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Triggering Sustainable Transitions in Entrepreneurial Ecosystems: Key Enabling Conditions and Outcomes

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ABSTRACT

While widely desired, sustainable transitions in entrepreneurial ecosystems (EEs) remain elusive. Identifying the critical EE conditions that foster knowledge-intensive sustainable entrepreneurship (KISE) is essential. This study classifies key EE elements that support KISE and examines its sustainable development outcomes. Using a mixed-methods approach, we apply the Delphi technique and the best–worst method (BWM) to analyze data from entrepreneurs. Findings indicate that formal policies, institutions, entrepreneurial culture, and social aspects are the most relevant EE elements for KISE. In terms of impact, KISE fosters local entrepreneurship, job creation, innovative products, and circular economy practices, contributing to economic well-being and long-term stability. These insights support policymaking that connects KISE to sustainable transitions within EE, particularly in developing countries. Our study advances the understanding of KISE's role in sustainability and highlights the need for tailored ecosystem strategies to enhance its impact.

1 | Introduction

Recently, academics and practitioners have been paying increasing attention to the entrepreneurial ecosystem (henceforth EE) metaphor, seeking a greater understanding of how individual and contextual factors influence entrepreneurial activity (O'Connor and Audretsch 2023; Stam and van de Ven 2021). The EE encompasses complex arrangements of a diversity of components and factors that collectively foster entrepreneurship and the development of innovative businesses (Huang et al. 2023; Trabskaia et al. 2023). In shaping the conditions for innovativeness, such components and their non-linear and dynamic interactions assume a local character, attracting and stimulating economic activities of a similar nature (Isaksen and Trippl 2017).

The spatial arrangement of EE can lead to path-dependent trajectories, which are facilitated by proximity, promoting the exchange of knowledge, ideas, and capabilities, even in developed nations, peripheral ecosystems in small towns, or rural areas (Fischer et al. 2018; Pan and Yang 2019). In this respect, recent literature has increasingly underscored the need to articulate innovation-driven entrepreneurship with grand challenges associated with social and environmental issues. Such a sort of entrepreneurship is intensive in the application of knowledge when generating new products, processes, services, and business models (de Moraes et al. 2023), playing a key role in promoting knowledge-based sustainable development (Juma et al. 2023), thus triggering economic transitions towards more inclusive and ecological production

models (Muñoz and Cohen 2018; Surie 2017; Turker and Ozmen 2021; van Rijnsoever 2022). In this context, the concept of knowledge-intensive sustainable entrepreneurship (KISE) emerges (Siqueira et al. 2023). While the business sector has been facing a huge demand to integrate social, environmental, and economic institutional logic in businesses (Cornelissen et al. 2021; Maibom and Smith 2016), through innovation entrepreneurs are playing a significant role in facilitating the transition to sustainability (Jordão et al. 2023; Klofsten et al. 2024; Meissner et al. 2024). In the meantime, the notion of an EE has gained prominence as a potential driver of KISE due to its capacity to offer entrepreneurs support for both financial sustainability and societal impact (Audretsch et al. 2024; Juma et al. 2023; Roundy 2024).

Interest regarding the overlap between sustainability, entrepreneurial activity, and the contextual dynamics of EE is growing in the literature (Fischer, Bayona-Alsina, et al. 2022; de Moraes et al. 2023; Siqueira et al. 2023). Nevertheless, it has yet to embrace the KISE phenomenon as a driver of sustainable transitions (Bertello et al. 2022; Jütting 2020; Kummitha 2022; Zioło et al. 2023). More than that, evidence is required about how EE configurations can effectively enable KISE (Siqueira et al. 2023), once a conspicuous gap remains regarding the identification of critical factors impacting business sustainability (Chandra et al. 2024; Kehinde et al. 2022). Conversely, KISE impacts linked to specific UN SDGs remain largely unaddressed (Lyons and Roundy 2023; Roundy and Randy Evans 2024). Based on these arguments, two research questions emerge: *What are the key elements of the EE that promote KISE? What are the critical sustainable development outcomes generated by KISE within the EE in which they operate?* Hence, this study aims to identify and classify the critical components within the EE that play a fundamental role in stimulating and supporting the creation and growth of KISE and elucidate the critical sustainable development outcomes resulting from KISE activities within the ecosystem.

By analyzing the complex relationships among the elements of the EE, the value creation, the sustainable development, and the outcomes of KISE, this study seeks to respond to requests from scholars who call for evidence regarding the level of importance of entrepreneurial elements in contributing to KISE development and inclusion in the agenda of EE policy (Audretsch et al. 2024; Gomes et al. 2023; Hervás-Oliver et al. 2021; Juma et al. 2023). We also aim to shed light on KISE's tangible and intangible contributions to the broader ecosystem, encompassing value creation from economic, social, and environmental dimensions aligned to the UN SDG. This, we believe, allows articulating a discussion around concrete and specific elements of sustainability, going beyond generic, unspecific debates on the topic. We expect our results to contribute to the literature on business sustainability, offering impactful insights to build a more robust, sustainable, and equitable economy *vis-à-vis* the quest for long-term social and economic development.

This article is organized as follows: Section 2 delves into the theoretical framework around KISE, EE, and sustainability value creation based on SDG. Section 3 delineates the empirical conceptual model. Section 4 presents the materials and methods. Section 5 brings out the results. Section 6 points out the discussions. Finally, Section 7 stands out the final considerations, followed by the references used.

2 | Literature Review

2.1 | Sustainable Transitions in Entrepreneurial Ecosystems

The EE has been increasingly used as a theoretical tool by scholars and practitioners to understand the context of entrepreneurship in territories (Audretsch and Link 2019; Reynolds et al. 2005). As the ecosystem develops, a complex network of relationships emerges, forming a hierarchical and coupled system that promotes flexibility and stability. This macro-level relevance of EEs is also supported by cross-national empirical evidence. Singh and Ashraf (2020) demonstrate that well-structured EEs are positively associated with national economic growth, reinforcing the strategic importance of ecosystem development in shaping sustainable and inclusive economies. Thus, the objective of the EE is to promote productive entrepreneurship that contributes to the general well-being (Baumol 1996; Stam and van de Ven 2021).

Following Stam (2015), EEs is a broad umbrella established from a set of actors and factors that are mutually dependent and seek to promote productive entrepreneurial activities. Stam (2015) still characterizes the EE metaphor as communities that share knowledge, financial resources from investors, human resources formed by educational systems, regulatory actions and licensing through government action, partnership actions through supply chains, and sales to interested consumers. One of the most widely accepted and used models in ecosystem literature was created by Stam and van de Ven (2021). In this model, 10 macro-level elements are crucial to driving entrepreneurship: formal institutions, culture, physical infrastructure, demand, networks, leadership, finance, talent, knowledge, and intermediary services. Together, these attributes provide resources that new local ventures could not otherwise access (Spigel 2017; Wurth et al. 2022).

Additionally, to better understand how EEs contribute to sustainability, we incorporate the multi-level perspective (MLP) on socio-technical transitions (Geels 2002). The MLP framework conceptualizes transitions as the result of interactions between three analytical levels: niches (where radical innovations emerge), socio-technical regimes (established practices and rules), and landscapes (macro-level trends). EEs can serve as mediating arenas where niche innovations such as KISE gain momentum, are institutionalized, and influence broader systemic changes toward sustainability.

On the other hand, the advent of sustainability has aroused the interest of scholars seeking to understand how EE promotes sustainable development (Audretsch et al. 2024; Theodoraki et al. 2022; Volkmann et al. 2021; Wurth et al. 2022). Yet, EE and sustainable development are multidimensional phenomena with different conceptualizations and theories (Audretsch et al. 2024). Plus, although EE's conceptual contributions had essential impacts in academic and policymaking debates across the globe, its core focus has remained deeply attached

to high-growth ventures, largely disregarding their connections (or lack thereof) with actual socioeconomic development (Audretsch 2021; Kuckertz et al. 2023; O'Connor and Audretsch 2023), the dynamics associated with industrial progress and innovation in EE have largely nurtured new business formation without including an agenda oriented towards social and environmental issues (Meissner et al. 2024).

In this respect, while the knowledge on EE components and dynamics has grown substantially over the past decade, conspicuous gaps remain as per the adequacy of these findings and the emergence of sustainable transitions. As a result, there is still considerable ground to cover when it comes to understanding how localized phenomena enable (or constrain) ecosystem-level shifts towards sustainability (Demirel et al. 2019; Pinkse et al. 2024; Potluri and Phani 2020; Raposo et al. 2022).

Furthermore, while formal structures and policies are often foregrounded in ecosystem studies, the role of informal entrepreneurial dynamics is equally crucial. Informal networks, norms, and community-based engagement can significantly shape entrepreneurial trajectories, particularly in developing contexts. As Munir and Watts (2025) show, ecosystems beyond formal institutions harbor rich, adaptive mechanisms that support entrepreneurial activity in subtle but powerful ways. Incorporating these informal dimensions provides a more comprehensive view of how ecosystems operate and how they can be leveraged for sustainable transitions.

As previously defined, KISE comprehends entrepreneurial activities that combine approaches dealing simultaneously with economic, environmental, and social goals (Cohen and Winn 2007; Johnson and Schaltegger 2020; Siqueira et al. 2023). Following this logic, KISE is expected to operate through distinct technological, managerial, and institutional logics from "traditional" entrepreneurs (Agarwal et al. 2018; Battilana 2018). In this context, intellectual capital (particularly human and structural assets) plays a key role in supporting the performance and sustainability orientation of startups. (Nalakam Paramba et al. 2023) reinforce this view by showing, through a bibliometric analysis, how different dimensions of intellectual capital are central to the sustainable performance of early-stage ventures. This happens due to typical KISE rationale focused mainly on generating social and/or environmental value (Hanohov and Baldacchino 2018). Drawing from this background, it becomes relatively clear that KISE faces challenges related to the necessary innovation capabilities required to address wicked social and environmental challenges—some of which might not be available in their respective EE (Demirel et al. 2019; Ibáñez et al. 2022; Pinkse et al. 2024; Scillitoe et al. 2018; Vo-Thanh et al. 2021). Plus, these firms likely need the support of a diversified group of stakeholders to become legitimate *vis-à-vis* market dynamics (Bozeman et al. 2015; Cohen 2006; Guerrero et al. 2021; Pandey et al. 2017; Theodoraki et al. 2022). Consequently, policymaking and institutional shifts are critical in shaping adequate EE conditions that aim at nurturing KISE (Siqueira et al. 2023).

Nonetheless, the nature of such interventions—and how they should look like—remain elusive (Bailey et al. 2018). In this regard, KISE ventures seem to require configurations that prioritize different aspects than those observed in "traditional" EE (Kuckertz et al. 2020) As per Volkmann et al. (2021), sustainable EE are directly aligned with sustainable development and the UN SDGs. For the authors, the sustainable EE can be understood as an ecosystem that relates the traditional elements of the EE with sustainability issues, focusing on promoting sustainable entrepreneurship (Volkmann et al. 2021). Similarly, (Theodoraki et al. 2022) refer to the EE as a road of integrating environmental, social, and governance (ESG) factors based on the ESG framework. Empirical studies show that, in emerging nations, EE creates opportunities to prevent failures caused by inadequate entrepreneurship policies (de Moraes et al. 2023), especially when sustainable-oriented, the EE can be a strong driver of value creation (Fischer, Bayona-Alsina, et al. 2022; Siqueira et al. 2023; Vicentin et al. 2024). In order to move the agenda of sustainable transitions in EE further, we need to dig deeper into the analytical components that facilitate the emergence and success of KISE ventures.

2.2 | Value Creation for Achieving SDGs

The 1990s saw a significant shift toward recognizing the collaborative and relational aspects of value creation. As efforts towards sustainability and the UN 2030 Agenda began to progress, value creation began to be addressed in organizations (Boruchowitch and Fritz 2022; Laukkanen and Tura 2020). The case of "sustainable value creation" refers to the Triple Bottom Line (TBL), a framework introduced by Elkington (1998) that describes how organizations can create value across multiple facets. According to Elkington (1998), business models should generate social, environmental, and economic value, contributing to sustainable development. Thus, sustainability value implies that all investments create economic, social, and environmental value while being inherently interconnected and mutually reinforcing (Arnold 2018).

Following Arnold (2018), the SDGs indicators can be adopted to analyze the impact of (innovative) business in terms of sustainability value creation. The SDGs represent an ambitious agenda for tackling the world's most wicked challenges (United Nations 2023). Adopted by the United Nations General Assembly in 2015 as part of the 2030 Agenda for Sustainable Development, 17 goals and associated targets aim to guide global efforts towards a more sustainable, inclusive, and equitable future (United Nations 2015). The SDGs offer a progressive, comprehensive, and coherent approach for organizations to achieve sustainability (Audretsch et al. 2024; Redman 2018). Hence, SDGs can be considered a starting point in guiding sustainable-oriented value creation propositions due to their three dimensions of TBL (Kruger et al. 2018).

In the sustainability value framework, economic value creation refers to the financial value of assets such as goods and services, whose value appropriation is based on a new action, product, or service that occurs through economic exchange for organizations, individuals, and society (Ritala et al. 2021). Environmental value creation refers to how business activities affect the environment and capital, including supply chain solutions, waste management, and material recovery, manufacturing costs, product life cycle management, regulatory

compliance, and organizational legitimacy (Park et al. 2010; Thomas and Lamm 2012). Finally, social value refers to actions that promote societal well-being, solve social issues, and serve marginalized populations (Kummitha 2022).

Entrepreneurial activities focused on creating sustainability value can therefore alleviate poverty, provide water and sanitation facilities, address gender issues, and combat climate change (Pelegrini et al. 2025; Pigola et al. 2025; Ranabahu et al. 2023). Additionally, through initiatives such as renewable energy and waste management, sustainability value contributes to business efficiency, increased transparency, responsiveness, and a positive reputation (Boruchowitch and Fritz 2022; Hechavarría et al. 2017; Pigola et al. 2025). By integrating innovative practices and social responsibility, KISE is capable of addressing not only socioenvironmental challenges but also enhancing firm performance (Lages et al. 2024). Again, the role of EE is key in these dynamics by (potentially) creating adequate contexts that can help these firms emerge, gain legitimacy, and thrive. Although entrepreneurship is considered an output of the EE, new value creation arises as an outcome of such processes, a function of interconnections between agents, organizations, and institutions that enhance economic growth while addressing environmental and social challenges (Acs et al. 2017; Vicentin et al. 2024).

Recent empirical work by do Prado and de Moraes (2024) reinforces this perspective by demonstrating how sustainability-oriented entrepreneurial perspectives, such as moral commitment, social support, and environmental concern, significantly influence sustainable value creation among knowledge-intensive entrepreneurs in Brazil. Their findings offer additional evidence that the relational and motivational dimensions of entrepreneurship are central to realizing the multidimensional value sought by KISE ventures.

In this study, the EE is considered imperative in fostering sustainability value creation (Kummitha 2022; Zioło et al. 2023).

3 | Conceptual Model

Figure 1 illustrates the complex relationship between the elements of the EE, the development, and value creation as outcomes of the KISE activities. As outlined in the Introduction Section, in order to respond to our first research question, we analyze the key elements of the EE that can stimulate the KISE. Regarding our second research question, we analyzed the main sustainable outcomes generated by the KISE activities within the ecosystem, focusing on the creation of economic, social, and environmental value.

4 | Materials and Methods

To achieve the research objective, this study compiled a list of indicators from the existing literature, which was subsequently refined based on feedback from entrepreneurs through the Delphi method. Such perspective grants our research an approach centered on the figure of entrepreneurs as core elements of EE, an aspect that has often been overlooked in literature in favor of analyses focused solely on contextual features (Roundy and Lyons 2023). Additionally, the resulting indicators were analyzed using the best–worst method (BWM), which effectively addresses multi-criteria decision-making (MCDM) challenges.

Figure 2 illustrates the three main steps of the methodological procedure.

As shown in Figure 2, the first step (step 1) involved an extensive literature review to identify the key elements of the EE that

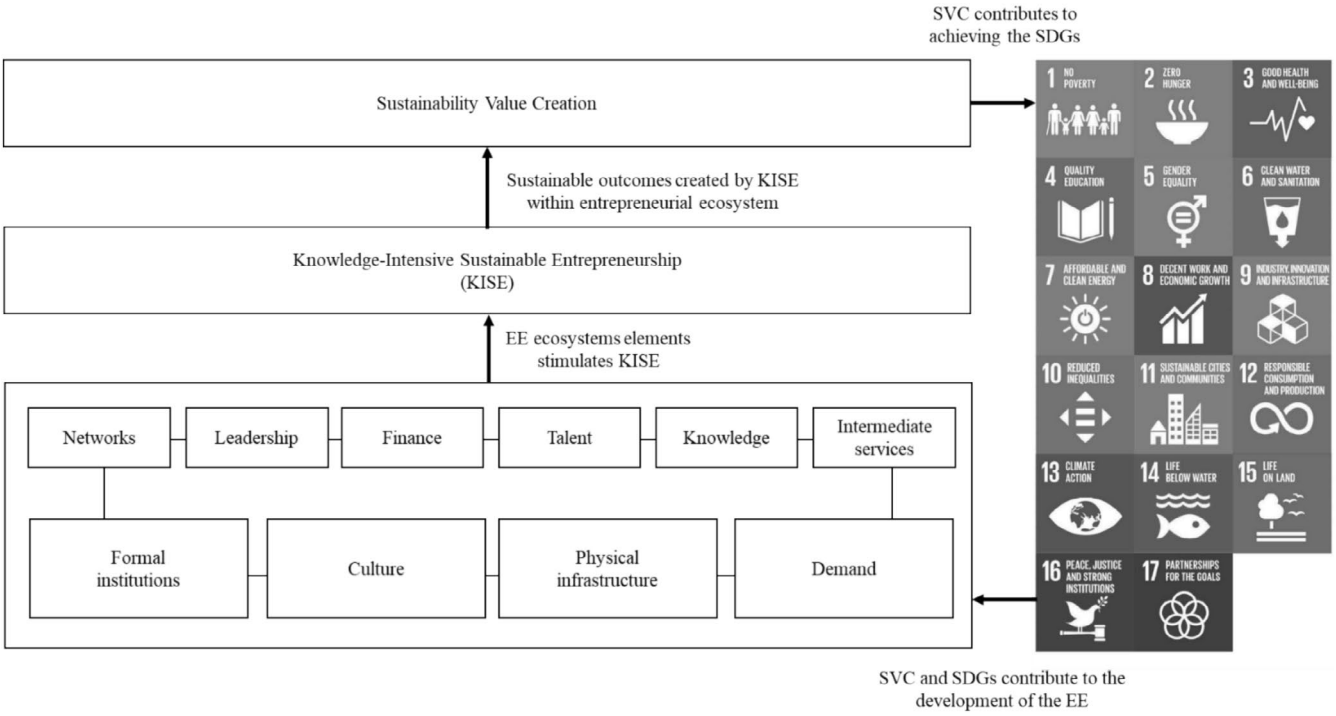

FIGURE 1 | Empirical conceptual model. *Source:* Adapted from Stam and van de Ven (2021).

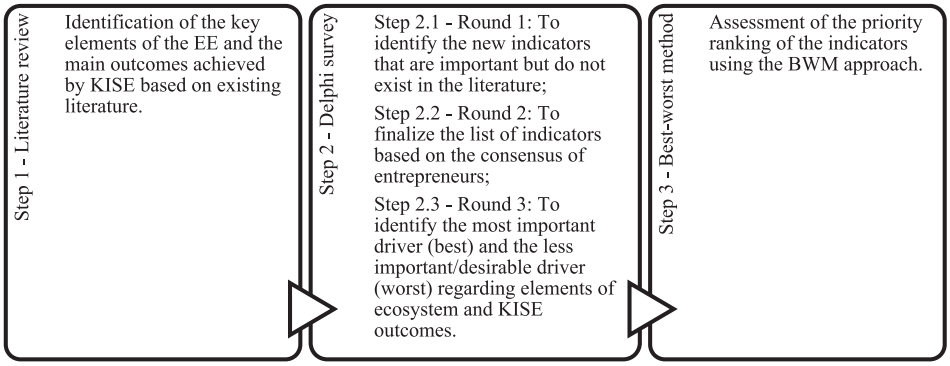

FIGURE 2 | Schematic flow diagram of the methodological procedure.

enhance the KISE phenomenon and the primary outcomes achieved through KISE activities. It was also possible to develop a first compilation of potential sustainable indicators from KISE outcomes.

In a second step (step 2), a Delphi survey consisting of KISE entrepreneurs with a high level of academic education was conducted to identify indicators other than those determined in the literature. The Delphi method is a well-established approach that facilitates the analysis of indicators by gathering consensus through a series of structured, anonymous, multi-round feedback sessions (Flostrand et al. 2020). The iterative nature of the Delphi method allows participants to assess how their evaluations of indicators align with those of others, facilitating shifts in opinion (Bolger and Wright 2011). It is essential to highlight that consensus does not mean unanimity (Fritschy and Spinler 2019). Finally, the number of Delphi rounds is determined by the stability of the responses (Kaushik and Tewari 2023). In this study, three rounds of Delphi were conducted.

The final stage (step 3) involves the BWM application. BWM is an MCDM technique created by Rezaei (2015) that is utilized in complex decision-making problems of prioritization. The BWM has been frequently used due to its high consistency and data flexibility regarding calculations with a minimized comparison matrix (Salimi 2017; Wang and Fu 2020). Since its creation, the BWM has been successfully adopted in various fields and disciplines (Kumar et al. 2019; Singh et al. 2021). Thus, it has been considered a prominent approach for prioritizing decisions and comparing decision-making criteria (Rezaei 2015).

In this study, BWM was developed through the mathematical model proposed by Rezaei (2016). Using Microsoft Excel, linear programming was performed with the support of the simplex method available in the Solver add-in. The simplex method is an algorithm used to solve linear programming problems and to optimize the allocation of limited resources, aiming at maximizing or minimizing an objective function under a set of linear constraints (Nash 2000). This algorithm works through an iterative procedure that solves the problem in a defined number of steps. In each iteration, it verifies whether the solution found is the ideal one.

From the structured linear equations with the comparative importance vectors obtained from Equations (1) and (2), it was aimed to minimize the ξ^* value. In total, four different rankings were established.

4.1 | Sample

As already mentioned, this study focused on Brazilian KISE. The sample of entrepreneurs comprises cases that participated in the PIPE program (Innovative Research in Small Enterprises), managed by the São Paulo Research Foundation (FAPESP), which supports knowledge-intensive entrepreneurs. The program began in 1997, inspired by the American Small Business Innovation Research (SBIR) program. PIPE promotes entrepreneurial projects that are intensive in knowledge and innovation (Fischer, Salles-Filho, et al. 2022). Thus, this group of participants can be considered a reliable source for conducting the present research (Fischer, Bayona-Alsina, et al. 2022; de Moraes et al. 2023).

For data collection, all entrepreneurs responsible for projects approved by PIPE FAPESP between 2014 and 2023 were considered. The projects were downloaded from the official FAPESP website, which included information about the responsible individuals. Initially, the data were cleaned by excluding projects with the same responsible entrepreneur. The final database included 1090 entrepreneurs. For each one, secondary data were gathered, encompassing email addresses, educational level, number of academic publications, and professional experience through searches on institutional, governmental, and social media websites.

From the secondary data collection, a filter was applied to select only those entrepreneurs who had completed a PhD, held a postdoctoral degree, or were a Senior Lecturer. This academic criterion ensured a consistent knowledge-intensive baseline for KISE ventures. In the next stage, a second filter was applied to identify sustainable ventures. This analysis was conducted based on the detailed descriptions available in the project abstracts. Four independent researchers, specialized in sustainability studies, evaluated the detailed descriptions of each project and classified the ventures as sustainable or traditional using a scale from 1 (not very sustainable) to 4 (very sustainable). Ventures that received at least three or four evaluations as highly sustainable were considered sustainable.

TABLE 1 | Summary of Delphi round 1.

EE elements	Social value creation indicators	Environmental value creation indicators	Economic value creation indicators
• Policies and formal institutions. • Entrepreneurial culture and social aspects. • Infrastructure. • Market demand. • Networking and collaboration. • Human capital and talent. • Finance and access to capital. • Knowledge creation. • Intermediary services.	• Number of job opportunities created. • Implementation of training and development programs. • Employee diversity. • Encouragement of local entrepreneurship, support for local suppliers. • Partnerships with social organizations.	• Use of renewable energy, energy efficiency. • Reduction, reuse, and recycling of waste; diversion of waste from landfills; use of sustainable packaging. • Reduction of water consumption, reuse of water, sustainable management of water resources. • Assessment and reduction of the environmental impact of suppliers, use of sustainable materials, responsible management of the supply chain. • Development of innovative products and processes with low environmental impact, investment in research, and sustainable development. • Adoption of reverse logistics practices.	• Increased (general) efficiency and reduced costs. • Increased profits and the creation of new business opportunities and markets. • Increased long-term stability and reduced risk. • Increased reputation and brand value. • Increased economic well-being.

This multi-stage filtering ensured relevance, rigor, and alignment with the study's goals.

Each entrepreneur in the population was individually invited via email to participate in our study. A total of 26 entrepreneurs participated in the three Delphi rounds and subsequently applied the BWM. Regarding the sample relevance, we used the parameters provided by Olawore et al. (2023), who affirm that the contribution of 10–15 participants for the Delphi survey is sufficient to reach an effective conclusion. Therefore, it can be concluded that our final sample is appropriate for BWM use. To minimize bias, responses were anonymized during the Delphi rounds, and the sustainability classification was conducted independently by four coders. All survey instruments were pre-tested with potential respondents to assess clarity, comprehension, and usability, ensuring that questions were interpreted as intended before full deployment.

5 | Results

Our sample profile is predominantly composed of women (57.7%). Regarding educational level, 37.7% of the sample has a PhD degree, while 65.3% have a postdoctoral degree. The participants have an average of 19 years of professional experience. In addition, their projects are classified in the following main areas: biotechnology (23.08%), biodegradable materials (11.54%), cosmetics (7.69%), medicine (7.69%), nanotechnology (7.69%), biofertilizer (3.85%), biodiversity (3.85%), biomaterials (3.85%), education (3.85%), renewable energy (3.85%), biological fluids (3.85%), renewable sources (3.85%), products industry (3.85%), sugar and alcohol industries (3.85%), agricultural microbiology (3.85%), and information technology (3.85%).

5.1 | Results From Delphi Survey

This study was conducted through a Delphi survey, which took place between April 23, 2024, and May 31, 2024, via a self-administered questionnaire accessible in Google Forms. As mentioned above, Delphi is performed in multiple rounds, where the first round is usually designed qualitatively to gain the breadth and depth of entrepreneurs' opinions, and subsequent rounds use a quantitative approach by assessing the descriptive statistics to establish the strength of opinion and achieve group consensus (Kaushik and Tewari 2023). Thus, in the first round (step 2.1), specialists were asked about: (i) the elements of the EE that play a fundamental role in stimulating and supporting the creation and growth of KISE; (ii) the indicators of social value creation that KISE has the potential to generate; (iii) the indicators of environmental value creation; and (iv) the indicators of economic value creation.

Results from the first round were analyzed through a content analysis following the recommendations of Elo and Kyngäs (2008). In this stage, similar answers were clustered. Table 1 lists the summary of the entrepreneurs' answers.

In the second stage of Delphi (step 2.2), the feedback from the first round was shared with the same panel of entrepreneurs. In this second round, the entrepreneurs reviewed the compiled responses and were able to agree, disagree, and point out new insights or adjustments in their responses. The results from the second round indicated a consensus of 90%. Consensus in this study was defined as strong convergence in the selection and ranking of elements among participants, even if not all responses were unanimous. This approach follows established practices in Delphi studies.

5.2 | Results From the BWM Approach

From the Delphi results, the third round (step 2.3) was conducted, in which entrepreneurs chose the most important/desirable driver (best) and the least significant (worst) driver regarding the key element of the EE that can stimulate the KISE modality. The exact process was repeated for each sustainable value dimension (social, environmental, and economic). Results from this third Delphi round were used in the BWM application.

Using a 9-point scale ranging from 1 (equally important) to 9 (definitely more important), the specialists determined the preference ranking for the best driver over other indicators to construct (best-to-other) a vector as shown in Equation (1) regarding ecosystem elements and the KISE outcomes

$$A_B = \{a_{B1}, a_{B2}, \ldots, a_{Bn}\} \quad (1)$$

where a_{Bj} denotes the preferences of the best-selected driver B over any other driver j.

The same occurs when determining the preference for each of the other criteria j over the worst criterion to construct (other-to-worst) a vector, as shown in Equation (2)

$$A_W = \{a_{1W}, a_{2W}, \ldots, a_{nW}\}^T \quad (2)$$

where a_{jWB} denotes the preference of other driver j over the worst driver, W.

5.2.1 | Results From the BWM in the EE

Results from best and worst vectors regarding the EE are shown in Table 2.

As already mentioned, for each entrepreneur, vectors A_B and A_W were structured and Equation (3) was solved through the simplex method. For this, the software follows a set of three iterative steps. *First*, it analyzes the basic equation that defines the boundary conditions and then applies this analysis to the object of study, as in Equation (3).

$$\min \ \xi^L \quad (3)$$

subject to

$$\left|\frac{W_B}{W_j} - x_{Bj}\right| \leq \xi^L, \text{ for all } j;$$

$$\left|\frac{W_j}{W_B} - x_{jB}\right| \leq \xi^L, \text{ for all } j;$$

$$\sum_j W_j = 1$$

$W_j \geq 0$, for all j.

From this equation (Equation 3), it was aimed to minimize the ξ^L value. In a *second* step, the objective is to identify the optimal weights of the indicators so that the maximum absolute differences for all j can be minimized for $\left|\frac{W_B}{W_j} - x_{Bj}\right|$ and $\left|\frac{W_j}{W_w} - x_{jW}\right|$. In this step, it is checked whether, among the vertices close to this solution, there is any other vertex whose correspondence and convergence are better. If positive, the process is restarted, focusing on this new vertex. Otherwise, the optimal solution is found (*third* step), and this result can be determined as the best approximate result for that set of equations and boundary conditions (Nash 2000).

The consistency ratio (ξ^L) was calculated for each pairwise comparison to ensure coherence in the evaluations provided by the entrepreneurs. Low ξ^L values across participants confirmed a high level of internal consistency, in line with the expectations of the BWM method (Rezaei 2016).

Table 3 shows results regarding Equation (3). Following Equation (3), ξ^L could directly be considered an indicator of consistency (Rezaei 2016). Low values of ξ^L indicate a high level of consistency. The average values of the weights were used to obtain the final weights for each criterion (Malek and Desai 2019). Thus, from the rank, we can affirm A1 > A2 > A4 > A6 > A3 > A7 > A8 > A5 > A9.

The results from Table 3 highlight that formal policies and institutions are the most critical elements of the EE in fostering and supporting KISE. This indicates that regulatory frameworks, tax incentives, and legal infrastructure play a fundamental role in enabling sustainable and knowledge-intensive businesses to thrive. Entrepreneurial culture and social aspects also emerged as highly relevant, suggesting that a favorable attitude towards entrepreneurship and strong social support networks significantly contribute to the success of KISE. Market demand and human capital ranked third and fourth, respectively, underscoring the importance of a receptive consumer base and access to a skilled workforce. Interestingly, intermediary services, such as incubators, accelerators, and consulting firms, ranked the lowest in importance. This suggests that either these services do not fully meet the needs of sustainable entrepreneurs or that KISE ventures are less dependent on such intermediaries for growth. Overall, the findings indicate that the institutional infrastructure of the EE—rather than traditional factors such as financing or networking—plays a decisive role in shaping a conducive environment for KISE.

These institutions reduce uncertainty and transaction costs by providing regulatory clarity, tax incentives, and access to public funding. Such mechanisms are particularly relevant for KISE ventures, which typically operate in higher-risk environments and rely heavily on formal legitimacy to navigate hybrid goals.

5.2.2 | Results From the BWM in Social Value Creation

Regarding sustainability value creation, Table 4 presents results from the best and worst vectors related to the social dimension.

Similar to EE assessment, for each entrepreneur, vectors A_B and A_W were structured for social value creation and Equation (3) was solved through the simplex method. The results are presented in Table 5. The final rank configures A4 > A1 > A3 > A5 > A2.

The results from Table 5 indicate that the most significant social value creation outcome generated by KISE within the EE

TABLE 2 | Pairwise comparison for subjectively perceived EE indicators by the panel.

Entrepreneur	Best	A1	A2	A3	A4	A5	A6	A7	A8	A9	Worst	A1	A2	A3	A4	A5	A6	A7	A8	A9
Entrepreneur 1	A1	1	3	3	2	4	2	2	2	2	A5	5	2	2	2	1	2	2	2	2
Entrepreneur 2	A1	1	3	3	3	3	3	3	5	3	A8	5	3	3	3	3	3	3	1	3
Entrepreneur 3	A2	2	1	3	3	5	3	3	3	3	A5	2	4	3	3	1	3	3	3	3
Entrepreneur 4	A1	1	3	3	3	7	2	4	4	4	A5	7	3	4	3	1	4	3	3	3
Entrepreneur 5	A4	4	4	3	1	4	3	4	4	4	A9	3	3	3	4	3	3	3	3	1
Entrepreneur 6	A1	1	2	2	2	2	2	2	2	2	A9	2	2	2	2	2	2	2	2	1
Entrepreneur 7	A2	2	1	3	3	4	3	3	3	3	A5	2	3	2	2	1	2	2	2	2
Entrepreneur 8	A1	1	3	3	3	4	3	3	3	5	A9	5	3	3	3	3	3	3	3	1
Entrepreneur 9	A2	2	1	2	2	3	2	2	2	2	A5	2	3	2	2	1	2	2	2	2
Entrepreneur 10	A1	1	2	3	3	4	3	2	3	3	A5	4	3	2	2	1	2	2	2	2
Entrepreneur 11	A2	2	1	3	3	2	3	3	3	4	A9	2	3	2	2	2	2	2	2	1
Entrepreneur 12	A2	3	1	3	3	5	3	3	3	3	A5	3	4	3	3	1	2	3	3	3
Entrepreneur 13	A1	1	2	2	2	2	2	2	2	4	A9	4	2	2	2	2	3	2	2	1
Entrepreneur 14	A1	1	2	2	2	2	2	2	3	2	A8	3	2	2	2	2	2	2	1	2
Entrepreneur 15	A2	2	1	3	3	3	3	3	3	4	A9	3	3	2	2	2	2	3	2	1
Entrepreneur 16	A6	2	2	3	3	3	1	4	3	3	A7	2	2	2	2	2	4	1	3	3
Entrepreneur 17	A4	3	3	3	1	3	3	4	3	5	A9	3	3	3	5	2	3	3	3	1
Entrepreneur 18	A6	3	3	4	3	5	1	3	3	3	A5	3	3	3	3	1	5	3	3	3
Entrepreneur 19	A2	2	1	2	2	2	2	2	2	4	A9	2	4	2	2	2	2	2	2	1
Entrepreneur 20	A4	3	3	3	1	3	3	3	5	4	A8	3	3	3	5	3	3	3	1	3
Entrepreneur 21	A2	3	1	3	3	3	3	3	3	4	A9	3	4	3	3	3	3	3	3	1
Entrepreneur 22	A4	4	4	3	1	4	3	4	4	4	A9	3	3	3	4	3	3	3	3	1
Entrepreneur 23	A1	1	2	2	2	2	2	2	3	2	A8	3	2	2	2	2	2	2	1	2
Entrepreneur 24	A1	1	2	2	1	2	3	3	1	3	A9	3	3	3	3	3	2	2	3	1
Entrepreneur 25	A2	3	1	3	3	3	3	3	3	5	A9	3	3	2	2	2	2	3	2	1
Entrepreneur 26	A1	1	3	3	3	3	3	3	3	4	A9	5	3	3	3	3	3	3	3	1

Note: A1 = Policies and formal institutions; A2 = Entrepreneurial culture and social aspects; A3 = Infrastructure; A4 = Market demand; A5 = Networking and collaboration; A6 = Human capital and talent; A7 = Finance and access to capital; A8 = Knowledge creation; A9 = Intermediary services.

TABLE 3 | Aggregate weight of subjectively perceived EE indicators by the panel and ξ^L value.

Entrepreneur	A1	A2	A3	A4	A5	A6	A7	A8	A9	ξ^L
Entrepreneur 1	0.211	0.078	0.078	0.117	0.047	0.117	0.117	0.117	0.117	0.023
Entrepreneur 2	0.261	0.099	0.099	0.099	0.099	0.099	0.099	0.045	0.099	0.036
Entrepreneur 3	0.143	0.238	0.095	0.095	0.048	0.095	0.095	0.095	0.095	0.048
Entrepreneur 4	0.274	0.103	0.103	0.103	0.034	0.154	0.077	0.077	0.077	0.034
Entrepreneur 5	0.087	0.087	0.116	0.279	0.087	0.116	0.087	0.087	0.052	0.070
Entrepreneur 6	0.179	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.071	0.036
Entrepreneur 7	0.139	0.238	0.093	0.093	0.066	0.093	0.093	0.093	0.093	0.040
Entrepreneur 8	0.261	0.103	0.103	0.103	0.077	0.103	0.103	0.103	0.042	0.049
Entrepreneur 9	0.106	0.197	0.106	0.106	0.061	0.106	0.106	0.106	0.106	0.015
Entrepreneur 10	0.239	0.133	0.088	0.088	0.053	0.088	0.133	0.088	0.088	0.027
Entrepreneur 11	0.133	0.228	0.089	0.089	0.133	0.089	0.089	0.089	0.063	0.038
Entrepreneur 12	0.100	0.250	0.100	0.100	0.050	0.100	0.100	0.100	0.100	0.050
Entrepreneur 13	0.196	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.043	0.022
Entrepreneur 14	0.197	0.106	0.106	0.106	0.106	0.106	0.106	0.061	0.106	0.015
Entrepreneur 15	0.144	0.225	0.096	0.096	0.096	0.096	0.096	0.096	0.053	0.064
Entrepreneur 16	0.136	0.136	0.091	0.091	0.091	0.227	0.045	0.091	0.091	0.045
Entrepreneur 17	0.103	0.103	0.103	0.261	0.103	0.103	0.077	0.103	0.042	0.049
Entrepreneur 18	0.103	0.103	0.077	0.103	0.042	0.261	0.103	0.103	0.103	0.049
Entrepreneur 19	0.105	0.211	0.105	0.105	0.105	0.105	0.105	0.105	0.053	0.000
Entrepreneur 20	0.103	0.103	0.103	0.261	0.103	0.103	0.103	0.042	0.077	0.049
Entrepreneur 21	0.100	0.250	0.100	0.100	0.100	0.100	0.100	0.100	0.050	0.050
Entrepreneur 22	0.087	0.087	0.116	0.279	0.087	0.116	0.087	0.087	0.052	0.070
Entrepreneur 23	0.197	0.106	0.106	0.106	0.106	0.106	0.106	0.061	0.106	0.015
Entrepreneur 24	0.170	0.102	0.102	0.170	0.102	0.068	0.068	0.170	0.045	0.034
Entrepreneur 25	0.101	0.236	0.101	0.101	0.101	0.101	0.101	0.101	0.056	0.067
Entrepreneur 26	0.250	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.050	0.050
Mean	0.159	0.148	0.100	0.130	0.085	0.114	0.097	0.094	0.074	0.040

is the encouragement of local entrepreneurship and support for local suppliers. This suggests that KISE ventures play a key role in fostering local economic activity by strengthening regional supply chains and promoting business opportunities for local entrepreneurs. The second most relevant outcome is job creation, reinforcing the notion that sustainable and knowledge-intensive businesses contribute significantly to employment generation. Employee diversity and partnerships with social organizations were ranked third and fourth, respectively, suggesting that while social inclusion and collaboration are present, they are not as central to KISE's impact as economic development. Finally, the implementation of training and development programs ranked the lowest, indicating that KISE ventures may prioritize market-oriented innovation over workforce education. These findings highlight that KISE contributes primarily to social value through economic empowerment, local development, and employment opportunities, rather than through direct educational or diversity-focused initiatives.

5.2.3 | Results From the BWM in Environmental Value Creation

For environmental value creation, results of best and worst vectors are listed on Table 6.

Based on each entrepreneur assessment, vectors A_B and A_W were structured for environmental value creation and Equation (3) was solved through the simplex method. Results are shown in Table 7, and present the following rank: A5 > A6 > A1 > A2 > A3 > A4.

TABLE 4 | Pairwise comparison for subjectively perceived social value creation indicators by the panel.

Entrepreneur	Best	A1	A2	A3	A4	A5	Worst	A1	A2	A3	A4	A5
Entrepreneur 1	A4	3	4	3	1	2	A2	3	1	2	4	2
Entrepreneur 2	A4	3	6	3	1	3	A2	3	1	3	5	3
Entrepreneur 3	A1	1	4	3	2	2	A2	4	1	3	2	3
Entrepreneur 4	A4	2	5	2	1	3	A2	2	1	2	5	3
Entrepreneur 5	A1	1	2	3	2	3	A5	4	3	3	3	1
Entrepreneur 6	A1	1	3	3	3	4	A2	2	1	2	3	2
Entrepreneur 7	A5	4	3	3	3	1	A5	2	2	3	2	1
Entrepreneur 8	A4	2	3	2	1	2	A2	3	1	3	4	3
Entrepreneur 9	A3	2	2	1	2	3	A5	3	1	3	4	3
Entrepreneur 10	A4	3	4	3	1	3	A5	3	2	2	3	1
Entrepreneur 11	A1	1	2	2	2	3	A2	4	1	3	2	3
Entrepreneur 12	A1	1	4	3	2	2	A2	2	1	2	3	2
Entrepreneur 13	A4	2	3	2	1	2	A2	4	1	3	3	3
Entrepreneur 14	A3	3	3	1	3	4	A5	2	2	3	2	1
Entrepreneur 15	A4	2	3	2	1	2	A2	2	1	2	3	2
Entrepreneur 16	A4	4	7	4	1	4	A2	4	1	4	7	4
Entrepreneur 17	A1	1	3	3	3	4	A5	4	2	2	2	1
Entrepreneur 18	A4	2	3	3	1	4	A5	2	2	2	3	1
Entrepreneur 19	A3	2	3	1	2	2	A2	2	1	3	2	2
Entrepreneur 20	A1	1	6	4	3	3	A2	6	1	3	3	3
Entrepreneur 21	A1	1	4	3	3	3	A2	4	1	3	3	3
Entrepreneur 22	A1	1	2	3	2	3	A5	4	3	3	3	1
Entrepreneur 23	A4	2	3	2	1	2	A2	2	1	2	3	2
Entrepreneur 24	A4	2	2	2	1	2	A2	2	1	2	2	2
Entrepreneur 25	A1	1	3	3	3	5	A5	5	3	2	3	1
Entrepreneur 26	A4	3	5	3	1	3	A2	3	1	3	4	2

Note: A1 = Number of job opportunities created; A2 = Implementation of training and development programs; A3 = Diversity of employees; A4 = Encouragement of local entrepreneurship, support for local suppliers; A5 = Partnerships with social organizations.

The results from Table 7 indicate that the most significant environmental value creation outcome generated by KISE within the EE is the development of innovative products and processes. This finding underscores the central role of sustainability-driven innovation in KISE, as these ventures prioritize environmentally friendly solutions, resource-efficient technologies, and eco-conscious product development. The second most relevant outcome is adopting reverse logistics practices, highlighting KISE's commitment to circular economy principles by ensuring responsible waste management and material reuse. The use of renewable energy ranked third, suggesting that while energy sustainability is essential, it is not as prioritized as product innovation and waste management. The reduction, reuse, and recycling of waste followed closely, reinforcing the commitment of KISE ventures to minimizing environmental impact. Interestingly, the assessment and reduction of the environmental impact of suppliers ranked the lowest, indicating that KISE firms may focus more on their internal sustainability practices rather than enforcing sustainability standards along their supply chains. These results suggest that KISE ventures drive environmental value primarily through innovation and operational sustainability rather than external environmental governance.

These findings align with those of Hadizadeh et al. (2024), who emphasized the pivotal role digital platforms play in supporting startups engaged in sustainable practices, particularly in developing countries. Their analysis shows how digital infrastructures can act as enablers of sustainable production models by fostering collaboration, enhancing efficiency, and enabling circular economy mechanisms. However, it is important to note that pursuing multiple sustainability outcomes may lead to trade-offs. For instance, circular practices can increase operational complexity and costs, potentially constraining financial scalability. Similarly, job creation and social outreach

TABLE 5 | Aggregate weight of subjectively perceived social value creation indicators by the panel and ξ^L value.

Entrepreneur	A1	A2	A3	A4	A5	ξ^L
Entrepreneur 1	0.154	0.077	0.154	0.385	0.231	0.077
Entrepreneur 2	0.164	0.075	0.164	0.433	0.164	0.060
Entrepreneur 3	0.357	0.071	0.143	0.214	0.214	0.071
Entrepreneur 4	0.192	0.068	0.192	0.397	0.151	0.055
Entrepreneur 5	0.339	0.218	0.145	0.218	0.081	0.097
Entrepreneur 6	0.417	0.167	0.167	0.167	0.083	0.083
Entrepreneur 7	0.184	0.105	0.184	0.342	0.184	0.026
Entrepreneur 8	0.184	0.184	0.342	0.184	0.105	0.026
Entrepreneur 9	0.167	0.083	0.167	0.417	0.167	0.083
Entrepreneur 10	0.326	0.196	0.196	0.196	0.087	0.065
Entrepreneur 11	0.357	0.071	0.143	0.214	0.214	0.071
Entrepreneur 12	0.184	0.105	0.184	0.342	0.184	0.026
Entrepreneur 13	0.385	0.077	0.154	0.154	0.231	0.077
Entrepreneur 14	0.159	0.159	0.409	0.159	0.114	0.068
Entrepreneur 15	0.184	0.105	0.184	0.342	0.184	0.026
Entrepreneur 16	0.147	0.059	0.147	0.500	0.147	0.088
Entrepreneur 17	0.431	0.157	0.157	0.157	0.098	0.039
Entrepreneur 18	0.221	0.147	0.147	0.379	0.105	0.063
Entrepreneur 19	0.184	0.105	0.342	0.184	0.184	0.026
Entrepreneur 20	0.457	0.065	0.130	0.174	0.174	0.065
Entrepreneur 21	0.417	0.083	0.167	0.167	0.167	0.083
Entrepreneur 22	0.339	0.218	0.145	0.218	0.081	0.097
Entrepreneur 23	0.184	0.105	0.184	0.342	0.184	0.026
Entrepreneur 24	0.188	0.125	0.188	0.313	0.188	0.063
Entrepreneur 25	0.433	0.164	0.164	0.164	0.075	0.060
Entrepreneur 26	0.167	0.083	0.167	0.417	0.167	0.083
Média	0.266	0.118	0.187	0.276	0.152	0.062

initiatives may divert resources from product innovation or process optimization.

5.2.4 | Results From the BWM in Economic Value Creation

Finally, for each entrepreneur assessment, vectors A_B and A_W were structured for economic value creation and Equation (3) was solved through the simplex method. Results are shown in Table 8.

Based on each entrepreneur assessment, vectors A_B and A_W were structured for economic value creation and Equation (3) was solved through the simplex method and found that A5 > A3 > A2 > A4 > A1. Results are shown in Table 9.

The results from Table 9 show that the most significant economic value creation outcome generated by KISE within the EE is the increase in economic well-being. This suggests that KISE ventures contribute to overall financial stability and prosperity by generating wealth, stimulating economic activity, and fostering long-term sustainability in their respective markets. The second most relevant outcome is long-term stability, reinforcing that these businesses are focused on building resilient, sustainable business models rather than prioritizing short-term profits. Increased profits and the creation of new business opportunities ranked third, indicating that while KISE ventures are economically viable, profit maximization is not their primary driver. The improvement of reputation and brand value followed, suggesting that market perception and sustainability-driven branding are essential but not the central focus of KISE. Lastly, increased efficiency ranked the lowest, implying that operational cost

TABLE 6 | Pairwise comparison for subjectively perceived environmental value creation indicators by the panel.

Entrepreneur	Best	A1	A2	A3	A4	A5	A6	Worst	A1	A2	A3	A4	A5	A6
Entrepreneur 1	A5	2	3	5	4	1	2	A3	3	2	1	3	5	3
Entrepreneur 2	A6	2	2	5	3	2	1	A3	3	2	1	3	3	5
Entrepreneur 3	A5	2	2	4	3	1	2	A3	3	3	1	3	4	3
Entrepreneur 4	A5	3	4	7	4	1	3	A3	3	4	1	3	7	3
Entrepreneur 5	A5	2	2	2	2	1	2	A4	2	2	2	1	2	2
Entrepreneur 6	A6	2	2	2	2	1	1	A4	2	2	2	1	3	3
Entrepreneur 7	A5	3	3	3	4	1	3	A4	2	2	2	1	3	2
Entrepreneur 8	A5	2	3	5	4	1	2	A3	3	2	1	3	5	3
Entrepreneur 9	A5	3	3	4	3	1	2	A3	3	3	1	3	5	3
Entrepreneur 10	A5	2	2	2	3	1	2	A4	2	2	2	1	3	2
Entrepreneur 11	A5	2	3	5	4	1	2	A4	2	2	3	1	3	2
Entrepreneur 12	A5	3	3	4	3	1	2	A3	3	3	1	3	5	3
Entrepreneur 13	A5	2	2	3	2	1	2	A3	2	2	1	2	3	2
Entrepreneur 14	A5	2	2	2	3	1	2	A4	2	2	2	1	3	2
Entrepreneur 15	A5	3	3	3	4	1	3	A4	3	3	3	1	4	3
Entrepreneur 16	A5	4	7	4	4	3	4	A2	4	1	4	3	7	4
Entrepreneur 17	A5	3	3	3	4	1	2	A4	3	3	3	1	5	3
Entrepreneur 18	A5	2	2	2	4	1	2	A4	2	2	2	1	5	2
Entrepreneur 19	A5	2	2	3	3	1	2	A3	2	2	1	2	4	2
Entrepreneur 20	A6	3	3	4	7	3	1	A4	3	3	3	1	3	6
Entrepreneur 21	A5	3	3	3	4	1	3	A4	3	3	3	1	4	3
Entrepreneur 22	A5	2	2	2	2	1	2	A4	2	2	2	1	2	2
Entrepreneur 23	A5	3	3	3	4	1	3	A4	3	3	3	1	4	3
Entrepreneur 24	A5	1	2	2	2	1	2	A6	2	2	2	2	2	1
Entrepreneur 25	A5	3	3	2	5	1	3	A4	3	3	3	1	5	2
Entrepreneur 26	A5	2	2	3	2	1	2	A3	3	2	1	3	4	2

Note: A1 = Use of renewable energy; A2 = Reduction, reuse, and recycling of waste; A3 = Reduction of water consumption; A4 = Assessment and reduction of the environmental impact of suppliers; A5 = Development of innovative products and processes; A6 = Adoption of reverse logistics practices.

reduction and productivity enhancements are less prioritized than broader economic contributions. These results indicate that KISE ventures primarily drive economic value through sustainable growth and financial resilience rather than immediate efficiency gains or aggressive profitability strategies.

While these findings reflect the context of a developing country (Brazil), we acknowledge that enabling conditions and sustainability outcomes may vary across ecosystem types. Urban ecosystems often benefit from stronger infrastructure and institutional density, whereas rural or peripheral ecosystems may rely more on informal networks and cultural cohesion. These contextual differences should be considered when generalizing the results to other geographies.

To better illustrate our overall results, Table 10 was created.

6 | Discussion

The data presented in Table 10 allow us to identify some behavior patterns. Regarding EE elements, criterion A1, which concerns policies and formal institutions, was selected as the most critical criterion in stimulating and supporting the creation and growth of KISE by most entrepreneurs. Policies and formal institutions, thus, consistently receive higher scores from entrepreneurs than other criteria, ranking as the first EE element to stimulate and support KISE. This result reinforces the argument that adequate policies and formal institutions create a conducive environment that encourages entrepreneurial activities (Spigel 2017). As per Stam and van de Ven (2021), formal institutions reflect the regulatory pillar of a society. Stable policies, in turn, reduce uncertainty for entrepreneurs, making it easier to plan and invest in new ventures (Stam 2015). Through effective regulatory

TABLE 7 | Aggregate weight of subjectively perceived environmental value creation indicators by the panel and ξ^L value.

Entrepreneur	A1	A2	A3	A4	A5	A6	ξ^L
Entrepreneur 1	0.195	0.130	0.053	0.098	0.328	0.195	0.062
Entrepreneur 2	0.179	0.152	0.054	0.120	0.179	0.315	0.043
Entrepreneur 3	0.176	0.176	0.059	0.118	0.294	0.176	0.059
Entrepreneur 4	0.157	0.118	0.047	0.118	0.402	0.157	0.071
Entrepreneur 5	0.158	0.158	0.158	0.105	0.263	0.158	0.053
Entrepreneur 6	0.136	0.136	0.136	0.091	0.227	0.273	0.045
Entrepreneur 7	0.137	0.137	0.137	0.098	0.353	0.137	0.059
Entrepreneur 8	0.195	0.130	0.053	0.098	0.328	0.195	0.062
Entrepreneur 9	0.133	0.133	0.067	0.133	0.333	0.200	0.067
Entrepreneur 10	0.156	0.156	0.156	0.089	0.289	0.156	0.022
Entrepreneur 11	0.179	0.179	0.119	0.066	0.278	0.179	0.079
Entrepreneur 12	0.133	0.133	0.067	0.133	0.333	0.200	0.067
Entrepreneur 13	0.156	0.156	0.089	0.156	0.289	0.156	0.022
Entrepreneur 14	0.156	0.156	0.156	0.089	0.289	0.156	0.022
Entrepreneur 15	0.143	0.143	0.143	0.071	0.357	0.143	0.071
Entrepreneur 16	0.141	0.071	0.141	0.081	0.424	0.141	0.141
Entrepreneur 17	0.133	0.133	0.133	0.067	0.333	0.200	0.067
Entrepreneur 18	0.161	0.161	0.161	0.065	0.290	0.161	0.032
Entrepreneur 19	0.171	0.171	0.081	0.114	0.293	0.171	0.049
Entrepreneur 20	0.148	0.148	0.111	0.056	0.148	0.389	0.056
Entrepreneur 21	0.143	0.143	0.143	0.071	0.357	0.143	0.071
Entrepreneur 22	0.158	0.158	0.158	0.105	0.263	0.158	0.053
Entrepreneur 23	0.143	0.143	0.143	0.071	0.357	0.143	0.071
Entrepreneur 24	0.238	0.143	0.143	0.143	0.238	0.095	0.048
Entrepreneur 25	0.132	0.132	0.198	0.060	0.347	0.132	0.048
Entrepreneur 26	0.164	0.164	0.073	0.164	0.273	0.164	0.055
Mean	0.159	0.145	0.115	0.099	0.303	0.180	0.058

frameworks, like funding, training, tax incentives, and access to basic infrastructure and telecommunications, for instance, entrepreneurs cognize an attractive environment where they can draw on (Isenberg 2010).

Especially in the case of KIE, previous studies argue that formal institutions are closely linked to local socio-economic development, playing an indispensable role in fostering this entrepreneurial typology (Leiponen and Byma 2009; de Mello et al. 2022). We, thus, validate the results provided by Chandra et al. (2024). In a similar proposal, they examined the hierarchical significance of EE factors affecting the environmental sustainability of business, in which governmental initiatives appeared as the most critical driver. Regulations protect intellectual property rights, encouraging innovation and investment in knowledge-intensive sectors (Aparicio et al. 2023). It also addresses education initiatives, incubators, and accelerators by providing necessary resources and mentorship that a closer approximation between academia and markets can establish (Fischer, Salles-Filho, et al. 2022). Conversely, in the KISE modality, policies and formal institutions are responsible for enabling green (and circular) business practices. These frameworks not only support the development of sustainable business models but also encompass green fiscal policies, investments, and job creation initiatives that directly support sustainable economic development (Maaßen and Urbano 2024; Wang et al. 2022). The academic sphere, in this context, is vital in educating and supporting future sustainable entrepreneurs through structured programs and research initiatives (Siqueira et al. 2023).

On the other hand, while intermediary services are represented by organizations that provide ancillary services to new market

TABLE 8 | Pairwise comparison for subjectively perceived economic value creation indicators by the panel.

Entrepreneur	Best	A1	A2	A3	A4	A5	Worst	A1	A2	A3	A4	A5
Entrepreneur 1	A3	3	3	1	2	2	A1	1	3	3	2	2
Entrepreneur 2	A3	2	2	1	2	2	A1	1	2	2	2	2
Entrepreneur 3	A3	4	3	1	3	3	A1	1	3	4	3	3
Entrepreneur 4	A5	4	3	2	2	1	A1	1	3	2	3	4
Entrepreneur 5	A5	2	2	2	2	1	A3	2	2	1	2	2
Entrepreneur 6	A3	2	2	2	2	1	A1	1	2	2	2	2
Entrepreneur 7	A3	3	2	1	3	2	A1	1	2	3	2	2
Entrepreneur 8	A5	3	2	1	2	2	A1	1	2	3	2	2
Entrepreneur 9	A5	3	2	2	2	1	A1	1	2	2	2	3
Entrepreneur 10	A3	2	2	2	2	1	A3	2	2	1	2	2
Entrepreneur 11	A3	3	2	2	2	1	A1	1	2	2	2	3
Entrepreneur 12	A5	3	2	2	2	1	A1	1	2	2	2	3
Entrepreneur 13	A5	4	3	2	3	1	A1	1	3	2	3	4
Entrepreneur 14	A3	4	2	1	2	2	A1	1	2	4	2	2
Entrepreneur 15	A5	3	2	3	2	1	A1	1	3	2	2	3
Entrepreneur 16	A5	7	4	4	4	1	A1	1	4	4	4	7
Entrepreneur 17	A2	2	1	2	3	2	A4	2	4	2	1	2
Entrepreneur 18	A5	5	3	3	3	1	A1	1	3	3	3	5
Entrepreneur 19	A5	3	3	3	5	1	A4	3	3	3	1	5
Entrepreneur 20	A5	5	3	3	3	1	A1	1	3	3	3	5
Entrepreneur 21	A3	5	3	1	3	3	A1	1	3	4	3	3
Entrepreneur 22	A5	2	2	2	3	1	A4	2	2	2	1	3
Entrepreneur 23	A5	3	2	3	2	1	A1	1	3	2	2	3
Entrepreneur 24	A2	2	1	2	2	2	A3	2	2	1	2	2
Entrepreneur 25	A5	4	3	3	3	1	A1	1	3	3	3	4
Entrepreneur 26	A3	4	3	1	3	3	A1	1	3	5	3	2

Note: A1 = Increased efficiency; A2 = Increased profits and creation of new opportunities; A3 = Increased long-term stability; A4 = Increased reputation and brand value; A5 = Increased economic well-being.

entrants (Spigel 2017), they may not provide the foundational support that robust policies and formal institutions can play in stimulating and supporting KISE. A significant number of entrepreneurs selected this element as the worst criterion compared to other EE elements. According to BWM results, intermediary services were ranked in the last position. Hence, our result is not totally in line with van Rijnsoever (2022) and (Siqueira et al. 2023). For these authors, support organizations and institutions are prominent in helping sustainable entrepreneurs overcome constraints in terms of ecosystem embeddedness. In our KISE case, entrepreneurs may have self-sufficient resources, networks, and knowledge to operate independently without relying on intermediaries (do Prado et al. 2022), or, alternatively, they may not be effectively assisted by such services. This is an interesting finding as it suggests the need for better adequacy in initiatives associated, for instance, with promoting incubators, tech parks, and business accelerators. When dealing with the KISE phenomenon, it appears that such intermediaries fall short in generating real value.

If we consider the final weights obtained for EE elements ranking, entrepreneurial culture and social aspects, followed by market demand, human capital and talent, infrastructure, finance, and access to capital also appear prominent for KISE development, which is corroborated by Vicentin et al. (2024) and Khatami et al. (2022). Interestingly, even with a sample of entrepreneurs considered knowledge-intensive, knowledge creation is the seventh EE most important element. This finding somewhat weakens previous arguments regarding knowledge *creation* being at the core of KISE (Link and Sarala 2019). An explanation might be that, in the KISE event, the emphasis might be more on the application and commercialization of

TABLE 9 | Aggregate weight of subjectively perceived economic value creation indicators by the panel and ξ^L value.

Entrepreneur	A1	A2	A3	A4	A5	ξ^L
Entrepreneur 1	0.081	0.145	0.339	0.218	0.218	0.097
Entrepreneur 2	0.081	0.145	0.339	0.218	0.218	0.097
Entrepreneur 3	0.083	0.167	0.417	0.167	0.167	0.083
Entrepreneur 4	0.071	0.143	0.214	0.214	0.357	0.071
Entrepreneur 5	0.188	0.188	0.125	0.188	0.313	0.063
Entrepreneur 6	0.125	0.188	0.188	0.188	0.313	0.063
Entrepreneur 7	0.098	0.206	0.353	0.137	0.206	0.059
Entrepreneur 8	0.105	0.184	0.342	0.184	0.184	0.026
Entrepreneur 9	0.105	0.184	0.184	0.184	0.342	0.026
Entrepreneur 10	0.188	0.188	0.125	0.188	0.313	0.063
Entrepreneur 11	0.105	0.184	0.184	0.184	0.342	0.026
Entrepreneur 12	0.105	0.184	0.184	0.184	0.342	0.026
Entrepreneur 13	0.077	0.154	0.231	0.154	0.385	0.077
Entrepreneur 14	0.091	0.182	0.364	0.182	0.182	0.000
Entrepreneur 15	0.093	0.209	0.140	0.209	0.349	0.070
Entrepreneur 16	0.059	0.147	0.147	0.147	0.500	0.088
Entrepreneur 17	0.190	0.333	0.190	0.095	0.190	0.048
Entrepreneur 18	0.075	0.164	0.164	0.164	0.433	0.060
Entrepreneur 19	0.164	0.164	0.164	0.075	0.433	0.060
Entrepreneur 20	0.075	0.164	0.164	0.164	0.433	0.060
Entrepreneur 21	0.083	0.167	0.417	0.167	0.167	0.083
Entrepreneur 22	0.184	0.184	0.184	0.105	0.342	0.026
Entrepreneur 23	0.093	0.209	0.140	0.209	0.349	0.070
Entrepreneur 24	0.188	0.313	0.125	0.188	0.188	0.063
Entrepreneur 25	0.083	0.167	0.167	0.167	0.417	0.083
Entrepreneur 26	0.083	0.167	0.417	0.167	0.167	0.083
Mean	0.111	0.186	0.231	0.171	0.302	0.060

existing knowledge rather than creating or prioritizing proven methods and technologies that are more immediately actionable (Bertello et al. 2022). It is worth highlighting that BWM involves a comparative analysis among factors. Further, as per Fischer et al. (2024), each region faces different barriers and distinct drivers in the functioning of their respective ecosystems.

In regard to BWM application in the social value creation pillar, "encouragement of local entrepreneurship and support for local suppliers" followed by "number of job opportunities created" appeared, respectively, as the first and second positions. The most logical interpretation suggests that these are the main outcomes of KISE activities within the EE. In fact, these propositions are aligned with social enterprise missions (Kamaludin et al. 2024). Implementing training and developing programs, contrary, are not at the center of KISE activities. Possibly, their focus may be on creating and developing solutions for the market (Sarasvathy 2001). This assumption can be upheld if we consider the "development of innovative products and processes" as the main environmental value creation outcome provided by these same entrepreneurs. Considering the sustainability emergency for sustainable products and processes, the innovative orientation of the KIE modality takes advantage of this skill to offer new (sustainable) solutions to the consumer market (Ben Hassen 2022).

Finally, "increased economic well-being" was pointed out as the main outcome related to the economic value creation dimension. Economic well-being can manifest in several ways, including job creation, innovation and productivity, increased income levels, wealth generation, enhanced local services, community development, and knowledge spillover, among others (Acs et al. 2017; Isenberg 2010; Stam 2015). Thus, from this result, we can comprehend that economic outcomes are interconnected with the

TABLE 10 | Synthesis from BWM results.

Rank	Ecosystem	Social value	Environmental value	Economic value
1°	Policies and formal institutions	Encouragement of local entrepreneurship, support for local suppliers	Development of innovative products and processes	Increased economic well-being
2°	Entrepreneurial culture and social aspects	Number of job opportunities created	Adoption of reverse logistics practices	Increased long-term stability
3°	Market demand	Diversity of employees	Use of renewable energy	Increased profits and creation of new opportunities
4°	Human capital and talent	Partnerships with social organizations	Reduction, reuse and recycling of waste	Increased reputation and brand value
5°	Infrastructure	Implementation of training and development programs	Reduction of water consumption	Increased efficiency
6°	Finance and access to capital		Assessment and reduction of the environmental impact of suppliers	
7°	Knowledge creation			
8°	Networking and collaboration			
9°	Intermediary services			

critical social and environmental impacts caused by KISE, as outlined in Table 10. Furthermore, these outcomes are mainly influenced by government and institutional support in the form of policies and formal institutions (Kehinde et al. 2022). From this point, EE can be considered the ideal scenario for sustainability value creation, since collaboration among different actors implies inputs and outputs capable of promoting sustainable transitions.

6.1 | Implications and Contributions

This study offers implications and contributions for theory and practice by answering two questions: "What are the key EE elements that promote KISE?" and "What are the critical sustainable development outcomes generated by KISE?". From the theoretical perspective, two main contributions can be outlined. *First*, this study has attempted to identify the factors influencing KISE from the EE perspective. Although literature related to EE and sustainability is gaining the attention of scholars, the question of how ecosystems contribute to sustainability remains in a first stage. Hence, we answer theoretical requests for exploration of KISE and its hybrid missions (Kummitha 2022; Zioło et al. 2023). Similarly, we went deep into understanding KISE impacts (through its outcomes) within the EE they endeavor. In particular, our findings are aligned with the recent literature on mission-oriented innovation policy, which emphasizes the role of public initiatives in addressing grand societal challenges through strategic, outcome-driven innovation efforts Mazzucato (2018). The case of PIPE-FAPESP illustrates how public support can be mobilized to create enabling conditions for KISE by aligning entrepreneurial incentives with broader sustainability goals, such as those outlined in the UN 2030 Agenda.

Second, to the best of our knowledge, this is the first empirical assessment that establishes a hierarchical ranking of various EE elements affecting KISE while also considering how KISE, in turn, contributes to the ecosystem through sustainable value creation. While previous studies have examined factors influencing sustainable entrepreneurial behavior, they often overlook the bidirectional relationship—how ecosystems shape KISE and how KISE impacts the ecosystem. Chandra et al. (2024) conducted a similar study to identify key EE elements affecting business sustainability; however, their research was limited by a smaller sample and focused only on entrepreneurial inputs without addressing how entrepreneurs actively generate sustainable value within the ecosystem. By applying a mixed-methods approach, including a Delphi survey with 26 entrepreneurs and the BWM, we provide a comprehensive understanding of both the enablers of KISE and its broader impact on sustainable development within EE.

Our analyses prioritized efforts that embrace sustainability and offer tangible guidance for policymakers and entrepreneurs. If we consider the macro layer results provided by identifying critical entrepreneurial elements for fostering KISE, the regulatory sphere, represented by formal institutions and responsible for policies, should prioritize progressive legislation and policymaking for incentivizing sustainable endeavors' activities. In particular, our findings suggest that formal policies such as targeted tax incentives for sustainability-oriented innovation,

government grants for clean technologies, and regulatory frameworks that support hybrid or triple-bottom-line business models are especially effective for enabling KISE. Programs like PIPE-FAPESP serve as practical illustrations, demonstrating how mission-driven public funding can legitimize KISE ventures, reduce early-stage risk, and create the institutional stability required for knowledge-intensive entrepreneurship to thrive in developing countries.

Rather than focusing heavily on networking and collaboration, as investing solely in intermediaries, governments should foster an entrepreneurial culture and social aspects to boost social (mainly through encouragement of local entrepreneurship and support for local suppliers), environmental (primarily through the development of innovative products and processes), and economic (by increasing economic well-being) value creation. Policymakers can foster an entrepreneurial culture conducive to sustainability transitions by embedding sustainability values in formal and informal education, supporting public campaigns that highlight successful KISE ventures, and promoting peer-to-peer learning networks. These initiatives help normalize social and environmental entrepreneurship as legitimate and desirable pathways, particularly in regions where short-term profit remains the dominant cultural narrative.

Entrepreneurs, in turn, should recognize the importance of navigating through the regulatory landscape and how they can engage with institutions to leverage available resources. Furthermore, our findings indicate a need to reorient ecosystem support structures to meet the needs of KISE ventures better. These insights are consistent with the MLP offered by Theodoraki and Messeghem (2017), who emphasize the importance of aligning entrepreneurial support organizations with the actual needs of entrepreneurs across different ecosystem layers. Their findings highlight how incubators and accelerators must be strategically positioned within ecosystem governance structures to nurture sustainable entrepreneurship effectively.

These findings also align with recent work by Pierrakis et al. (2024), who show that cleantech incubators can play a critical role in sustainable EEs, provided they are strategically aligned with the fundraising needs, operational strategies, and policy support required by mission-driven ventures. The relatively low relevance attributed to intermediary services suggests that incubators and accelerators may not be effectively tailored to sustainability-driven entrepreneurs. We recommend designing support programs that include green business diagnostics, training on impact measurement, and improved access to climate finance mechanisms. Such interventions can enhance the ability of KISE ventures to scale and generate systemic impact, especially in resource-constrained settings.

Finally, our paper contributes to SDGs indicators achievement by improving the understanding of the phenomenon of sustainable EE in the scenario of a developing country (Fischer, Bayona-Alsina, et al. 2022), added to the creation of sustainability value advent (Lyons and Roundy 2023; Roundy and Randy Evans 2024). Specifically, considering the context of the PIPE FAPESP program, results indicate these projects are primarily aligned with SDG 17, Partnerships for the Goals, by providing evidence that these entrepreneurs cooperate in achieving the broader goals of the 2030 Agenda for Sustainable Development within ecosystems.

7 | Final Remarks

Our research aimed to identify and classify the critical elements within the EE that play a key role in stimulating and supporting the creation and growth of KISE. We also aimed to elucidate the sustainable development outcomes of KISE activities within ecosystems. The empirical results helped to find the elements of the ecosystem that have the most significant impact on KISE and the most important results in terms of value creation in each sustainable development dimension by KISE. Accordingly, our contribution offers a novel perspective on the interplay between EE elements and the KISE phenomenon. By digging into these matters, we identified the main components driving the growth of an entrepreneurial type aligned with sustainability and, at the same time, how the outcomes generated by KISE contribute back to the ecosystem, reinforcing and shaping its dynamics over time. Since policies, formal institutions, entrepreneurial culture, and social aspects emerged as critical drivers for sustainable entrepreneurial engagement, our findings provide relevant insights into the mechanisms underlying sustainable transitions in EE.

Since policies, formal institutions, entrepreneurial culture, and social aspects appeared to be vital to the orientation of individuals to engage in sustainable entrepreneurial endeavors, our assessment brings relevant insights to understand the underlying mechanisms of sustainable transitions in EE. More than that, our research demonstrated that the incentive for local entrepreneurship, the development of innovative products and processes, and the increase in economic well-being are the main impacts caused by Brazilian KISE within the EE they operate. Consequently, we could underscore the contextual dynamics of KISE, a debate significant for developing countries, where the low maturity of EE can hinder the establishment of conditions necessary for sustainable entrepreneurship.

Our results, however, are not free from limitations. Our sample comprises Brazilian entrepreneurs in the State of São Paulo, Brazil. Furthermore, the cross-sectional nature of the data collection method used prohibits the assessment of longitudinal patterns, making it impossible to conduct an in-depth analysis of the evolving dynamics in the relationship between the dimensions examined over time. Therefore, we suggest future research exploring the relationship between EE and KISE using qualitative and longitudinal studies. Qualitative approaches are capable of capturing essential subtleties in developing an EE focused on sustainability. Likewise, studies with larger samples of entrepreneurs, applying symmetric techniques such as structural equation modeling (SEM) and regressions, are welcome to establish comparisons with results obtained here. Regarding MCDM application, another technique could also be used, like the fuzzy Step-Wise Weight Assessment Ratio Analysis (Fuzzy SWARA) in order to obtain the subjective perspectives of entrepreneurs to rank EE elements and KISE outcomes. Longitudinal studies, using secondary data of ecosystems, would also be enriching by helping to understand the phenomena over time. In this sense, we encourage research with fuzzy-set qualitative comparative

analyses (fsQCA) to analyze how different configurations of elements of the EE influence KISE growth and outcomes. This would enable the discovery of the core and contribution conditions for high levels of entrepreneurial sustainability value creation. These are issues of critical relevance considering the key role played by entrepreneurs and EEs in setting up economic structures that function in harmony with social and environmental challenges.

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