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Demystifying the modalities of startup ecosystem: Key value-drivers towards new venture sustainability

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ABSTRACT

The study contributes to startup ecosystem advancement by delving into the performance complexity of the new endeavors, holistically examining all possible quantitative and qualitative parameters and their intricacies affecting system functioning efficacy, venture resilience, and long-term sustainability. Employing a Modified Total Interpretive Structural Modeling (M-TISM) framework, the study identifies a four-tier hierarchical structure of core value drivers, with the institutional environment to be the foundation strengthening the entire system, with mentor support as the key pillar and founders to be the key actors driving the output of the successful ecosystem-the ventures, ideas, and financial system. The interpretive linkages, derived from an extensive literature base, are cross-verified through expert-based focus group discussions to ensure conceptual robustness. The findings underscore the need for supportive policy frameworks, inclusive institutional reform, and regionally balanced incubator networks to foster equitable and durable startup ecosystems. This study provides actionable insights for policymakers, emerging entrepreneurs, and ecosystem stakeholders aiming to develop resilient entrepreneurial infrastructures that foster innovation, mitigate systemic vulnerabilities, and support inclusive economic development.

Statement regarding ethical approvals

Review and/or approval by an ethics committee was not needed for this study because experts' participation was completely voluntary and anonymous. It involves no personal, identifiable, sensitive, or private information. No sensitive content is documented in the research.

1. Introduction

The 21st century has emerged as the start-up era, marked by a global surge in entrepreneurial ventures. Post-COVID-19 disruptions further accelerated this momentum [1], with skilled entrepreneurs, innovative business models, investor networks, and supportive ecosystems driving the growth and resilience of start-ups [2]. The rising momentum is vibrant with the remarkable surge in the unicorns, the ventures valuing above USD 1 billion. Viewed from the valuation benchmark, the global startup landscape appears to be accelerating, reportedly producing one unicorn every two days; with this metric, India ranks third globally, following the United States and China.

While the sharp rise in ventures, funding, and ecosystem facilitators signals progressive expansion of the startup ecosystem, however, the traditional performance indicators, such as profitability and scalability, reveal that only a few achieve operational success. The discrepancy of valuation and performance raises critical questions about the reliability of valuations, legitimate signals of venture potential, and the actual progress of the ecosystem [3]. In this direction, the study seeks to explore the dynamics of the startup ecosystem to identify the crucial factors impacting a venture's survival and long-run sustainability.

The performance literature [4,5], stakeholders' perspective [6], resource-based view [7,8] unveil business outcome a multi-dimensional phenomenon subject to numerous factors, quantitative, internal, external, controllable, non-controllable, and others [9]. A wide range of dynamism, changes in regulations and policy, investor behavior, and other factors make the performance of new ventures is more complicated [10]. According to signalling theory, start-ups often face an information void due to their newness and lack of performance history. In such contexts, signals like founder background, accelerator recognition, investor endorsements, and customer traction serve as markers of legitimacy, helping ventures attract critical resources within the

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ecosystem [11–13]. However, empirical evidence infers the incomplete, context-dependent signals susceptible to strategic exaggeration, thereby limiting their efficacy in identifying venture real calibre [14,15]. The over-reliance on such signals enhances the valuation discrepancies, where ventures are mispriced due to flawed perceptions rather than grounded assessments of systemic viability or long-term value creation [3].

These limitations underscore the need for a comprehensive ecosystem-level analysis, beyond isolated signaling mechanisms, to unfold the complex web of interdependencies among institutional, individual, and environmental factors. Start-up research has been pragmatic as one of the most attractive areas, gaining the traction of scholars and practitioners from finance, economics, marketing, operations, logistics, policy-making, and other domains. However, the literature appears fragmented and exclusive, focusing on particular sectors, regions, or parameters such as valuation [16], gender [17,18], founder traits [19], business models [2,20], associations [21], time periods [22], financing [23], and others. The segregated approach confined to specific factors impedes effective decision-making. Understanding and resolving the performance complexity of the new endeavors seek in-depth insight into the entire system dynamics, key drivers, subsystems, attributes, role play, and and how the interrelationships among the subsystems- institutional, relational, and agent-level elements collectively shape the structure and sustainability of startup ecosystems in emerging economies.

The study contributes to advancing startup ecosystem research by comprehensively examining the globally fastest emerging Indian start-up system terrain, considering all possible quantitative and qualitative parameters, their interrelationships and interdependencies, and the likely impact of the sub-systems' traits and intricacies on new venture performance, success, and long-term survival. Grounded in stakeholder theory, resource-based view, institutional theory, and signaling theory, the study captures the perspectives of key actors- founders, incubators, accelerators, and financiers to explore the performance gaps and factors affecting ecosystem efficacy. A thorough understanding of ecosystem dynamics related to key factors influencing startup success addresses the information void and mitigates the signal distortion by improving comprehension of authentic and less informative indicators of venture potential, thus elevating evaluation quality and facilitating effective resource allocation. Venture performance, idea, leadership, founding team traits, business model viability, and marketing are dominated by cultural and regional dynamics [24], resulting in varied performance across ecosystems impacted by variation in economies, culture, genders, age, industries, market timings, and other factors [25,26]. The institutional, regulatory, cultural, economic, and financial uniqueness, development pattern across economies [27] validates the exclusivity for the in-depth and precise understanding of the system constituents' behaviour pattern, ecosystem's operating dynamics, and the vital parameters impacting the new ventures' performance trajectory. The study seeks to explore the multi-stakeholders' perspective- ventures, founders, regulators, incubators, accelerators, and financers- to get an insight into the crucial parameters and the loopholes that need to be addressed to bridge the expectation void among the resource-seeking ventures and resource providers.

Adopting a bottom-up systems approach, the study applies Modified Total Interpretive Structural Modeling (M-TISM) to structure the ecosystem hierarchically. The framework unearths a four-tiered structure, with the institutional environment at the foundational level, enabling mentor support and founder development, which in turn catalyze the generation of high-quality ventures, ideas, and financial flows, recognized as the ultimate outcomes of a thriving ecosystem. The findings offer critical implications for entrepreneurs, investors, and policymakers by highlighting actionable levers for enhancing startup performance and building resilient, inclusive, and scalable entrepreneurial ecosystems. The study also opens new avenues for theoretical refinement and policy innovation in emerging market contexts.

The paper is composed of five fragments. The next sections contain the literature review portraying the key elements of the start-up ecosystem and their interconnections and significance on the growth of new ventures and the entire system's progress. The third segment explains the methodological contribution of the paper, followed by the key findings. The study is finally concluded with a discussion of the key results and implications for the decision-makers.

2. Literature review

2.1. Start-up ecosystem theoretical underpinnings

Upsurge in the new ventures with the novel ideas from the young entrepreneurs led to the emergence of the startup ecosystem composed of founders' [28], innovative business ideas [29], financing agents-seed funds, venture capitalists, angel investors [30,31], mentors, incubators and accelerators [32–34], institutional framework and other facilitators [35–37]. Notwithstanding the spurt in the new ventures, the success rate is not much appreciating, with a large number of ventures appearing to be struggling for operational viability, funding for scaling-up, and bleeding losses due to hefty expenses [38–40]. Unable to endure the heat of adversities, many new market entrants shut down within a year or two [41,39]. Business Information Tracking Series (BITS) infers that fifty percent of new ventures fail to survive beyond four years, with one-third of owners getting success post-venture closure. Perhaps learning from failures strengthens the founders' experience by exposing them to the market reality [42–44].

Ecosystem theory, reinstated from the biotic phenomenon, conceptualizes entrepreneurial ecosystems as dynamic systems in which interdependent elements and systemic linkages collectively shape resilience and sustainability [45–47]. The extant literature underscores the multifaceted nature of startup ecosystems where the interaction and interplay of a myriad list of factors collectively determine the trajectory of entrepreneurial outcomes [48–52]. Startup ecosystem performance and development have been narrated in literature through varied theoretical lenses. For instance, upper-echelon theory underscores the significance of founding teams and management [37,53,54], the resource-based view (RBV) situates funding, knowledge base, networking, incubators and accelerators' support as core strategic assets enabling growth and competitive advantage [55–57]. Founders' education, venture capital access, and resource upgrading through mentorship and incubation further reinforce these capacities [8,58], with funding rounds simultaneously serving as resources and performance benchmarks [31,59]. Complementing this, institutional theory underscores the role of regulatory frameworks, policies, and conducive environments in sustaining ecosystem legitimacy and functionality [60–62]. Signaling theory emphasizes legitimate signals to overcome the liability of newness and establish the new venture's potential and credibility in the absence of past performance records [13]. In the absence of a past performance matrix, established records, and founders lacking experience, the founders' traits, education, team capabilities [63], venture propositions, viability of the business model, scalability potential [49], and affiliations [64,65] serve as critical signals of venture legitimacy and bridge the communication void between resource-seeking ventures and resource facilitators- investors, accelerators, mentors, networks, and others.

Taken together, these perspectives position the start-up ecosystem as a multilayered construct where the founder, idea, mentor support system, funding system, institutional environment, and business venture are the significant paradigms, whose key attributes, interdependencies, and interactions are vital signals and determinants of the system's success, advancement, and fostering the progress of the new ventures [66]. Exclusive to these visible parameters, countless hidden modalities affect customers' and investors' sentiments and start-up success journeys, aiding the advancement of knowledge and overcoming obstacles immensely contribute to shaping business endeavors and enhancing

venture and entrepreneur prevalence [67–69].

2.2. Start-up ecosystem key constituents

E1: Founder and founding team

Upper echelon theory posits the founding team as the prime driver towards the venture's success, from launch to long-term sustainability [23,70,71]. Startups in the same industry with similar business models unveil varied outcomes attributed to founders' traits [72]. Founders' education, affiliation, experience, personality [73,74], social and political ties [37,75], dominate the fund-raising capabilities, innovativeness, brand-building and the overall venture success and long-term survival [75]. Founder passion, courage to take off ideas [76], fairness [28], clarity of objectives, communication ability, flexibility, adaptability, proactiveness, founding team's motivation [28] are vital factors impacting venture survival and persistence [76–78]. Endeavors with clear objectives and strong backing of ambitious, risk-averse, and proactive founders with a personal stake in the business are more resilient and agile to adverse market dynamics. However, in recent years, new venture creation as the planned exit strategy has been in vogue [79,80]. Studies observe the crucial impact of the founders' replacement on firms' performance [76,81].

Studies aligned venture success with founders' entrepreneurial family background and prior experience [42,82]. Studies also document the impact of gender disparity in startup funding, innovation, product development, and overall outcome [17,83–85]. Although women founders are seen as more ambitious, risk-averse, and determined [86], yet women-led firms typically face discrimination from investors and struggle for fundraising [87–90]. These contradictions highlight that venture outcomes cannot be fully explained by founder traits alone but are mediated by broader institutional and social contexts.

E2: Business idea

A startup's business idea is often regarded as the cornerstone of entrepreneurial value creation, reflecting creativity, originality, and problem-solving capacity [91–94]. The novelty aspect signaling potential differentiation and competitive edge of the venture is the prime value driver and magnetic traction of all the stakeholders- investors, shareholders, partners, accelerators, incubators, and government [95,96]. An ordinary business idea can be transformed into a lucrative business, yet the longevity, recognition and sustainability warrant that the idea should be financially and operationally viable, scalable [49,97,98] and should be socially desirable [99,100]. Venture-exclusive traits, uniqueness, and novelty supplemented with external endorsements aid new ventures in attracting funding [101].

These literary corroborations underscore that while uniqueness may attract initial traction, but durability rests on viable, scalable, and legitimate models. Venture-exclusive traits and external endorsements validating credibility, mitigate uncertainty and ease resource access [101]. Theoretically, this reframes the business idea not as a static point of origin but as a dynamic construct whose value unfolds through continuous adaptation, market validation, and institutional legitimation.

E3: Mentors support- accelerators, incubators, seed fund providers

Being the new market entrants lacking experience, the new ventures' successful drift requires handholding in terms of mentorship, financial support, and other collaborations [102–104]. Universities play a vital role in this support framework, operating as knowledge hubs and anchoring incubator or accelerator programs, therefore channelising research, talent, and legitimacy into startup growth [105,106]. Incubators aid in shaping the high-potential idea into the venture, building legitimacy [30], and enhancing recognition and survival potential [33,107]. Accelerators, in contrast, provide intensive, time-bound support that equips early-stage ventures with knowledge, skills, and networks, significantly influencing venture quality, innovation, and resource access [51,108]. Studies endorse the significant impact of accelerators on shaping venture quality, fostering knowledge [109,110], innovation [111], facilitating networking [112], access to strategic resources [34], and opening funding avenues [113,114].

Taken together, these initiatives highlight that mentorship infrastructures are not peripheral supports but central mechanisms in venture evolution. These mentorship initiatives are integral constituents toward a healthy ecosystem that, along with improving the venture and entrepreneur quality, acts as a crucial linkage connecting the vital subsystems together [110,115–117]. Theoretically, this reframes incubators and accelerators as institutional scaffolds that transform individual entrepreneurial capacity into ecosystem-level capability, underscoring their role as systemic enablers rather than one-off supports.

E4: Financial system

An efficient financial system facilitating easy availability of resources is the prime need of a healthy start-up ecosystem, impacting the successful transition of an idea to a sustainable venture [31,118]. However, lack of collateral, credit history, and track records makes the new ventures disadvantaged, pushing them to rely on alternative financing channels [119,120]. The ecosystem leads to the evolution of an entrepreneurial financial system composed of state-backed programs (such as India's FFS and SISFS), venture funds, angel investors, seed funds, incubators, accelerators, and other financing infrastructures [31,118,121]. Narrowing the void of traditional credit markets, these funding arrangements finance the early-stage startups based on the potential business idea, founding team, market potential, scaling-up possibilities, founders' background, and other parameters authenticating the credentials [122,123].

Albeit an intensive funding ecosystem, alternative arrangements, diverse funding options accommodating varied requirements- funds quantity, payment options flexibility, project or industry suitability, and others, hardly a handful of the ventures succeed in entering the funding arena and raising adequate finance [101]. Studies unveil that financing is not a neutral process, but rather selective, evaluative, and often biased [124]. Investors filter ventures not only on quantitative parameters like firm age, business model viability, and feasibility [125,126] but also on intangible attributes such as founders' recognition, alliances, innovation [127–130], active media participation [131], intellectual capital-trade-marks, brand, patents [132]. Studies also suggest the investor's traction to be industry and region-specific [133,134]. Apart from these, the possibility of investors' biases cannot be ruled out [135]. Loss-bleeding startups, with doubtful business models fetching huge valuations and successive successful funding rounds, prima facie, AAsssuggest hidden modalities of investors' behavior. This underscores that financial flows act as signals of legitimacy, validating founders and ideas in ways that extend beyond pure economic rationality [122,136].

E5: Institutional environment

From an institutional theory perspective, the structure, quality, and responsiveness of formal institutions such as regulatory frameworks, legal systems, and policy instruments play a decisive role in shaping entrepreneurial behavior not only by setting rules but also by defining what is legitimate and desirable [60,137,138]. Institutional environment reduces uncertainty, facilitates enabling conditions influencing the perceived desirability and feasibility of starting ventures [62,139,140]). In emerging economies, like India, where the entrepreneurial landscape is marked by economic complexities, regional disparities, bureaucratic inertia, and cultural heterogeneity, institutional support becomes even more critical [141]. Supportive policies, low entry barriers, and ease-of-doing-business reforms function as signals of legitimacy, shaping investor confidence and entrepreneur expectations [142,143]. Federal support in the form of subsidies, seed grants, tax subsidies, tax-relief windows, capex support, and low-interest or interest-free loan are various incentivizing initiatives followed by economies across the globe to promote a healthy and versatile ecosystem for entrepreneurial growth [144,145]. These interventions, along with enhancing system legitimacy, also act as complementary mechanisms to strengthen the support structures- angel funding, venture capital, incubators, and accelerators

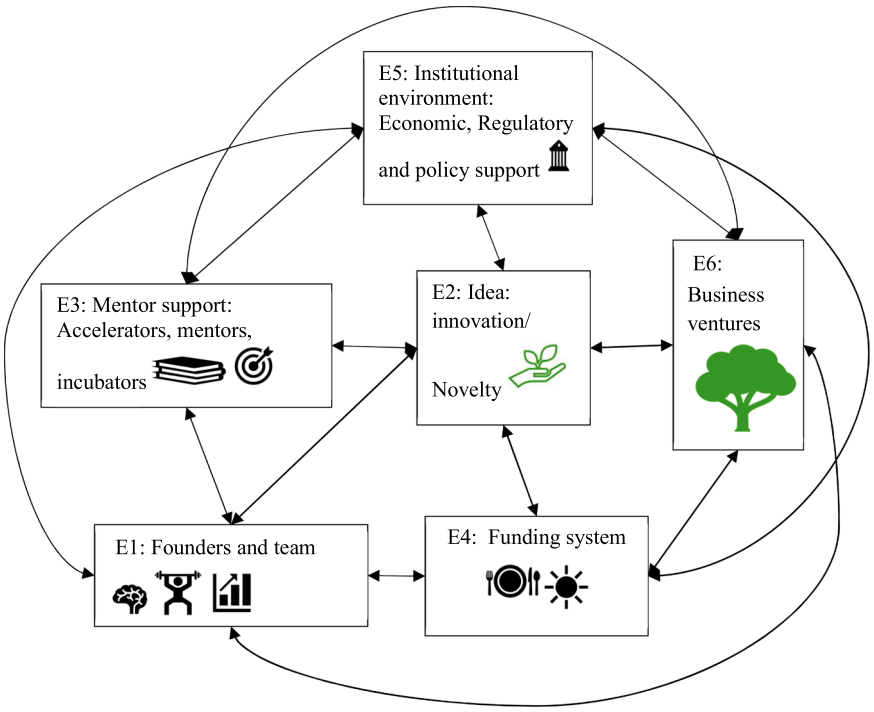

Fig. 1. Start-up ecosystem.

[146,147].

E6: Business venture

Beyond survival, ventures are system multipliers, advancing economic growth, exports, employment, and social development, while also serving as role models that inspire future entrepreneurs [148,149]. Yet the ecosystem is not uniformly enhanced by all ventures. Non-viable or loss-making models, despite attracting funding and high valuations, represent resource misallocations that risk weakening trust, distorting investor behavior, and draining financial and institutional capacities [150,151].

Analytically, ventures embody the final translation mechanism of ecosystem characteristics into measurable outcomes. Their success validates the ecosystem by reinforcing legitimacy, while their failure exposes system vulnerabilities, signaling the need for recalibration. In this sense, ventures are both the outcome and ongoing driver of ecosystem evolution.

New ventures are not passive recipients of ecosystem support but are the prime actors and value creators advancing the entire system network [152,52]. The quality of a business venture is the core element dominating the system modalities [38]. Venture with innovative and flexible models, and collaborative strategies, and cost-efficient lean practices are agile to sustain the changed market dynamics [29,153]. With AI's increased acceptance, the market has witnessed a boom in AI-based business models, outperforming the market with their cost dynamism, fundraising ability, competitiveness, and other efficiency perspectives [154].

Ventures with innovative business ideas and operating viable models are assets for economic growth and progress wheels supporting the economy's economic, social, and financial development, contributing to GDP growth, exports, taxes, and attracting foreign inflows [149]. Along with addressing problems, creating jobs, and boosting local economies, value-yielding establishments are role models for aspiring young entrepreneurs [148]. Loss-making ventures are deadlocks, encumbering the economic and financial resources [151]. The non-profitable business, with an unviable business model, despite fetching high valuation and funds, is a sinking ship and results in heavy losses once the reality is exposed. A healthy and productive ecosystem desires the direction of the sub-system's energies toward viable endeavours *vis-à-vis* unviable models [150].

In the backdrop of the multifaceted dimensions of the start-up ecosystem, a nuanced understanding of startup ecosystem performance requires a comprehensive analysis, incorporating the key theoretical perspectives and contextual specificities. Knitting together the threads of RBV, upper echelon, and institutional theories, the study unearths the Indian startup ecosystem operational dynamics, the crucial value drivers, the interconnections and complexities involved, and their impact on the system constituents and overall system functioning and performance. Assuming Founder (E1), Idea (E2), Mentor Support (E3), Funding System (E4), Institutional Environment (E5) and Venture (E6) as key sub-systems (Fig. 1), the study seeks to explore the intricate associations among the system core drivers and their collective impact on startup performance and the grey areas to be addressed for the system's overall progress. Fig. 1 portrays the conceptual framework of the startup ecosystem proposed, integrating the core constituents- venture idea, business ventures, founding team, funding system, facilitators (accelerators, incubators, mentors), and institutional framework (economic, regulatory, and governing institutional framework) for the holistic analysis of the system functioning in startup performance and survival. The Figure portrays the seven subsystems (E1 to E7) connected through arrows (↔), suggesting the possible linkages among the subsystems.

The next section describes the research pedagogy used in the study.

3. Methodology

The research attempts to unfold the dynamics of the startup ecosystem using the holistic top-down system approach, considering all possible factors/subsystems and their inter-dependencies likely to impact the system's performance. With venture, idea, founders, institutional support, incubators, and investors' network as key constituents of the startup ecosystem (Fig. 1), the study delves into the ecosystem intricacies, crucial drivers, interconnectivity among these vital elements, reinforcing startup legitimacy, strategic positioning, and amplifying the quality of signals. Decoding the driving-dependence complexity utilizing interpretive linkages among the system

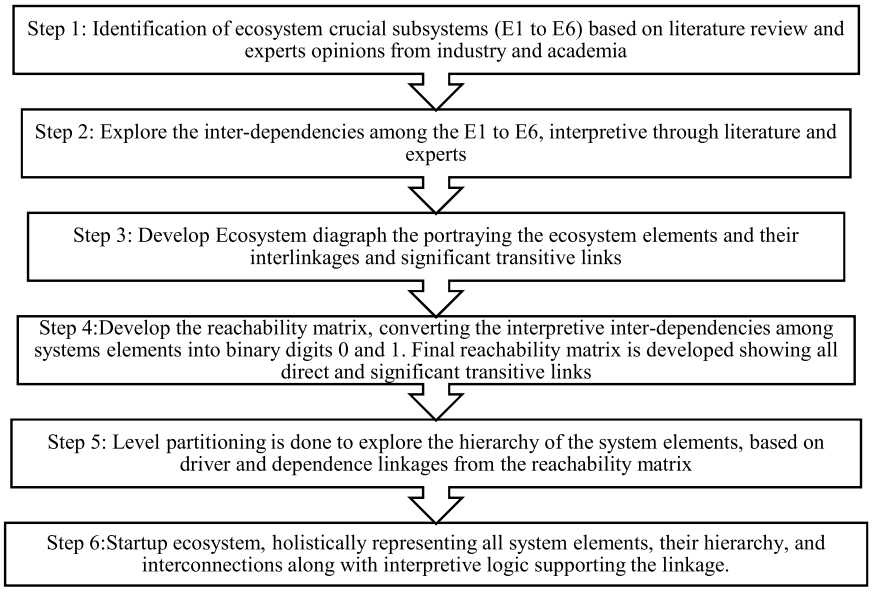

Fig. 2. Step-by-steps procedure.

components, the study develops a Modified Total Interpretative Structure Model (MTISM) [155], demonstrating the hierarchical pattern of the ecosystem from the foundation pillar to the final outcome.

3.1. Modified total interpretive structure model (MTISM)

The systems approach is an interdisciplinary scientific decision-making approach of resolving complex issues comprehensively by analyzing all possible aspects, interconnectivity, and interdependence impacting the decision [156]. MTISM, TISM, and ISM are qualitative system approaches that develop hierarchical models based on logical interpretive driver-dependence association among the elements/ factors underpinning the problem/issue/ decision [157,158]. The interpretive structural models (ISM, TISM, and MTISM) are rigorous models derived based on interpretive linkages supported by the existing theories and facts. Real-world veracities enhance the validity of these models, making them practically acceptable for theoretical advancement.

MTISM is a modified interpretive structure modelling approach of systematically addressing the problem logically, connecting what, why, and how, enveloping the problem [159]. It is a mathematical approach to addressing a problem, considering all possible drivers and their permutations and combinations, and arriving at the best possible quantifiable solutions by delving into the root causes/ drivers of the problems based on intricate relationships among the sub-systems. Depending upon the driving ability of the elements to influence the progression of other related elements, the hierarchical structure sequentially arranges the constructs from top to bottom based on their enabler significance, per se, the element with the least dependent power appears as root level representing the key driver/enabler influencing others and the highly dependent elements occupies the top strata, as the highest element. Top-down approaches holistically examine systems by identifying key value drivers, their interrelationships, and root challenges, enabling effective decision-making through a deep understanding of system complexities and dynamics [160,161]. Sensitivity analysis across multiple interaction scenarios enables the formulation of robust strategic interventions and adaptive policy frameworks to navigate systemic uncertainties. Improvement over the traditional TISM method, M-TISM involves exploring inter-dependencies among the elements using sequential pair-wise comparison and simultaneous transitivity check, thereby reducing the time and efforts involved in the earlier approach [159,162]. The approach has been widely used by scholars for resolving managerial issues in varied areas to identify the pattern of key driving elements, crucial factors, situation instigators, and enablers [163,164].

Using E1 to E6 as the core system essentials (Fig. 1), the study attempts to develop the Startup Ecosystem MTISM Model to unearth the startup system's intricacies based on interlinkages among the subsystems.

Six-steps procedure followed to develop the Startup Ecosystem MTISM Model is portrayed in Fig. 2.

3.2. Key variables, data collection and validation

Founder (E1), Idea (E2), Mentor Support (E3), Funding System (E4), Institutional Environment (E5), and Venture (E6) (Fig. 1) constitute key variables of the study that represent the key subsystems of the start-up ecosystem.

The core basis of the MTISM is interconnectivity among the key drivers/ factors/sub-systems. The proposed framework fundamentally rests on the interconnectivity among the six subsystems (E1–E6). To enhance robustness, the study uses a two-fold verification for validating the linkages among subsystems- E1 to E6. Firstly, interpretive linkages were first derived through an extensive review of scholarly literature. Appendix 1 details these theoretically grounded associations, ensuring that the initial model reflects established conceptual insights.

Finally, the theoretically interpretive associations from the literature are verified, capturing the stakeholders' opinions to apprehend the real-life scenario. To capture expert validation, focus group discussions with key ecosystem stakeholders, a purposive sampling approach was adopted to ensure heterogeneity and representation from the most influential actors within startup ecosystems. In total, 48 experts, consisting of five accelerators, thirty founders from varied cohorts of 3 separate accelerator programs, three members associated with venture capitalists and angel funds, and ten private consultants engaged in mentoring the startups for funding and valuation, form the key respondents for the analysis. The rationale of select stakeholder categories is to gain a balanced perspective of venture creators, enablers, financiers, and advisors, who are the key constituents impacted and likely to affect the system's growth. The opinion from diverse stakeholders is likely to strengthen the external validity of the model.

The focus group setting facilitated deliberation, cross-examination of opinions, and consensus-building on the plausibility of subsystem linkages. Verbal informed consent was obtained from all participants prior to their involvement in the study. The participation was voluntary, and participants were informed about the purpose of the study and were

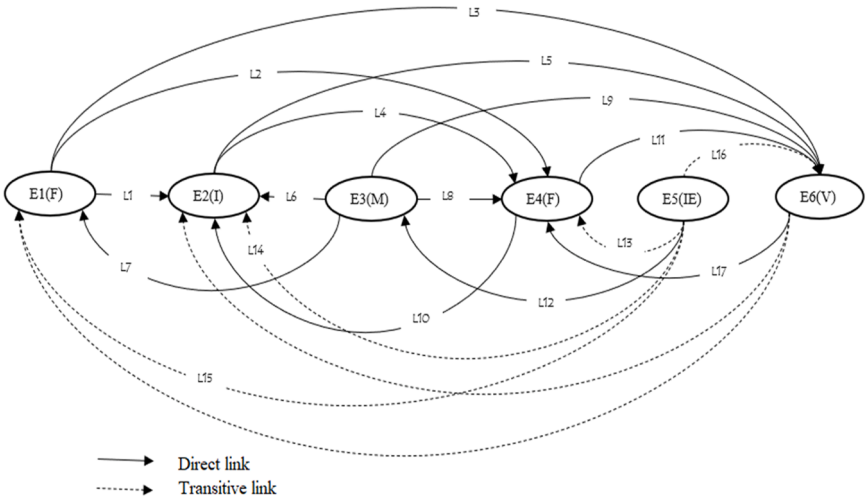

Fig. 3. Start-up ecosystem diagraph.

assured of confidentiality. By combining literature triangulation with multi-stakeholder validation, the study ensures that the interconnections among subsystems (E1–E6) are both theoretically defensible and practically grounded.

The subsequent section 4 details the development of MTISM and key findings.

4. Development of MTISM of start-up ecosystem and key findings

With Founder (E1), Idea (E2), Mentor Support (E3), Funding System (E4), Institutional Environment (E5), and Venture (E6) as important subsystems, the study develops a hierarchical model of the start-up ecosystem by aligning the sub-subsystems according to their driver-dependence association. The sub-section details the steps used.

4.1. Inter-linkages among the key subsystems (E1 to E6)

MTISM models are grounded on the interconnections among the subsystems. The interconnectivity is established following the two-step validation of the linkages among subsystems- E1 to E6; first, the literature interpretive and, further, cross-verifying these theoretically interpretive linkages through experts' verification to apprehend the real-life scenario. Out of n*(n-1), i.e., 30 expected inter-connections, we found 18 linkages validated by existing literature and verified by experts. The knowledge base of linkages and the supported literature is portrayed in Appendix 1.

4.2. Development of Startup-ecosystem diagraph

Based on the literature-interpretive and experts' verified linkages among the subsystems- E1 to E6, the startup ecosystem diagram (Fig. 3) has evolved. The diagraph portraying all direct and transitive interpretive linkages, offers a holistic view of the system's interconnections. In total, seventeen interpretive linkages are captured in the digraph; here, the directed arrows represent the direct associations among subsystems (Ei → Ej), while dotted arrows depict the transitive associations.

Transitive links capture indirect influence derived from direct associations. The transitive relationship symbolizes the relative connections among the elements derived from significant direct association among the elements, respectively. For instance, if subsystem E1 influences E2 (E1 → E2) and E2 influences E3 (E2 → E3), then E1 is indirectly connected to E3 through a transitive linkage (E1 → E3). Such links highlight second-order or higher-order influences that may not be explicitly visible but are logically embedded in the system structure.

Transitivity plays a crucial role in interpretive modeling. In **traditional TISM**, transitive links are incorporated by default—once an indirect influence exists, it is automatically assumed in the final structure. This ensures model completeness but may also generate redundant or weak linkages. In MTISM, the transitive links with significant logics are only further examined and validated by experts, thereby reducing the time and effort involved. This refinement reduces unnecessary complexity, making the final structure more concise, retaining its interpretive depth. These verified connections were then carried forward into the final model development, ensuring both rigor and contextual relevance.

4.3. Development of reachability matrix

The startup ecosystem digraph is decoded into a reachability matrix. Table 1 portrays the reachability matrix, with 36 cells representing the reachability information from subsystem Ei to Ej. Existence of relationships from Ei to Ej is exhibited in binary codes 0 and 1; here, 1 signifies the existence of reachability from element E(i → j), and

Table 1
Reachability matrix.

	E1: Founder	E2: Idea	E3: Mentor support	E4: Fundings	E5: Institutional environment	E6: Business Ventures
E1: Founder	**1**	1	0	1	0	1
E2: Idea	0	**1**	0	1	0	1
E3: Mentor support	1	1	**1**	1	0	1*
E4: Fundings	0	1	0	**1**	0	1
E5: Institutional environment	1*	1*	1	1*	**1**	1*
E6: Business Ventures	0	1*	0	1	0	**1**
Ei→Ej: Direct=1						
Ei→Ej: Indirect=1*						
Ei→ × Ej; No relation=0						

Table 2
Identification of hierarchical level using level partitioning.

Elements	Reachability Sets (Ei to j)	Antecedent sets (Ej to i)	Interaction set	
Iteration level 1				
E1:Founder	1246	135	1	
E2: Idea	**246**	**123456**	**246**	**I**
E3:Mentor support	12346	35	3	
E4: Financing system	**246**	**123456**	**246**	**I**
E5: Institutional environment	123456	5	5	
E6: Venture	**246**	**123456**	**246**	**I**
Iteration level 2				
E1: Founder	**1**	**135**	**1**	**II**
E3: Mentor Support	13	35	3	
E5: Institutional environment	135	5	5	
Iteration level 3				
E3: Mentor Support	**3**	**35**	**3**	**III**
E5: Institutional environment	35	5	5	
Iteration level 4				
E5: Institutional environment	**5**	**5**	**5**	**IV**

Table 3
Hierarchical echelons of startup ecosystem.

Hierarchical echelons	Elements	Significance
Prime level	E5: Institutional Environment	Foundation/ Roots/ Pillar
Secondary Level	E3: Mentor Support (Accelerator and incubator programs)	Key supporters
Third level	E1: Founder	Key Actor
Fourth level	E2 (Idea), E4 (Funding), E6 (Venture)	Output: quality idea, financial system, and quality venture

0 symbolizes no relationship from E(i → × j). The * exhibits the transitive links.

The matrix exhibits existence of 24 in connections; inter se, 6 are self-interaction among sub-systems contained in diagonal cells E11, E22, E33, E44, E55 and E66; remaining 18 relationships represent 12 direct relationships, portrayed with direct arrows in the diagraph (Fig. 3) and 6 transitive linkages (highlighted with *) as shown by dotted arrows in Fig. 3.

4.4. Identification of hierarchy of system elements

The reachability matrix (Table 1) is further processed for partitioning to explore the hierarchy among the system elements. The study uses Warfield's level-partitioning [165] to identify the hierarchical relationships among the elements based on their driving and dependence linkages. Table 2 details the hierarchical level identification. The reachability sets column represents the reachability among the elements from left to right (Ei→Ej) as shown in the Reachability Matrix (Table 1); the antecedent sets represent the interactions from top to bottom (Ei ↓Ej). The reachability sets (Column 2) and antecedent sets (Column 3) are used to extract the interaction sets (Column 3); the elements present in both reachability and interaction sets represent the interaction set elements. For example: if the Reachability sets consist of one element (2) and the antecedent set contains three elements (1, 2,3), then 2 is present in both reachability and antecedent columns and will be extracted into the interaction set. If the reachability and interaction set elements are the same, the elements are labelled at the first level of the hierarchy. Here, the reachability and interaction sets consist of the same element (2), thus, 2 will be identified as the highest level in the hierarchy, and the process will be repeated for the remaining elements till all the elements' hierarchy is established.

Table 2 details the hierarchical levels partitioning process. At the first iteration, E2 (Idea), Venture (E6), and Financing System (E4), with similar elements in reachability and interaction sets, are identified as top-level elements with the least driving and highest dependence power. The iteration process is repeated with the remaining elements (E1, E3, E5) extracted from E1 (Founder) with the same reachability and interaction set as the second highest echelon. Third-level iteration resulted in E3 (Mentors' support) at the third-highest level, followed by E5 (Institutional environment) as the root-level element.

Table 3 shows the results of the level partitioning. The four-level iterations of partitioning using reachability and antecedent sets segregated the six system constituents (E1 to E6) into four hierarchical echelons (Table 3). Here, the institutional environment (E5) unearthed at the base level, representing it to be the root or founding pillar strengthening the entire ecosystem; the mentor support (E3) at the second level infers the accelerators and incubators programs as sustenance for the enrichment of the founders' skills and knowledge towards the development of a healthy ecosystem. Founders (E1) appear at the third level echelon, followed by Idea (E2), Venture (E6), and Financing system (E4) at the top level of the hierarchy, indicating them to be the indicators/ outcome/output of the successful startup ecosystem. Finally, the startup ecosystem is developed, exhibiting the subsystems, their hierarchical structure, connecting links, and the interpretive logics unfolding the interactions and intricacies involved (Fig. 4).

4.5. Startup ecosystem MTISM key findings

Fig. 4 presents the Modified Total Interpretive Structural Model (MTISM) of the startup ecosystem, with six core subsystems: the institutional environment, mentor support, founders, venture, idea, and financial system. This empirically validated model depicts a four-tier hierarchical structure, mapping the interpretive linkages and relative driving power among the system components. The model capturing the systemic logic and dynamic interdependencies governing the new ventures' development offers a structured representation of ecosystem functioning from the foundational to the outcome level.

At the base of the hierarchy, the institutional environment (E5) emerges as the primary driver and the foundation pillar strengthening the entire ecosystem. Progressing upward, mentor support and accelerator engagement emerge as key enablers of venture development. The directional arrow connecting Institutional environment (Level I) with Accelerator, mentors, and incubators (Level II) underscores the strategic significance of policy stability, regulatory clarity, and supportive governance in strengthening the mentorship programmes (accelerators, universities, or incubators), the key facilitators fosters' the startup growth via grooming the venture idea, mentoring programmes, networking and desired handholding to overcome the teething bottlenecks.

Progressing upward, mentor support and accelerator engagement emerge as key enablers of venture development. The directional arrows from E3 (Accelerator, mentors, and incubators) to E1-Founding team (III echelon), E2-Idea, and E6-venture (at IV level echelon) authenticate the enabling role of mentorship in grooming the founders, idea and new venture progression. These actors function as ecosystem intermediaries, bridging institutional provisions with entrepreneurial capability building, offering necessary resources and social capital. These advisory networks are critical conduits of knowledge transfer, credibility enhancement, and shaping entrepreneurial trajectories. They serve as intermediary signaling mechanisms, working as a proxy for startup quality and potential. These findings align with institutional theory, which posits a stable and enabling institutional context as normative and cognitive support for entrepreneurial growth and macro-level signals, reinforcing investors' and stakeholders' confidence in the ecosystem's

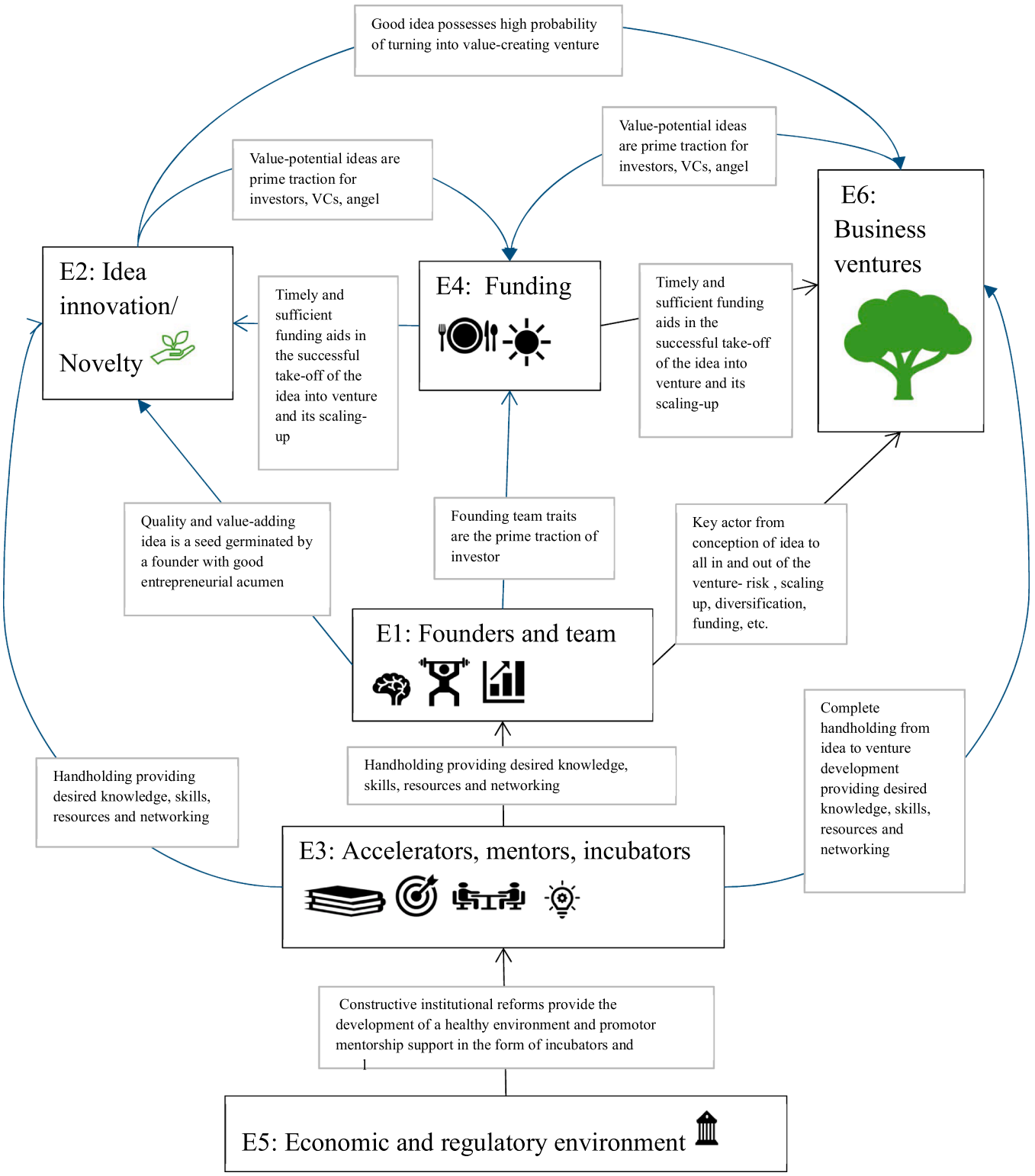

Fig. 4. Start-up ecosystem.

credibility.

The founders and team (E1) appear at the second-highest level in the ecosystem, followed by venture (E6), idea (E2), and financial system (E4), which appears as the highest-level echelon, confirming them to be the tangible realization of ecosystem functionality. These widely accepted signals of ecosystem vibrancy appear to be the emergent outcomes of the structural interplay of system elements rather than isolated indicators.

The direction arrows from the founding team (E1)to venture (E6), idea (E2), and financial system (E4)- the highest-level elements in the hierarchy, portray the enabling role of a strong founding team grounded on the strong institutional support and mentorship, in idea quality, venture sturdiness and efficient financial system. Aligning with the upper echelon theory and resource-based view (RBV), the model lends credence to founders' traits- education, experience, motivation, innovativeness, risk-taking spirit, and networking as the vital elements

grounding the venture sustainability and system progression.

The multi-tiered structure revealed through MTISM underscores that startup success is not the result of isolated factors, but rather the outcome of synergistic interactions among foundational institutions, enabling support systems, and key entrepreneurial agents. Findings highlight the critical interdependence between institutional grounding, actor dynamics, and signal coherence in shaping sustainable startup ecosystems. For instance, venture visibility or funding access may appear as signals of success, but the model reveals that they are contingent on upstream ecosystem health, particularly institutional strength and mentorship quality. Demonstrating the deeper systemic structure underpinning venture success, the findings challenge the over-reliance on valuation metrics based on superficial or fragmented indicators such as pitch success or investor backing. This systemic perspective offers a more nuanced understanding of value creation, reinforces the importance of coherent policy and institutional design, and sets the stage for strategic interventions aimed at fostering resilience, equity, and long-term performance across diverse entrepreneurial landscapes.

5. Discussion and research implications

The startup ecosystem is a complex, dynamic, and interdependent system, underpinned by multiple theoretical perspectives that offer a unique perspective on its structure, functioning, performance, and development. The study attempts to capture a holistic understanding of the start-up ecosystem performance complexities using a top-down approach, integrating all possible aspects impacting the system's functioning. Integrating the threads from RBV, upper-echelon, signaling, and institutional theories, the study evolves the start-up ecosystem MTISM, with founders, ideas, venture, funding system, mentor support, and institutional environment as the key value drivers.

The MTISM portrays the logical operational flow of the system, hierarchically from the root-level driver to the top-level echelon. Study advocates a holistic system orientation, emphasizing that venture success emerges from the interaction of foundational inputs (institutional environment), intermediate enablers (accelerators, incubators, and mentorship programs), and active actors (founders' capabilities and dynamism). Aligning with institutional theory, the model positioned the institutional environment as the foundational enabler, underscoring its adaptive and fragile role in shaping entrepreneurial outcomes. Prior studies emphasize that policy stability and supportive governance are critical for sustained venture survival [60,61,140]. In India, initiatives such as Startup India, Digital India, and Atal Innovation Mission have enhanced legitimacy, reduced policy ambiguities, and spurred entrepreneurial momentum, positioning institutions as active catalysts of ecosystem growth. However, the early-stage ventures are still navigating policy complexity, institutional gaps, and the uncertainties of an evolving regulatory landscape; these constraints are transitional and likely to ease as the regulatory landscape matures and stabilizes.

Moving upward in the hierarchy, the mentor support, incubators, and accelerators emerge as second-tier elements, reinforcing the developmental role of intermediaries in shaping founder capabilities and resource access. At the apex, lie venture performance, innovation (idea), and financial mechanisms, recognized globally as key indicators of ecosystem success[1]. The cascading effect from institutions to mentors and founders reflects the relevance of legitimacy, norms, and cognitive frameworks in the smooth functioning of the system, as corroborated by existing literature. The intermediary mechanisms- mentorship and accelerator networks are critical role in venture-level capacity building by transmitting institutional support [166]. Being the new market entrants lacking experience, the new ventures' successful drift requires handholding in terms of mentorship, financial support, and other collaborations. The significance of incubators and accelerators in the startup ecosystem is globally recognized and empirically validated [167,168]. On examining the role of university-based accelerators, the study [169] posits accelerators-programs as launchpads for ventures, supporting growth, reputation, and development. Research data from Crunchbase, Inc42, and Startup India affirm that incubator-backed startups in India secure approximately 2.5 times more funding and display higher survivability compared to their non-incubated peers. Despite India's impressive rise in the global startup ecosystem, ranking twentieth globally and third in Asia (as per the Blink Global Startup Ecosystem index), regional disparities in incubator distribution highlight structural gaps. South India hosts 45 % of India's incubators (out of 1100 total incubators), contributing to the dominance of startup hubs like Bengaluru and Hyderabad. This asymmetry calls for more regionally inclusive policy interventions and linkage of incubator programs with educational institutions to nurture early-stage entrepreneurial talent.

Overall findings resonate with the existing literature that corroborates startup success as a multi-dimensional phenomenon influenced by varied aspects- environmental, institutional, managerial, societal, and human factors [170–172]. New ventures' journey progression from the ideation stage to maturity navigates through collaboration with other actors in the ecosystem, where ventures move from early dependence and openness to more structured forms of collaboration, eventually reaching platform leadership [173]. The findings are consistent with the resource-based view, which advocates complementary resources for sustainability and a competitive edge [8,59], as well as the systematic approach, which favors holistic evaluation grounded on a relational network of key elements over linear causality [2]. Integrating institutional foundations with dynamic actor-based interactions, the MTISM advances the understanding of the startup ecosystem by revealing the layered dependencies and interpretive pathways among its elements. It offers a critical refinement to traditional perspectives of relying on signals as static proxies of venture success and valuation, and advocates for a holistic, systems-level understanding of startup performance to overcome signal distortion, improve predictive validity, and facilitate informed decisions. By making these interconnections explicit, the framework contributes to valuation legitimacy, mitigating signal distortion, and supports more informed decision-making for ecosystem stakeholders.

The study offers significant implications for researchers, practitioners, and policymakers.

Implications for policy-makers

Research framework highlights the significance of a strong institutional foundation for the resilient ecosystem. In emerging ecosystems like India, adaptive institutional interventions, regulatory clarity, policy coherence, and governance effectiveness can steer entrepreneurial momentum.

Implications for investors, practitioners and decision-makers

Highlighting the conditional efficacy of signalling theory, the study cautions investors against over-indexing on superficial or fashionable signals and calls for broader due diligence that accounts for ecosystem maturity and systemic alignment. Isolated reliance on signals can lead to valuation mismatches and resource misallocations; effective decision-making warrants the rigorous analysis of the system complexities and interdependencies to understand its robustness.

Implications for researchers

The MTISM framework equips researchers to study startup ecosystems holistically, highlighting interdependencies across institutional, intermediary, and venture levels. It encourages moving beyond isolated factors to analyze system-wide dynamics, supporting more accurate

[1] https://startupgenome.com/report/gser2024

Appendix 1
Knowledge base of interpretive linkages.

Link 1: Founder and team (E1) to Idea (E2)	Founders are essential actors, pivotal from the conception of the business idea to its successful implementation [174,175]. Entrepreneurial team diversity [176], founders' traits-education, experience, risk-taking ability, passion, and proactiveness to innovate are significant in generating constructive ideas and converting them into viable business opportunities [177,178]. Aligned with upper echelons theory, founder typologies influence venture trajectories. Revolutionary founders are viewed as pivotal in initiating novel ventures, adapting to the environmental dynamics; discoverer founders are opportunity seekers and focused on capitalizing emergent prospects [179]; technology-versed founders, grounded in dynamic capabilities theory, are more likely to spearhead digital transformation and foster radical innovation by leveraging technological acumen [144].
Link 2: Founding team (E1) to Funding (E4)	Founders' traits are strongly allied to fundraising potential gy [180]. Founding team diverse abilities, network, experience, background, female members, founders' dedication, capital contribution, growth orientation, and innovativeness are key determinants affecting funding choice and volume [23]. For instance, where the bootstrapped startups with physical capital have a high possibility of raising bank finance [181], the growth-oriented and innovative ventures are more likely to attract subsidies, grants, and funds from private equity investors [144]. Founders' prior experience, academic affiliation, and social ties with VCs are important precursors to successful VC funding and valuation [180,182]. Studies confirm the impact of founders' age [183], gender [17] CEO's attractiveness on venture capitalist decisions [184].
Link 3: Founding team (E1) and Venture (E6)	Founders' knowledge, experience, traits, and networks are crucial pillar of venture success. They drive the venture's progress by unleashing critical resources, experience, and knowledge. Founders' unique personalities, values, team dynamics, and investor ties are significant parameters directing venture advancement [53, 185,186].
Link 4: Idea (E2) to Funding (E4)	Lucrative business ideas are the first traction of the financiers/ investors [187]. Value-creating ideas have a high potential for attracting funding [129,188].
Link 5: Idea (E2) to Venture (E6)	Venture creation begins with ideation—the foundation of transforming ideas into viable businesses [189,190]. The quality of idea, novelty, and potential to drive value is the foundation for successful venture creation and rapid progression [38,191]. Idea unique traits, focus, complexity, scalability, timing—shape market acceptance, funding prospects, and final outcomes [192].
Link 6: Mentor Support (E3)- Founder (E1)	Seed accelerators run fixed-term programs offering founders mentorship, training, and access to investors and strategic resources [193]. Apart from serving as training hubs, these programs facilitate emergent founders' handholding, mentorship, requisite knowledge, access to strategic resources, networking, and other complementary resources and skills desired for advancing the venture idea to new heights, overcoming the bottlenecks in the venture's progress journey [110,194,195].
Link 7: Mentor Support (E3)- Idea (E2)	Innovative ideas rarely thrive in isolation; accelerators and incubators act as early-stage grooming grounds, providing critical feedback, mentorship, and resources to shape ideas into viable ventures [195–197]. They help refine business models, align market focus, and connect founders with skills, networks, and strategic or financial support [32,110,198].
Link 8: Mentor Support (E3)- Funding (E4) (Transitive)	Accelerator programs serve as a significant link between startups and fundraising. Enhancing the idea potential through grooming programs, resources, and networking, accelerator programs act as an important platform, facilitating first-level recognition of the idea, venture, and founders [199]. Apart from seed funding, accelerators also introduce the startup to potential investors, VCs, and angel funds [32]
Link 9: Mentor support (E3)- Venture (E6) (Transitive)	Accelerators and incubation programs are integral to the entrepreneurial system and vital tools for fostering startup growth [166]. From the successful incubation of the business idea to venture creation and successful progression, the incubators and accelerators provide complete hand-holding to the founders- requisite knowledge, skills, resources, infra support, networking with peers, as well as funding houses [112,195,200].
Link 10: Funding (E4) -Idea (E2)	Funding propels ideas toward realization [188]. Adequate seed capital at the early stage is vital for validating concepts and enabling successful venture takeoff [187,201].
Link 11: Funding (E4)- Venture (E6) (Transitive)	Sufficient and timely funding is vital for new ventures' growth, rapid progression, and long-term sustainability [31,118,202]. Inadequate historical records and collateral restricting the fundraising ability of the startups enhances their reliance on the new modes of finance- VCs, angel funds, who asses ventures based on idea quality, team strength, and market potential—validating credibility and enabling future growth credential [50,122,203].
Link 12: Institutional Environment (E5)-Mentor support (E3)	The institutional theory supports the institutional environment, regulators, policies, and processes as virtual pillars aiding the growth of new organizations [137]. With the growing startup ecosystem, institutional development emerged in the form of incubators and accelerator programs [204]. The regulators emphasize the incubator programs to foster entrepreneurial growth by providing the necessary skills, knowledge, and resources desired [205]. A strong institutional environment, facilitating good quality productive mentor program reforms, enhances the entrepreneurs' confidence in the accelerators and incubators program. Strong reforms weed out the low-quality ventures and enhance the quality of the venture selection in the cohorts [142]
Link 13: Institutional Environment (E5)-Funding (E4): (Transitive)	A healthy regulatory environment and constructive reforms and practices enhance the entrepreneur and investors' confidence and develop a healthy financial nexus with transparent practices and alternatives [206]. On the contrary, a restrictive environment, regulatory deficiencies, inappropriate and inflexible laws, an underdeveloped capital market, etc., act as demotivating factors for investors [207].
Link 14: Institutional Environment (E5)-Venture (E6): (Transitive)	Constructive changes and reduced institutional impediments benefit new enterprise development and progression. The institutional changes have a substantial impact on entrepreneurs' attitudes and risk-taking behaviors.
Link 15: Institutional Environment (E5)-Idea (E2): (Transitive)	Constructive reforms, low institutional barriers, incubators, accelerator support, seed funds, subsidies, etc., enhance entrepreneurial acumen, leading to good ideas progression.
Link 16: Institutional Environment (E5)-Founders (E1): (Transitive)	Institutional reforms are the backbone for any system's conducive growth and stability. Constructive and flexible reforms strengthen the

(*continued on next page*)

Appendix 1 (*continued*)

	founder's confidence and enhance entrepreneurial acumen and spirit to capitalize on emergent opportunities and adapt swiftly to changing dynamics [208].
Link 17: Venture (E6)-Funding (E5)	Venture caliber, potential in business ideas, market potential, and scaling-up possibilities are key parameters authenticating the start-up credential to the investors [201,209,210].

modeling, hypothesis testing, and actionable insights.

6. Conclusions

The research unfolds the systemic and interdependent dynamics of the ecosystem impacting the new venture's survival and long-term sustainability. Unearthing the hierarchical interdependencies among institutional, relational, and entrepreneurial subsystems, the model offers a scalable framework facilitating evidence-based informed decisions for diagnosing ecosystem performance, valuation assessment and identifying legitimate signals. Underscoring the systemic and interlinked nature of new venture performance, the study advances the literature by moving beyond isolated factors to highlight interdependencies, offering practical pathways for policy, investment, and academic inquiry. Yet the India-centric validation constitutes a regional limitation; extending the research across diverse geographical environments can unearth how ecosystems globally foster sustainable entrepreneurial growth, innovation, and venture success.

CRediT authorship contribution statement

Anshu Agrawal: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix 1

Appendix 1.

Data availability

Data will be made available on request.

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