69]; Cumming et al. [70] https://www.fundstiger.com
14	The greediness of investors for more return	Investors always look to get more and more returns in a short period	By expert
15	A small amount of investment (even US\$ 1 can be invested)	Even a small amount, as low as 100 US\$, can be invested through the CF platform	Sanchez [69]; Cumming et al. [70]; Turan [71]
16	Lack of developed stock exchanges or other fundraising infrastructure	Many countries are lacking in the infrastructure of fundraising, where CF is the only option to raise fund	By expert

- (i) if the cell value in the SSIM is V , it converts into 1 and 0 in the reach-ability matrix for the (i, j) and the (j, i) , respectively
- (ii) If the cell value in the SSIM is A , then it converts into 0 and 1 in the reach-ability matrix for the (i, j) and the (j, i) , respectively
- (iii) If the cell value in the SSIM is X , then it converts into 1 and 1 in the reach-ability matrix for the (i, j) and the (j, i) , respectively
- (iv) If the cell value in the SSIM is O , then it converts into 0 and 0 in the reach-ability matrix for the (i, j) and the (j, i) , respectively

The reach-ability matrix after required transitivity is formed and shown as BDRM (binary direct relationship matrix) is presented in Table 3.

The reach-ability and antecedent set for each factor are considered from the final reach-ability matrix, as shown in Table 3 (Warfield, 1974). The reach-ability set of an element

consists of the factor itself and the other elements which may support achieving, that is, all factors with value 1 in the row. Correspondingly, the antecedent set of an element is a combination of the element itself and the other elements, which facilitate achieving it, that is, all factors with value 1 in the column. The intersections of both reach-ability and antecedent sets are calculated, and factors with equal intersection values are ranked at the top in the hierarchical model of ISM. Afterwards, the levelled factors are eliminated from another remaining set of factors. Level identification processes of all sixteen considered factors are completed in five iterations, given in Table 4. The calculated hierarchy levels of these selected factors form the digraph as the final level of ISM. The structural digraph is created from the iterations, as shown in the figure. Arrowheads show the connection between the factors, from factor I to heading towards j .

MICMAC, that is, (Matrices d'Impacts Croises Multiplication. Appliqué a UN Classement) "cross-impact matrix multiplication applied to classification," is calculated on the

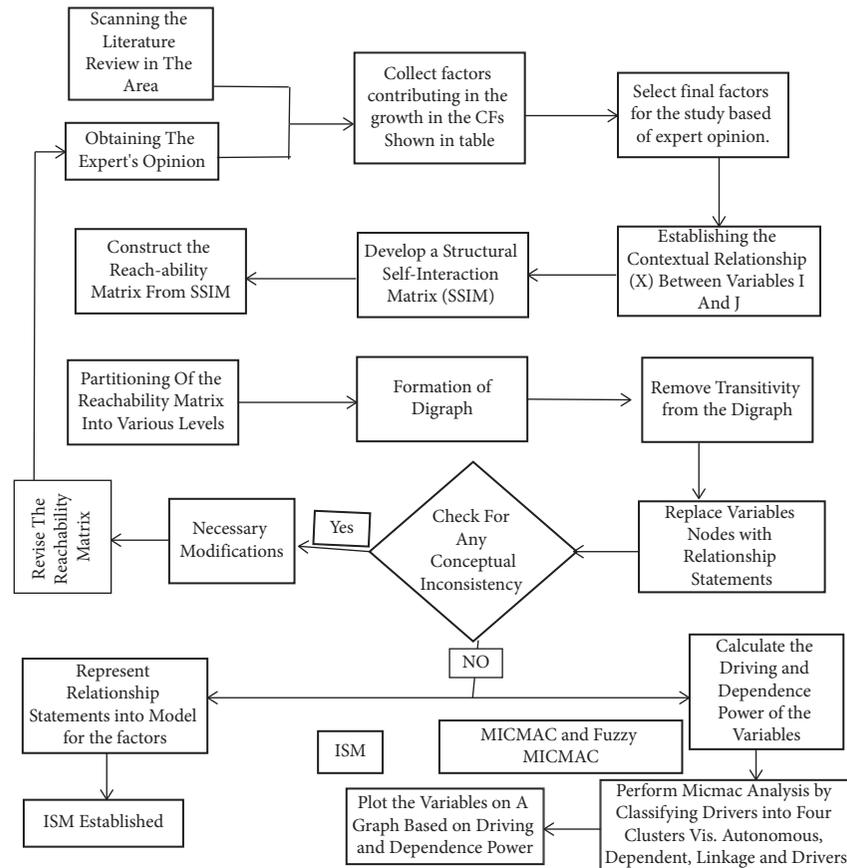


FIGURE 1: Flow diagram for preparing the ISM model.

Input. List of all the factors.

Output. ISM structure for crowdfunding.

Step 1. List out all the factors to be considered in the study.

Step 2. A contextual connection is recognized among all the identified variables in step 1 for pairwise examination.

Step 3. An SSIM, structural selfinteraction matrix for pairwise relationships among variables, is developed.

Step 4. A reach-ability matrix is developed and checked for transitivity. The transitivity relation among variables is a fundamental hypothesis made in ISM. If element A is associated with element B and B is connected to C, then A is linked to C.

Step 5. The reach-ability matrix is partitioned into different levels to form initial relationship matrix (IRM).

Step 6. A directed graph is drawn by the removal of transitive links based on association found in the reach-ability matrix to form final relationship matrix (FRM).

Step 7. The resulting digraph is transformed into an ISM.

Step 8. The developed ISM model of the previous step is reviewed and checked for “conceptual inconsistency.” Some essential modifications can be made as required.

Step 9. The MICMAC and Fuzzy MICMAC analyses are performed to classify all factors in four broad clusters to check the consistent association.

ALGORITHM 1: ISM in a fuzzy environment.

principle of matrices multiplication [49]. A fuzzy set theory is being used to enhance the responsiveness of MICMAC analysis to come out from the limitations of the ISM model. This technique is called Fuzzy MICMAC, where an additional input for the dependencies between relationships of barriers is being introduced [73]. Further, to draw Fuzzy MICMAC (FMICMAC), data from the same selected expert should be recollected to convert data of BDRM into FDRM (fuzzy direct

relationship matrix). FDRM has been derived from the final BDRM, and the used fuzzy sets are described as membership functions with an actual unit interval [0, 1]. A 7-point scale has been used for this fuzzy evaluation, as shown in Table 4.

The expert opinion has been gathered from the same expert panel with ratings for obtaining a direct reach-ability matrix. A triangular fuzzy number “ U ” is represented as a triplet set $(x, y, \text{ and } z)$. The triangular fuzzy function is

TABLE 2: Structural selfinteraction matrix (SSIM).

	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
1	O	O	V	V	O	X	A	A	O	O	A	O	A	O	O	X
2	V	V	V	V	O	X	O	V	V	V	V	X	O	V	X	
3	A	X	V	A	O	O	A	X	V	O	O	X	O	X		
4	O	O	O	A	O	A	A	X	V	V	V	V	X			
5	A	O	V	A	O	A	A	O	O	O	V	X				
6	X	O	O	V	O	A	O	V	O	X	X					
7	X	O	O	A	A	V	O	V	X	X						
8	X	O	O	X	O	O	X	V	X							
9	X	A	O	O	O	X	O	X								
10	O	O	O	X	O	X	X									
11	V	A	O	X	O	X										
12	X	O	O	V	X											
13	O	V	X	X												
14	O	A	X													
15	O	X														
16	X															

TABLE 3: Reach-ability matrix after transitivity.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1
2	0	1	0	1	1	0	0	1	0	1	0	0	0	1	0	0
3	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	0
4	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0
5	0	1	0	1	1	1	0	1	0	1	1	0	0	1	0	0
6	0	0	1	0	1	1	1	1	0	1	0	0	0	1	1	0
7	1	0	1	1	0	1	1	0	1	0	0	0	0	0	0	0
8	0	0	0	1	1	0	0	1	0	0	1	0	0	1	0	0
9	1	0	1	0	1	0	0	1	1	0	1	0	1	0	1	1
10	0	0	0	1	1	0	0	1	0	1	1	1	1	1	0	0
11	1	0	1	1	1	0	0	1	0	1	1	0	0	1	0	0
12	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0
13	1	0	0	1	1	0	0	1	0	1	1	0	1	0	0	0
14	0	0	0	1	1	1	0	1	0	1	1	1	1	1	0	0
15	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	0
16	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1

TABLE 4: 7-point fuzzy scale used in the calculation.

Possibility of reachability	No	Negligible	Low	Medium	High	Very high	Full
Triangular value	(0, 0, 0)	(0, 0.1, 0.3)	(0, 0.3, 0.5)	(0.3, 0.5, 0.7)	(0.5, 0.7, 0.9)	(0.7, 0.9, 1)	(1, 1, 1)

expanded by using a lower limit value (x), a median value (y), and an upper limit value (z), where $x < y < z$. These points signify the coordinates of three vertices of $\mu(U)$ in fuzzy set U . For better representation, defuzzification of the collected result on the fuzzy scale is to be performed to get a crisp number for the FDRM. The best nonfuzzy performance (BNP) value has been achieved by using the parameters of

$$BNP_{ij} = \left[\frac{(z - a) * (z - b)}{3} \right] + z. \tag{1}$$

The FDRM's power is calculated by using principle-based on fuzzy matrix repeatedly multiplication rule, ($C = \max k \{ \min (i, j) \}$) till it is converged. The convergence point can be determined where the driving and dependence

powers of selected factors are stabilized or cyclic in their variation with a certain periodicity.

The main idea of FMICMAC is to find the driving and the dependence power of barriers selected in the study by plotting a graph with driving power along the Y-axis and dependence power along the X-axis. The barriers have been categorized into four different categories based on their power; the different categories are as follows:

- (i) quadrant I: autonomous category: these factors are weak in both dependence and driving powers, and they usually are disjointed from the structure.
- (ii) Quadrant II: dependent category: these factors have high dependence power but low driving power.

TABLE 5: Dependence power and driving power for factors based on stabilized FDRM.

Factor	Dependence power	Driving power	Factor	Dependence power	Driving power
1	14.2	10.3	9	13.3	11.4
2	2.5	13.9	10	8.6	12.7
3	12.5	8.5	11	9.1	12
4	12.2	11.6	12	8.5	12.1
5	11.3	10.3	13	11	11
6	13.4	10	14	11.7	12.3
7	13.4	11.5	15	9	8.5
8	13.3	11	16	13.3	11.3

- (iii) Quadrant III: linkage category: these factors are weak in both dependence and driving powers. They are the most critical factors and have a very high impact on the system. A slight change in these factors has a direct impact on others.
- (iv) Quadrant IV: independent category: factors of this quadrant have high driving power but less dependence power.

The categorization of factors used in the study was carried out by using MICMAC and FMICMAC analyses. The analyses are performed based on driving and dependence powers calculated based on expert opinion. All factors' driving and dependence power after stabilization in a fuzzy environment are given in Table 5. A complete integrated model for ISM of these identified factors with 5 levels is given in Figure 2, with factor number 2, that is, "No or Low in regulation," at the base level. Factors 13 and 14, "Innovative structure of CFs" and "Greediness of investors for more returns," are on the top level in a hierarchy with maximum dependency power. These identified factors are distributed in only two quadrants of the FMICMAC graph. The explanations of the outcome are discussed in Section 6; as a result, discussion. Figure 3 shows the diagram of Fuzzy MICMAC on dependence and driving powers of factors.

7. Result Discussion

While the growth of CF is undeniably rapid, their lack of recognition among ordinary investors is a major source of concern for their long-term viability. Closing such gaps is crucial if crowdfunding is considered a credible alternative to traditional fundraising methods for larger transportation infrastructure projects. The market's recent exponential growth has created strong connections with other economic sectors, especially start-ups. These organisations exert pressure on regulators to enact the proper legal frameworks to guarantee long-term viability. It is not easy to create such a legal structure; many factors affect how it is integrated into day-to-day business operations. Without first learning the facts about these variables, no one can guarantee a sustainable structure. The objective of the current work was to identify parameters related to CF in a fuzzy environment using a well-established ranking technique. The components used in this study were taken from published literature and expert input and are based on the ISM modelling approach in a fuzzy environment. In order to show how the variables

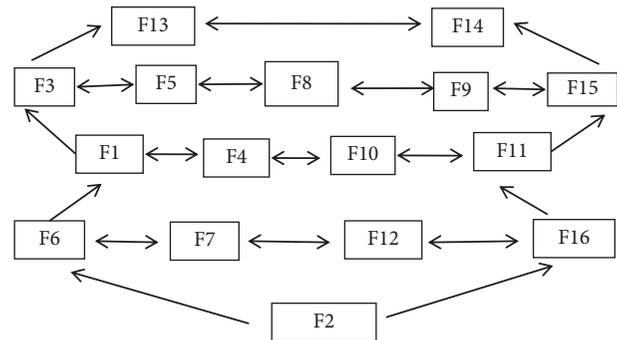


FIGURE 2: ISM-based model for barriers.

relate to one another, a structure based on the ISM model is developed. Then, a description of the goal is given before inputs from the chosen experts are gathered in two stages, initially on a binary scale and then on a fuzzy scale. Finally, MICMAC developed a graph based on driving power on the y -axis and dependence power on the x -axis. Fuzzy MICMAC analysis elucidates elements' relative meaning and interdependence in great detail.

Although the study is unique in various aspects and seems to be a primary attempt by authors to highlight CF in transportation, still the finding has some similarities with past research conducted in different industries; Agrawal et al. [6] explained the geographical factor of CF and Aitamurto [74] judged CF in journalism and Brabham [75] in public arts. All variables that accept "No" or "Low" as regulatory thresholds fall within quadrant III. There are linkage variables with a high degree of dependant power and a high degree of driving power. These elements exert a significant influence on the system. They significantly impact the system, as each act directly affects others. The fact that most elements fall into this group helps explain the meteoric rise in the popularity of CF. All of these aspects contribute to the acceptance of CF as a novel and unique technique of fundraising. Regulation is the only factor in quadrant IV; it generally moves independently of other system elements. The industry's players have no direct control over the factor.

Although the lack of or low regulation is crucial in the growth and adoption of this novel way of fundraising by regular investors, it cannot be managed directly by the CF industry's connected members. Certain elements, such as "high financial literacy," maybe a positive force in some regions of the world while functioning as an opposing force in a sizable portion of the emerging economy.

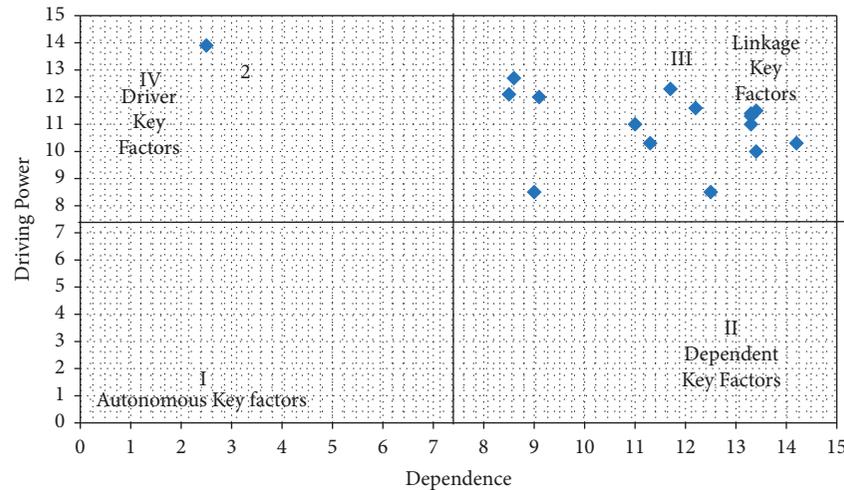


FIGURE 3: Diagram of Fuzzy MICMAC on dependence and driving powers of factors.

8. Recommendation and Policy Implication

The financial system is important for the country's economic progress and its long-term viability. CF is becoming one of the most popular ways of capital creation, even for large projects in the transportation sector, because of rising digitalization. Investors, particularly those from emerging nations, are growing increasingly interested in the operation, regulation, and understanding of CF. Investment objectives can be addressed by understanding the CF leading factors. Decision-makers should pay less attention to the independent category of elements when making any decision because none of the chosen parameters falls within the autonomous quadrant. All of them should be considered during the CF selection process and at frequent intervals to verify that targeted financial goals are met. Except for "No or Low," all factors in regulation fall into a quadrant's linkage category, which is important for decision-making because their values might reflect changes in other aspects. Without a doubt, the literature findings offer regulators valuable information. Market regulators should ensure that the financial industry as a whole is secure and supported.

9. Limitations and Scope of Future Research

For the purposes of this investigation, the framework built using the ISM and MICMAC models was tested in a nonlinear setting with sixteen variables that influence the growth of the CF market. Certain variables were not included in the framework because they were deemed insufficient for the study's goals and were restricted to the transportation industry. Investors can utilize a model developed as part of this research to assess the strength of CF and make investment decisions as a result of the model's development.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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