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Advancing sustainable entrepreneurial universities: sustainability transformations of university business incubators in Germany

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Abstract Given the profound environmental and societal challenges, many higher education institutions (HEI) have adopted sustainability as a central mission to induce desirable societal impacts. While previous research investigated the transformation processes of HEIs toward sustainability, few studies took an explicit entrepreneurial perspective and questioned its implications for the Entrepreneurial University (EU) model. To address this gap, our study explores the emergence and pursuit of a Sustainable Entrepreneurial University (SEU). We specifically focus on the role of sustainable university business incubators (UBIs) as primary institutions of entrepreneurship within the SEU model. Using a multiple-case study of four German UBIs, we illustrate how they embarked on their sustainability journey, developed internal capacities to support sustainable entrepreneurship, and overcame various barriers during their transformation trajectories. Our analysis identifies six distinct sustainability transformation stages and proposes a stylized model to explain the emergence of sustainability in UBIs. Based on these findings, our study discusses several theoretical implications for the SEU. We illustrate that SEU sustainability impacts evolve over time and that continuous leadership commitment

is a mediating factor. Moreover, our results suggest that SEUs strategically engage in external partnerships with alternating functions. Given the urgency to promote sustainable entrepreneurship in HEIs, the study concludes with several practical recommendations for practitioners and policymakers. Moreover, it offers suggestions for future research to explore the potential of SEUs and their contribution to addressing pressing societal and ecological challenges.

Plain English Summary University startups as catalyzers for sustainable impact– How university business incubators adopt sustainability missions and rethink startup support. In a world challenged by significant environmental and societal issues, many universities increasingly incorporate sustainability into their missions to make a positive impact. Our research takes an entrepreneurial perspective and focuses on the role of university business incubators in this transformation. By examining four German cases, we explore how these incubators adopted sustainability as a central mission, developed internal capacities to support sustainable startups, and addressed various challenges during their transformation. Our study outlines six distinct stages in the sustainability transformation of university business incubators, highlighting critical factors such as the enduring commitment of leadership and the strategic importance of external partnerships. Drawing from our findings, we discuss the implications of realizing the Sustainable

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Entrepreneurial University model, which promotes sustainability through entrepreneurship. Our research serves as a valuable resource for managers and staff looking to promote sustainability within business incubators and provides guidance for policymakers and university leaders working to develop effective startup strategies in response to societal and environmental challenges.

Keywords Technology transfer · Sustainable entrepreneurship · Incubator · University entrepreneurship · Academic entrepreneurship

JEL Classification L26 · L31 · M13 · I23

1 Introduction

Over the past decades, many Higher Education Institutions (HEI) worldwide have embraced the Entrepreneurial University (EU) model to meet the demand for technology transfer and knowledge-based startups in an increasingly knowledge-driven society (Audretsch, 2014). The EU model emphasizes “an entrepreneurial management style, with its members (faculty, students, and staff) acting entrepreneurially and that in turn interact with its outside environment (community/region) in an entrepreneurial manner” (Guerrero et al., 2016a, 2016b, p. 556). Initially focused on entrepreneurial activity on campus, the EU model evolved to stress the HEIs’ role in nurturing the entrepreneurial capital of societies, assuming their active engagement in innovation ecosystems (Guerrero et al., 2016a, 2016b). It transformed the foundations of many HEIs, giving rise to entrepreneurial education, university business incubators, and technology transfer offices. Proponents highlight its potential to create new revenue streams, institutional innovation, engagement in innovation ecosystems, and contributions to the modern economy (Guerrero et al., 2015; Urbano & Guerrero, 2013).

Despite its popularity, the EU model and its comrades, the third mission, technology transfer, and academic entrepreneurship, have faced criticism. Some scholars have questioned whether the EU model can effectively stimulate the desired outcomes. Indeed, empirical evidence suggests mixed effects when comparing EUs with traditional counterparts, implying that entrepreneurial activities in HEIs may

ultimately depend on many contextual factors (Hayter et al., 2018). Other scholars even called the EU inherently unsustainable, given its high costs (Meek & Gianiodis, 2023). Therefore, only a few elite universities may apply it successfully, while most have only modest success (Gianiodis & Meek, 2020). A recent argument questions the EU’s relevance given the pressing global ecological and societal challenges. Scholars criticize that the suggested “societal contribution” present in most EU mission statements “is today widely perceived and promoted as being chiefly an economic contribution” (Trencher et al., 2014, p. 156). Given the urgency of the climate crisis, they suggest HEIs become “change agents within all societies” (Lozano et al., 2013, p. 8) and realize their inherent function as “societal transformers” (Lozano et al., 2013; Trencher et al., 2014, p. 152). Scholars called HEIs to abandon their focus on economic outcomes and expand it to societal impacts (Fini et al. 2018). Bound by the contract between science and society (Gibbons, 1999), scholars even claimed HEIs morally responsible for adopting a mission-driven approach that “takes societal challenges as a compass” (Kivimaa et al., 2017, p. 631). These critiques have led to calls for reevaluating the EU model and its alignment with sustainable development, giving rise to the Sustainable Entrepreneurial University (SEU) (Cai & Ahmad, 2021).

Surprisingly, few studies have explicitly applied an entrepreneurial perspective to HEI sustainability engagements, leaving the SEU concept underexplored and scattered in the literature (Cai & Ahmad, 2021). Only a handful of studies reference the SEU concept, with most relying on ambiguous definitions (e.g., Apostolopoulos et al., 2018). Moreover, many studies that would arguably be in the scope of the SEU, such as research on sustainable entrepreneurial education (e.g., Karahan & Stoeckermann, 2023), do not abstract the findings to the EU level to pave the way for SEU theory development. Particularly, little attention has been given to the role of primary institutions of entrepreneurship within the SEU model, such as university business incubators (UBIs). It remains unexplored how the pursuit of an SEU model affects UBIs and vice-versa, how they transform their business model to create the organizational preconditions for effectively inducing sustainable entrepreneurship, and how they contribute to SEU sustainability impacts. These gaps are at the heart of understanding

the SEU, given that many UBIs flourished during the adoption of the EU model. Even though previous SEU research has described general strategies for UBI sustainability transformations (Tiemann et al., 2018), associated barriers (Kivimaa et al., 2017), and activities of sustainable UBIs (Millette et al., 2020), there is a need to understand better the relationship between these aspects *throughout* the UBIs sustainability transformation trajectory. Indeed, research in related fields, such as HEI sustainability transformations (Verhulst & Lambrechts, 2015) or corporate sustainability transformations (Lozano, 2013), described transformations more profoundly by proposing distinct trajectory stages with specific objectives and barriers. The current UBI literature lacks such analytical depth, merely assuming gradual processes. More research is needed to understand the micro-level factors of influence and transformation processes.

To address these gaps, this study's research design encompasses multiple dimensions. At the analytical level, this study uses a multiple-case study to explore the sustainability transformation processes of four German UBIs, aiming to uncover the trajectory stages of UBI sustainability transformations and develop a stylized model. Given that the UBIs are embedded within the general HEI context, we also shed light on the relationship between the HEI and UBI in sustainability transformations. Finally, we abstract our results at the UBI level to contribute to SEU theory development. Our inductive research approach arguably offers a promising and novel perspective into SEUs, given the inherent interrelation between UBIs and the SEU. Sustainable UBIs facilitate the SEU model by fostering sustainable academic entrepreneurship (SAE), which we define as all activities of organizations that enable the recognition, development, and exploitation of opportunities for commercializing scientific knowledge to bring into existence future goods and services with economic, social, and ecological gains (Belz & Binder, 2017). On the one hand, they perform SAE in a narrow sense by enabling the development of immediate responses to societal challenges (Fini et al., 2018; Karahan et al., 2022). For instance, sustainable UBIs enable students to engage in eco-innovation projects or promote spin-outs that address the United Nation's Sustainable Development Goals (SDGs). On the other hand, they also apply SAE in a *wide* sense. Sustainable UBIs

transform internal organizational processes and culture at various levels of HEIs to incubate mission-driven activities, e.g., organizing idea competitions for greening the campus or engaging NGOs as new partners (Urbano & Guerrero, 2013). To cite Almansour (2022, p. 4), "Business incubation embodies the very spirit of SDGs, and alignment with SDGs can enhance the vibrance of the entrepreneurial ecosystem in universities." Thus, analyzing how sustainability missions emerge in UBIs' and how they pursue SAE means a promising opportunity for developing SEU theory and fostering knowledge on SEU transformations (Klofsten et al., 2019).

Hence, this study contributes to three literature streams. First, we add to the literature on sustainable UBIs by delineating sustainability transformation trajectories and developing a stylized model of such processes. Additionally, our study contributes to the general UBI literature by providing insights into organizational change processes, a gap recently stressed by Bergman and McMullen (2022). Finally, our results also advance SEU literature by formulating new theoretical propositions that enhance our understanding of the phenomenon. Furthermore, this study is also valuable for practitioners. By outlining transformation activities, drivers, and barriers throughout the trajectories, we provide a roadmap for the development of management strategies and enable navigating UBI sustainability transformations effectively. Moreover, we offer a set of recommendations for various SEU stakeholders, including policymakers, HEI managers, and employees. Finally, we conclude policy implications for establishing SEUs.

2 Theoretical background

Following our research design (see Table 1), three strands of literature are relevant to this study. First, the literature on sustainable business incubation provides insights into the overall phenomenon of UBI support for sustainable entrepreneurship. Second, given the lack of research on UBI sustainability transformation, the literature on HEI sustainability transformations sheds light on how such processes unfold at the UBI level, given the contextual similarities. Finally, the SEU literature is relevant for discussing our findings and theory development.

Table 1 Research design

Dimension	Level	Research objective	Examples of relevant literature
Analytical layer	Sustainable university business incubators	Understand the stages of UBI sustainability transformation trajectories	(Fichter & Hurrelmann, 2021; Fichter & Tiemann, 2018; Kivimaa et al., 2017; Surana et al., 2020)
Research context	Sustainability transformations of HEIs	Understand how UBIs' sustainability transformations are affected by and trigger similar processes at the HEI level	(Ávila et al., 2017a, 2017b; Hoover & Harder, 2015; Lozano et al., 2013; Sammalisto et al., 2015; Verhulst & Lambrechts, 2015)
Research goal	Sustainable entrepreneurial university	Understand the evolution of SEUs within their organizational units and identify novel properties of the SEU model	(Cai & Ahmad, 2021; Fichter & Tiemann, 2018; Fini et al., 2018; Klofsten et al., 2019; Wagner et al., 2019; Wakkee et al., 2019)

2.1 Sustainability transformations of HEIs

Throughout history, HEIs demonstrated an inherent capability to adjust their missions to societal needs with continuously evolving roles (Stephens & Graham, 2010). Moving from the missions of research, education, and technology transfer, researchers argued that fostering sustainable development may indicate a novel HEI evolution of becoming a “transformative university” (Trencher et al., 2014, p. 169). Building on Newman (2007), we define sustainability transformations as the processes of realigning organizational goals, governance mechanisms, culture, and practices to meet demands and address impacts locally and globally while operating within social and ecological limitations.

Previous research showed that HEI sustainability transformations are inherently complex and context-dependent (Cai & Ahmad, 2021; Hayter & Cahoy, 2018). HEIs are “both affected by and affect the institutional environment in its efforts to meet regional economic and societal needs in a sustainable way” (Wakkee et al., 2019, p. 196). Therefore, no two HEI transformation processes will be identical, as empirical evidence suggests. For instance, Ferrer-Balas et al., (2008, p. 309) investigated the sustainability transformations in seven HEIs in Japan, Spain, India, the USA, and Sweden without finding a dominant configuration pattern between transformation actors, frameworks (niche vs. mainstream) and levels (incremental vs. renewal). Fichter and Tiemann (2018) found similar evidence. The authors compared the emergence of sustainability support in two US universities with two German universities and found that external cooperation and networks

were more pronounced in the USA, while public funding appeared more important in Germany. However, while the individual transformation trajectories of each HEI are subjected to case and context-specific characteristics, some findings were repeatedly reported within the literature, indicating that HEI sustainability transformation processes may still be governed by overarching patterns, which we outline in the following. Ultimately, an inquiry into HEI sustainability transformations may thus focus on understanding the interconnection between influencing factors, context, and transformation activities.

2.1.1 Enablers of HEI sustainability transformations

Since universities are part of complex innovation systems, scholars identified various drivers and enablers of HEI sustainability transformations. Table 2 summarizes internal and external enablers of sustainability transformations from three empirical studies.

While *external* stakeholders can affect HEI sustainability transformations in many regards, previous research emphasizes three central mechanisms. First, most studies highlighted the provision of funding for sustainability-related activities, e.g., novel sustainability teaching offerings or green-tech research collaborations, as an enabler for sustainability transformations (Wagner et al., 2019). Such funding opportunities offer HEIs the resources to engage with sustainability in niche projects, often a starting point for more general sustainability transformations (Verhulst & Lambrechts, 2015). A second external trigger commonly mentioned by previous research is sustainability-related policy changes, e.g., enforcing sustainability criteria in HEI audits. Such interventions

Table 2 Selected enablers and barriers of HEI sustainability transformations

	Enablers	Barriers
Internal (individual and project level)	Key individuals, as promoters, initiators, and networkers for sustainability Individual-level skills and competencies Intermediaries and networks Sustainability-related education offering	Insufficient managerial and leadership skills Lack of awareness, motivation, and commitment to sustainability and organizational change, sustainability fatigue Lack of knowledge, training, and education about sustainability High work pressure and lack of time
Internal (organizational level)	University sustainability strategy, including targets, visions, priorities Organizational units dedicated to sustainability, such as faculties, centers for sustainable entrepreneurship, or innovation centers Institutional structure promoting cooperation and collaboration A dedicated unit that governs sustainability transformations Organizational competencies and culture Leadership commitment	Conservative culture and resistance to change Lack of funding, infrastructure, and human resources Decentralism leading to cultural plurality and disconnect between HEI units, lack of cooperation, coordination, and communication Established incentive mechanisms merely emphasizing academic output Bureaucracy Lack of recognition, commitment, and support by HEI leadership
External (ecosystem level)	Media attention for sustainability Student interest and demand Government programs and regulation Collaboration and partnerships with externals Public and private sector funding, demand for talent with sustainability capabilities	Lack of ecosystem ties and collaboration, i.e., public–private partnerships Disfavoring, inconsistent, or insufficient legislation, and policies for sustainable development and innovation and transfer in general Market entry barriers for sustainable start-ups Lack of guidelines, standards, and conceptual clarity for sustainability in HEI, absent performance indicators Lack of demand and interest in sustainability offerings
Selected literature	Menon and Suresh (2021), Fichter and Tiemann (2018), Ferrer-Balas et al. (2008)	Ávila et al., (2017a, 2017b), Fichter and Tiemann (2018), Verhulst and Lambrechts (2015)

The systematization does not necessarily represent the authors' original segmentation

inevitably result in adopting and internalizing sustainability within HEI governance systems to ensure compliance (Menon & Suresh, 2021). Third, some studies highlighted society's general awareness of sustainability as another enabler. This factor increases student demand for new sustainability teaching offers or corporate interest in sustainability-related university-industry collaborations (Fichter & Tiemann, 2018). In turn, a “vital” *internal* enabler of HEI sustainability transformations refers to individual-level activity by change agents or sustainability champions Fichter and Tiemann (2018, p. 518). Key individuals may not only relate to the persons who engage in sustainability activities of HEIs but also consider those who provide (managerial) support and permission within the HEI hierarchy (Surana et al., 2020). A second internal enabler identified by previous research relates to the HEI institutional environment,

specifically HEI governance systems and strategy. In this regard, Fichter and Tiemann (2018) stressed the role of appropriate incentive structure, culture, and sustainability vision to induce sustainability transformations.

Whether internal, external, or a combination of both factors are most influential in triggering HEI sustainability transformations is still contested. For instance, Fichter and Tiemann (2018, p. 520) concluded that internal drivers might be “more influential than external drivers.” Also, Wakkee et al. (2019) argued that in the context of the EU, human capital and knowledge embedded in HEI employees is likely the only resource available given the lack of dedicated funding in HEIs. In contrast, Menon and Suresh (2021) identified three external enablers as the most influential. More research is required to provide a final answer. On a case-by-case level, the enablers

may ultimately vary due to the contextual nature of HEI sustainability transformations.

2.1.2 Trajectories, activities, and barriers of HEI sustainability transformations

Considering that various enablers can initiate sustainability transformations, it is unsurprising that previous research has identified a range of transformation activities, as illustrated in Table 3, and associated barriers, as displayed in Table 2. What transformation trajectory an HEI might follow is highly contingent on the enabling factor that triggered the sustainability transformation, as illustrated by Wagner et al. (2019). Based on a multiple-case study of three different HEI sustainability projects, i.e., a master's degree, a UBI, and a course on sustainable entrepreneurship, the authors argued that different sustainability projects might induce distinct sustainability transformation trajectories. Previous research distinguished three generic transformation trajectories encompassing bottom-up, top-down, and mixed approaches. A bottom-up trajectory is illustrated by Verhulst and Lambrechts (2015), which investigated the sustainability transformation of a Belgian university. The authors distinguished four stages: (1) bottom-up projects of engaged individuals, (2) connecting those projects, (3) developing a sustainable development strategy at the top management level, and (4) implementing the strategy. The study found that bottom-up and top-down transformation stages ultimately merge as the HEI's transformation progresses. Moreover, the authors identified various stage-dependent barriers, such as "sustainability fatigue," lack of resources, demotivation, and lack of support (Verhulst & Lambrechts, 2015, p. 202). Also, Sammalisto et al. (2015) described a mere bottom-up transformation trajectory. The authors argued that the institutionalization of sustainability depended on the faculty's and staff's sustainability competence and understanding. Based on a Swedish case study, they suggested a sustainability competence model with four stages, including knowledge, inspiration, practice, and intelligence.

In contrast, Velazquez et al. (2006) suggested a change management model that is top-down driven. It comprises a four-phase process that departs from vision development to its execution across the main HEI activity domains. Wakkee et al. (2019), among the few articles referencing the SEU, also described

Table 3 Relevant literature on HEI sustainability transformation trajectories

Study	Verhulst and Lambrechts (2015)	Wakkee et al. (2019)	Velazquez et al. (2006)
Scope	Sustainability transformations of HEIs	Sustainable entrepreneurial university	Sustainability transformations of HEIs
Transformation stages	<p>Stage 1: Engaged individuals engage in autonomous bottom-up sustainability projects, e.g., courses</p> <p>Stage 2: Communication across the independent projects to share insights and eventually approach sustainability holistically</p> <p>Stage 3: Developing a shared sustainable vision and sustainability strategy at the top management level</p> <p>Stage 4: Implementing the strategy across campus with continuous enforcement by top leadership</p>	<p>Stage 1: Developing a sustainability vision for the university</p> <p>Stage 2: Engaging in sustainability initiatives inside and outside the campus, i.e., education and outreach</p> <p>Stage 3: Creating institutions to support sustainable entrepreneurship</p> <p>Stage 4: Scaling sustainability initiatives to local communities and policymakers</p>	<p>Stage 1: Developing a sustainability vision for the university</p> <p>Stage 2: Formulate a mission statement, defining the who, what, and why</p> <p>Stage 3: Enact a sustainability committee to create policies, targets, and objectives at various HEI levels</p> <p>Stage 4: Execute sustainability strategies inside and outside the campus across all HEI activity domains—education, research, outreach and partnership, and campus sustainability</p>

a top management-driven transformation trajectory. Based on the case of an Indian HEI, the authors shed light on both internal HEI transformation processes and external impacts on local communities. Their study emphasized the role of the campus director, who perceived local environmental issues as necessary to engage the HEI in solution-solving. By adopting a sustainability mission, he mobilized faculty and students, who developed new sustainable entrepreneurship lectures and outreach activities, such as sustainability workshops, business competitions, and social volunteering projects. The HEIs SAE activities effectively induced sustainable transformations in local communities, such as an increased awareness of sustainability and waste management practices. Also, Fissi et al. (2021) illustrated a top-down-driven sustainability transformation. The authors described how the HEI management of an Italian University developed a strategic plan, established a “Green Office” that coordinated all sustainability initiatives across campus, and engaged in various activities to spur the sustainability of HEIs. Finally, Tiemann et al. (2018) proposed a combined transformation trajectory in which sustainability is simultaneously enacted at the HEI from the top-down and bottom-up. Based on the cases of two US and two German HEIs, the authors found that HEIs perceive sustainability and entrepreneurship either as integrated missions and engage in activities that address both topics, such as sustainability awards for student business plans competitions, or pursue them as additive priorities, e.g., offering entrepreneurship classes to sustainability students.

Even though bottom-up, top-down, or combined trajectories appear essentially different at first glance, some activities and barriers were found across the transformation trajectory types (Baker-Shelley et al., 2017). The sustainability transition management literature offers a helpful categorization to illustrate the similarities (Loorbach & Wijsman, 2013). All transformation trajectories involve *strategic* activities, such as formulating a shared vision, developing sustainability strategies, and facilitating knowledge exchange between sustainability projects (Verhulst & Lambrechts, 2015). Strategic activities aim at coordinating and scaling sustainability transformation. Particularly, communication was a critical factor throughout the transformation processes, such as transformation narratives, that link perceived realities with envisaged future states (Wakkee et al., 2019).

Moreover, they entail continuously enforcing sustainable development as a new organizational mission (Sammalisto et al., 2015). Strategic activities are critical to the success of sustainability transformations but face severe barriers that discontinue the processes. Across the studies, scholars criticize the unfavorable governance and policies, bureaucracy, and lack of resources (Adams et al., 2018; Ávila et al., 2019). The most commonly referred barrier involves the lack of leadership support. For instance, Ávila et al., (2017a, 2017b) stressed that HEI leaders often lack a clear vision, making bottom-up initiatives the main drivers of a sustainability transformation. However, without leadership support, they were deemed “destined to fail in the long term” (Ávila et al., 2017a, 2017b, p. 1270). Also, Fichter and Tiemann (2018, p. 521) expressed that “without a person in faculty, staff or university management who takes on the role of power promoter, expert promoter or process promoter or champion, the chances of successfully establishing support systems are small.” However, as Kivimaa et al., (2017, p. 639) noted, leadership support for sustainability is not “self-evident despite the interest of the unit head.” Moreover, sustainability transformation trajectories entail *tactical* activities. On the one hand, these involve creating partnerships with stakeholders outside the HEI. Such externally targeted tactical activities aim at expanding the HEIs resource base, e.g., engaging in partnerships with sustainability experts that provide consulting (Tiemann et al., 2018) or outreach activities to foster knowledge transfer and impact within local communities (Wakkee et al., 2019). On the other hand, internal tactical activities imply building alliances within the HEI to engage others throughout the transformation (Lozano et al., 2013) and develop the transdisciplinary environment needed for holistic transformations and sustainability solutions (Yarime et al., 2012). A common barrier described in the literature is the political nature of transformation. Hoover and Harder (2015) identified various tensions during HEI sustainability transformations, such as the contradiction between collaboration and competition across sustainability projects or individualistic and collectivistic aspects.

At the center of the sustainability transformations are *operational* activities, which include all activities for executing the transformation and realizing sustainable impacts. Many scholars described the various engagements of HEIs for sustainability, such as

delivering sustainable lectures (Verhulst & Lambrechts, 2015), engaging in participatory sustainability projects (Yarime et al., 2012), or opening sustainability centers (Soini et al., 2018), of which a complete account is beyond the scope of this study. They frequently rely on the three HEI missions of research, teaching or education, and outreach, engagement, or transfer for clustering HEI sustainability activities (e.g., Tiemann et al., 2018). For instance, Fissi et al. (2021) illustrated the sustainability engagements of an Italian University along its campus operations, such as wastewater management, teaching activities, such as introducing an environmental engineering curriculum, research practices, such as engaging in sustainability research projects, and community engagement, such as public lectures. Moreover, the authors distinguished two kinds of activities: “On the one hand, reducing the negative impacts of [HEI] activities on the economy, society, and environment; on the other hand, implementing and fostering sustainable practices in curricula and research programs.” (Fissi et al., 2021, p. 1) A HEI’s activities are ultimately specific to the context (Tiemann et al., 2018; Wagner et al., 2019). Concerning operational activities during sustainability transformations, only a few studies exist. Table 3 and the reviewed literature on transformation trajectories provide examples of such activities. In this regard, Kivimaa et al. (2017) provided a helpful distinction by separating people-based and process-based approaches. The latter encompasses activities that address integrating sustainability into operational routines, such as using life-cycle analyses in projects, introducing an environmental management system, or including sustainability questions in project proposals. In contrast, people-based approaches target enhancing the organizational capacities for sustainability, such as including sustainability experts in the teams or collaborating with sustainability research centers outside the campus.

Finally, *reflexive* activities focus on evaluating the sustainability transformation’s progression and effectiveness in inducing the desired sustainability outcomes (Wakkee et al., 2019). Given the complexity of sustainability and the decentralized nature of HEIs, it is difficult to specify general indicators for a comprehensive assessment of HEIs. Depending on the context, scope, and assessment goals, previous research proposed specific HEI sustainability assessment tools (for an overview, see Alba-Hidalgo et al.

(2018)). For instance, Berzosa et al. (2017) reviewed four sustainability assessment frameworks for HEIs. The authors showed that all of them apply slightly different assessment indicators along four general areas of social (e.g., working conditions and commitment to the community), curricular (e.g., syllabus and scholarships), environmental (waste, water, energy), and economic (funding and investment). Many scholars stressed that sustainability assessment or evaluation in HEIs requires participatory approaches to connect sustainability commitment and implementation plans (Lozano et al., 2015). However, few studies have investigated reflexive activities in the context of sustainability transformation. There is some evidence that reflexive activities are particularly relevant in the early stage of top-down initiated sustainability transformation trajectories. For instance, Verhulst and Lambrechts (2015, p. 195) described how assessments of sustainability integration in education programs triggered sustainability transformations, essentially being an “eye-opener for policy and staff.” Also, Wakkee et al. (2019) reported a holistic problem assessment as the starting point for identifying relevant operational transformation activities. However, previous research also indicated reflexive activities as central throughout sustainability transformations. Again, Verhulst and Lambrechts (2015) described how local leaders and individuals exchanged experiences and learnings made in niche-driven sustainability projects to induce a more strategic integration of sustainability.

The reviewed literature primarily focuses on sustainability transformations at the HEI level. However, there is a significant gap in research regarding UBI sustainability transformations. It remains unclear whether the findings from HEIs can be directly applied to the UBI context and what unique characteristics may be involved in the UBI sustainability transformation process.

2.2 The emerging SEU concept

Applying a deliberate entrepreneurial perspective to HEI sustainability engagements is a relatively recent line of research. Cai and Ahmad (2021) conducted a systematic literature review on transformations in universities’ societal engagement in Europe to explore the SEU conceptually. The authors identified 61 articles, of which most were published after 2017.

However, their methodology excluded important SEU keywords, such as teaching, research activities, and ecological aspects of sustainability. It is thus reasonable to assume that the literature on SEUs is greater than assumed within their study. In the absence of a consistent, systematic review of the SEU literature, Table 4 provides an unsystematic selection of previously published studies that can be associated with the SEU, even though some authors do not explicitly use the term. Most of them investigated sustainability as a new empirical phenomenon within existing lines of EU research, such as sustainability competencies among entrepreneurship students (Ploum et al., 2018), sustainable entrepreneurship in teaching (Karahan & Stoeckermann, 2023), or university-industry cooperations to foster sustainability (Nave & Franco, 2019). Nevertheless, a few conceptual studies described the SEU as a more general phenomenon. In the following, we focus our review on studies that model the SEU conceptually and empirical findings on sustainable UBIs.

Most conceptual SEU studies employed a relatively broad understanding of the SEU. For instance, Cai and Ahmad (2021, p. 21) defined the SEU as “an ideal-type university in innovation ecosystems; it has evolved from an entrepreneurial university that has integrated its economic, social, and environmental responsibilities for SDGs into its three intertwined missions, namely teaching, research, and societal engagement.” A similar definition was proposed by Apostolopoulos et al., (2018, p. 362), which defined it as an organization that “embeds the SDGs in all its activities and assumes the role of a key player in shaping the economy, society and environment at

both local and international levels.” When comparing the SEU models proposed within these studies, it is unsurprising that they show high similarity in suggested activities, stakeholders, and contextual factors. Concerning SEU activities, there is a consensus that it encompasses all three missions of universities. For instance, the conceptual framework developed by Tiemann et al. (2018) models support new (sustainable) firm creation as an interconnection between research, education, and transfer activities with an aligned HEI institutional framing (strategies, structures, and culture). The authors described several SEU activities within their case study on four HEIs, such as a fellowship program with social enterprises, a grant program for research in social entrepreneurship, and student “eco-preneurship” projects. Concerning SEU stakeholders, scholars agree that the new societal engagement role involves a wide range of actors; for an overview, see Cai and Ahmad (2021). They distinguished various internal actors, such as HEI management, governments, alumni, or entrepreneurship centers, and externals, such as governments, venture capitalists, and NGOs. Moreover, previous research suggested sustainability as a critical institutional pillar with new governance mechanisms, reporting approaches, and culture.

The framework proposed by Wagner et al. (2019) provided a more nuanced understanding among the few conceptual SEU studies. Based on a theory of change approach, the authors illustrated how various SEU activities are dynamically connected concerning the required inputs and resulting outputs, outcomes, and impacts. For instance, the authors described different sustainability impacts, such as accelerating the

Table 4 Overview of selected studies on the SEU

Topic	Sub dimension	Relevant literature
SEU concept	Definitions, stakeholders, conceptual models, outcomes	Apostolopoulos et al. (2018); Cai and Ahmad (2021); Fichter and Tiemann (2018); Fini et al. (2018); Giovanelli et al. (2021); Wagner et al. (2019)
SEU activities	Sustainable entrepreneurship education	Cincera et al. (2018); Karahan and Stoeckermann (2023); Kuckertz and Wagner (2010); Lans et al. (2014); Lopes et al. (2023); Ploum et al. (2018); Sher et al. (2020); Wyness et al. (2015)
	Sustainable UBIs, spin-offs	Almansour (2022); Fernández-López et al. (2022); Fichter and Hurrelmann (2021); Karahan et al. (2022); Kivimaa et al. (2017); Lamine et al. (2018); Millette et al. (2020); Surana et al. (2020)
	Ecosystem partnerships	Nave and Franco (2019); Theodoraki et al. (2018)
SEU transformation		Kivimaa et al. (2017); Tiemann et al. (2018); Wakkee et al. (2019)

energy transformation, enhancing the capacity for sustainable entrepreneurship, or contributing to the profile of a region. Thus, their study suggested that SEU activities differ in configuration and functioning, which challenges using generic SDGs as an overarching goal of the SEU.

2.3 Sustainable startup support in UBIs

The emerging SEU literature emphasized the role of UBIs in facilitating sustainable impacts of HEIs (Lamine et al., 2018). As a result, previous academic research primarily concentrated on examining how UBIs stimulate and support sustainable startups and assessing the outcomes generated. In this regard, UBIs were found to be generally interested in sustainable entrepreneurship (Klofsten et al., 2016), with some frontrunner organizations already supporting sustainable startups. The UBI literature provided some empirical evidence for such SAE support activities. For instance, Cheah and Ho (2019) illustrated how a Singaporean UBI supported two social startups, e.g., by providing intermediation and mentoring. Also, Millette et al. (2020) elaborated on the activities and stakeholders of sustainable UBIs. The authors developed a circular economy business incubator framework that adds new tasks to the conventional model, such as providing sustainability knowledge, and argued that such organizations entail inherently more diverse partnerships. Hence, sustainable UBI models show increased brokering or intermediating functions (Lamperti et al., 2023). In turn, Theodoraki et al. (2018) investigated the intersection between UBIs and stakeholders of the entrepreneurial ecosystems. Based on social capital theory, the authors found that UBIs offer three support dimensions for ecosystem sustainability: cognitive, e.g., developing shared values; structural, e.g., creating dense relationships with other ecosystem stakeholders; and relational, e.g., developing trust in collaborations.

While these findings highlight some best-in-class examples, other scholars found that actual SAE support among UBIs was “negligible” (Kivimaa et al., 2017, p. 641) and “less than impressive” (Klofsten et al., 2016, p. 44). Kivimaa et al. (2017) investigated the role of UBIs in fostering SAE. Based on the case of a Finnish university, the authors found that the UBI neglected to engage in SAE activities despite an existing HEI sustainability mission

and reporting standards. Interestingly, the authors observed that some sustainability-driven startups still emerged within the UBI’s conventional startup support structures. Also, Almansour (2022) found conflicting evidence on the overall effectiveness of UBIs in supporting SAE. The authors investigated how British entrepreneurs perceived the UBIs’ support for sustainable entrepreneurship based on an analysis of 38 open-ended essays. They found heterogeneity among the data; approximately half of the entrepreneurs praised the opportunities to “think outside the box,” being more aware of sustainability, while the other respondents criticized the lack of sustainability focus (Almansour, 2022, p. 7). Particularly, offering knowledge and intense support appeared challenging to UBIs, such as understanding specific sustainability problems or shaping holistic problem exploration.

The heterogeneity among empirical studies reflects that supporting SAE in UBIs is still an emerging phenomenon. There is consensus that UBIs must effectively adapt offerings to support sustainable entrepreneurship (Cheah & Ho, 2019). To cite Surana et al., (2020, p. 41), which explored the role of incubators as a policy tool for supporting developing countries, business incubators are “effective when their activities go well beyond what has been commonly defined in traditional incubator literature.” Given that sustainable startups have distinct properties (Fichter & Olteanu, 2022), conventional startup support might not yield the same effectiveness in the sustainable entrepreneurship context. Whether the SAE support activities lead to the desired impacts was investigated by Karahan et al. (2022). Based on 299 German university spin-offs, the authors showed that the supported ventures’ economic, social, and ecological impacts are related to different UBI support services. Also, Kher et al. (2023) investigated the link between Social Impact Accelerators and for-profit social ventures. The authors showed accelerated ventures, higher external financing, more revenues, and full-time employees than their unaccelerated counterparts. Their results, however, are contingent on the gender composition of the founding team, the operating location, and/or the age when joining the accelerator.

These findings illustrate that UBI can (under certain conditions) contribute to sustainable development, thus making it a promising policy intervention. As previous research shed light on the *why* and the *what* of SAE support, the concluding question turns

to *how* to bring about sustainability-centered UBIs, which has so far been neglected by previous research. Informed by the literature on sustainability at the HEI level, the SEU, and empirical insights into SAE support in UBIs, this study aims to investigate UBI sustainability transformation trajectories. Understanding these processes is of theoretical and practical significance, considering the substantial number of global entrepreneurial support organizations still utilizing conventional business incubation models but will eventually engage with sustainability and SAE in their future operations (Fini et al., 2018; Klofsten et al., 2016).

3 Methods

3.1 General research strategy

Given the absence of existing theory to explain the emergence and integration of SAE in UBIs and our objective to understand the dynamics of complex organizational transformations, we adopted a qualitative research approach (Eisenhardt, 1989). The case study approach is particularly suited because it “recognizes relationships among constructs within and across cases and their underlying logical arguments” (Eisenhardt & Graebner, 2007, p. 25). Hence, we designed a multiple-case study following literal and theoretical replication logics, whereby a set of cases is treated as a series of experiments to explore the links between a set of observations across cases (Yin, 2017). Our primary units of analysis were the UBIs’ sustainability transformations. We chose the German context due to our knowledge of the market, existing network, data access, and the country’s history in fostering sustainability within HEIs.

3.2 Sampling

Our sampling approach followed a strict selection process as we included only those cases that sufficiently matched our research focus and our objective to develop SEU theory (Eisenhardt & Graebner, 2007). First, we identified potential cases based on four data sources: desktop research, consultations with practitioners, such as advisors of the Social Entrepreneurship Network Germany, the research team’s network contacts, and public reports about the German academic entrepreneurship landscape. We then listed the case candidates and rated them based on seven selection criteria. Inspired by Fonseca and Chiappetta Jabbour (2012), these comprised (1) expression of a sustainability-driven mission in public communications, (2) evidence for existing sustainability-driven SSS, (3) track record of spin-out startups with a sustainable impacts, (4) sustainability as a selection criterion, (5) relevant partnerships with sustainability-driven organizations (such as sustainability-driven NGOs and VCs), (6) clear affiliation to a research organization, and (7) evidence for at least three years of SAE activity. Furthermore, we decided to focus on UBIs specialized in technology-driven innovation to control for contextual factors across the cases. Third, the (few) cases that met our requirements were validated by practitioners and experts of the German EU system. Table 5 describes the four cases investigated by this study.

Cases A and B were the primary focus of our investigation and were studied more intensely. Both cases are considered frontrunner UBIs in fostering SAE, thus making them “unique” cases (Yin, 2017). Furthermore, the research team had profound access to facilitate the in-depth research (“revelatory;” Yin, 2017). Following a theoretical sampling logic, we included cases C and D to validate our findings and

Table 5 Case overview

	Case A	Case B	Case C	Case D
UBI type	Incubator	Accelerator	Accelerator	Incubator and accelerator
Affiliation	Technical University	Research Organization	Technical University	Formerly attached to several universities
UBI employees	15	30	10	12
Startups supported	+ 170	+ 500	+ 130	+ 500
Founding mission	Technology Transfer	Technology Transfer	Technology Transfer	Sustainable Entrepreneurship

The displayed data is based on 2021 reporting

elaborate on the later stages of the UBIs' sustainability transformations (see further elaborations below) (Eisenhardt & Graebner, 2007).

We recognize that our sampling was not without challenges. For instance, we included both incubators and accelerators despite prior research indicating that they tend to operate somewhat different business model designs, e.g., variances in their program length or support offering (Galbraith et al., 2021; Pauwels et al., 2016). Nevertheless, we argue that such program-related differences are negligible and that both organizational types are relevant as our study focuses on organizational transformation processes. However, we also examined the selected cases for variation but found no significant differences among their organizational properties, position within the HEI, and startup support offerings. Another challenge concerned case B, which is affiliated with a public research organization instead of a university. We argue that case B still matches our research focus as UBIs in both contexts show strong convergence. Their central mission is to enable technology transfer by fostering academic entrepreneurship. Moreover, UBIs in both contexts target scientists, and their support activities involve similar offerings. The only difference comprises a minor emphasis on student entrepreneurship in UBIs of research organizations, which is negligible as it only affects a fraction of the overall UBI activities.

3.3 Data collection

Given that sustainability transformations are complex processes, we followed the suggestions of Yin (2017). Our data collection strategy segregated different methodologies into a systematic approach and included various data types central to the subsequent triangulation and data analysis. We collected the data between January and August 2021. Our process started with preparatory meetings in which we presented each case UBI with our research objectives and discussed relevant data sources. This step was critical as it enabled us to identify "key informants" who participated in the organization's sustainability transformation and granted us access to various internal data sources (Yin, 2017, p. 90). Moreover, the preparatory meetings helped us to target various UBI teams and stakeholders across hierarchical levels (Eisenhardt & Graebner, 2007). In fact, we could identify two interviewees

who were former members of the UBIs and had played a leading role during the transformation. Our approach ensured the collection of relevant data and thus enabled a holistic understanding of the UBIs sustainability transformations.

We then prepared and conducted 19 semi-structured interviews, which were all held in German. Given the exploratory nature of our investigation, we followed the suggestions in Yin (2017) of prioritizing general, open-ended questions to ensure the interviewees could share their unbiased perspectives. Our literature review inspired our interview protocol and brought up various aspects corresponding to sustainability transformations of HEIs, the SEU, and UBIs while maintaining openness to emerging topics. Our questions focused on identifying critical events, triggers, and organizational activities of the sustainability transformation (for a sample interview protocol, see Table 11 in the Appendix). In this regard, Loorbach and Wijsman (2013) proved valuable in providing us with an overall structure for transformation activities. Appendix A shows an exemplary interview protocol; however, given that our interviews varied in length (between 30 min to 2 h) and the interviewees' positions in the UBI hierarchy, we refined the protocol for each interview. Moreover, we scheduled the interviews across the cases sequentially over several weeks (e.g., Wakkee et al., 2019). This approach allowed us to sketch the UBIs' respective sustainability transformations during the data collection and deepen our inquiry by adding more specific questions to the interview protocol (Eisenhardt, 1989), such as asking about events mentioned in previous interviews. We conducted three additional interviews before concluding the data analysis to test and validate our findings. All 19 interviews were recorded and transcribed for data analysis.

Another essential data source comprised internal documents, press releases, and relevant websites, such as the social media channels of the UBIs and employees. Besides providing additional insights, they enabled us to corroborate the interview data and increase the analysis' validity (Yin, 2017). Furthermore, we relied on observational data, such as internal meetings and site visits, which granted more profound insights into the UBIs' respective contexts. Table 6 presents an overview of the underlying data for this study.

Table 6 Overview of data sources

Case	Interviews			Archival documents		Observations	
	Staff	Leadership	Total	No	Examples	No	Examples
A	6	2	8	+30	Mission Statement, Incubation Program, Sustainability concept, Press releases	5	Site visits, internal presentations, workshops
B	5	2	7	+25	Mission Statement, Social Media Channels, Incubation Program	1	Site visits
C	1	1	2	5	Incubation Program, Workshop Schedule, Website	0	-
D	1	1	2	5	Incubation Handbook, Application Evaluation Strategy, Website	1	Workshops

3.4 Data analysis

Before our investigation, we assumed similar transformation trajectories across the cases before collecting the data. Hence, our initial analytical strategy followed a pattern-matching approach and a literal replication logic to predict and reproduce similar results across the cases investigated (Yin, 2017). However, during the first interviews, we observed variations in the data. Some UBIs appeared more advanced in aligning their organizations with SAE. For instance, case B provided dense data on the early sustainability transformation stages, but the advanced developments of cases A, C, and D were just emerging in the UBI. Moreover, we noticed that the transformation trajectories across cases showed both similarities and differences, which could be ascribed to case properties (Table 5) and influencing factors (see Table 7). For instance, the transformation activities of case D showed high convergence with the advanced developments of cases A and C after they had established sustainability as an organizational goal. However, the other transformation stages seemed not applicable because case D was founded with an SAE mission. Moreover, we realized that the change agents' position in the UBI hierarchy profoundly affected transformation, leading to a leadership-induced transformation in case A and a bottom-up-induced trajectory in case B. Given these factors, we concluded that a theoretical sampling strategy and related analytical methods were more applicable to theory development (Yin, 2017). Such approaches attribute case selection and analysis to *theoretical* reasons such as replication, extension of theory, contrary replication, and elimination

of alternative explanations (Eisenhardt & Graebner, 2007; Yin, 2017). Thus, instead of aiming to describe one general sustainability transformation trajectory by replicating similar findings across the cases studied (literal replication), we refocused our inquiry to investigate the distinct *trajectory stages* and their inherent dynamic interrelationships. The identified similarities and variations of the trajectory stages across the cases formed our insight into the overall sustainability transformation phenomenon, enabling us to understand its patterns and critical influential factors. In the following, we outline the six steps of our research methodology displayed in Fig. 1.

Upon collecting the data, we investigated each sustainability transformation trajectory separately at the within-case level. In step 1, we examined the vast amount of data gathered from the different data sources and extracted relevant evidence on UBI sustainability transformation to prepare the consecutive analysis. To this end, we used an open inductive coding approach to ground our theory development within the data and reduce the risk of confirmation bias (Strauss & Corbin, 2015). Following our research question, we first created generic codes, such as transformation triggers, activities, events, and barriers. The research members then examined the data and coded all relevant evidence case-by-case. A large share of the data extracted comprised interviewee statements, such as "In February, we introduced a new process in our consulting team. Each of us selected two SDGs and presented them during our weekly meeting, which triggered several discussions." However, given that our research design included various data sources, our evidence also encompasses, e.g., posts about upcoming sustainability events shared

Table 7 An overview of properties and influencing factors across specific UBI sustainability transformation stages

	Leadership-induced trajectory	Bottom-up-induced trajectory	Maturity	Advocacy
Scope	Holistic	Niche	Holistic	Holistic
Function of partnerships	Absorbing	Complementing	Enhancing	Scaling
Transformation driver	Leadership	Bottom-up	Combined	Combined
Impact	UBI	UBI	HEI	Ecosystem

We omitted the Nascent stage because it is a prelude to sustainability transformations. We also omitted the Ambiguity stage, as its nature vastly depends on the type of distress and previous stage attainment

on the UBI social media profile, newspaper articles about the opening of a new facility dedicated to sustainable entrepreneurship, photos that show printed SDG posters at the office walls, which we took during the site visits, or observational notes from the startup workshops we attended.

In step 2, we structured and triangulated the data using the event listing, time sequencing, and flow chart method to deconstruct each UBI's sustainability transformation over time (Miles et al., 2013). For each case, we first compiled a comprehensive list of the data collected in step 1, i.e., transformation activities, events, milestones, and associated barriers. Each list entry included a title and short description ("what"), reference to the data source ("who"), and time indication ("when"). In this regard, our interview protocol and data collection strategy proved valuable as it requested that the interviewees give time indications throughout the interviews. Moreover, the time information on internal documents, press releases, and email communication helped correctly assign interview statements. Based on the time information, we then organized the data chronologically on a timeline to represent the sequence of events and activities within each UBI's transformation journey. This chronological arrangement allowed us to gain a structured understanding of the distinct UBIs' transformation progression. Both steps effectively facilitated two data triangulation approaches. The first triangulation implied the integration of different data sources when reconstructing the sustainability transformation trajectories of each case UBI. The second triangulation encompassed those transformation events referred to by multiple data sources. If the data collected provided conforming or complementing insights about an event, we summarized them within one aggregated list entry. If they, however, entail conflicting evidence, such as diverging accounts of the developments or contrasting contextual or time information, we asked the UBIs for further clarification. Both approaches, thus, enabled a holistic and rich account of the phenomenon investigated. Finally, we created flow charts for each UBI sustainability transformation, visually mapping out the trajectory's sequence of events and activities.

Building on the results of step 2, we then segregated the transformation trajectories into distinct trajectory stages based on two approaches. On the one hand, we examined the data for critical events relating

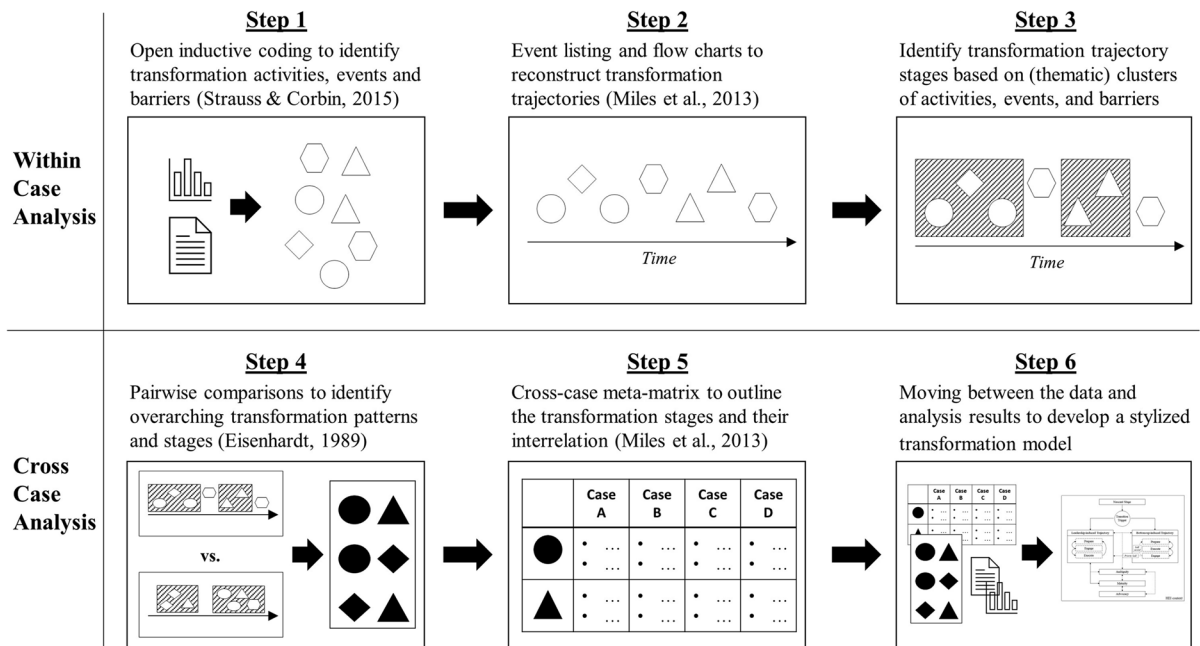


Fig. 1 Research methodology. Source: authors

to key turning points with substantial changes or shifts in the transformation process. They serve as indicators for trajectory stage boundaries and mark transitions between different trajectory stages. Most of them were identified by the interviewees and described as significant achievements, e.g., the launch of the first sustainability accelerator, or organizational distress, e.g., change agents leaving the organization. On the other hand, we also examined the UBIs' transformation flow charts for clusters of activities and events that encompass thematic overlap, are interconnected, or belong to a similar transformation activity type (Loorbach & Wijsman, 2013). For instance, our analysis revealed several operational transformation activities clustered within a short period in Case B, indicating a distinct period in which sustainability initiatives were implemented at the UBI.

We then progressed our analysis from the within to the cross-case level to develop a generalizable theory (Miles et al., 2013). During step 4, we performed forced pairwise comparisons across the cases (Eisenhardt, 1989). Following Eisenhardt (1989, p. 540), this tactic is particularly useful, as it identifies "new categories and concepts which the investigators did not anticipate." Essentially, each research team member selected two cases and listed similarities and

differences between the transformation trajectories. This involves comparing the transformation activities, events, barriers, and identified stages. We then repeated the task for another combination of cases. Based on the results, the research team then engaged in follow-up discussions to explore potential explanations for the cross-case variations and similarities. For instance, we questioned why bottom-up change activities failed in one UBI but succeeded in another context or discussed why the type and magnitude of impacts varied in line with the rising UBI maturity. Using pairwise comparisons was particularly useful as it enabled us to triangulate our insights at the UBI level to identify overarching trajectory stages, such as a nascent trajectory stage, patterns, such as the link between bottom-up and top-down trajectories, and influential factors, such as the role of leadership support, as potential explanations for between-case variations (Yin, 2017). In step 5, we created a cross-case meta-matrix (Miles et al., 2013) with a similar process described by (Eisenhardt, 1989). In one column of the matrix, we listed the overarching trajectory stages, patterns, and influencing factors identified in step 4. In the other columns, we outlined them on a case-by-case level. This step helped structure and validate our observations in step 4 and provided the

arguments to conclude the stylized transformation stages. Finally, by moving between the data and the results of our analysis, the last step was to construct a stylized model for UBI sustainability transformations, which illustrates the interrelation of the trajectory stages (Miles et al., 2013).

Our research design relied on multiple methodologies, which combined improved the validity of our results. Yin's (2017) approach guided our overarching research design, i.e., our case sampling strategy, data sources selection, and analytical strategy. Specifically, the outlined theoretical replication logic and pattern-matching approach were central to planning, executing, and reporting our research strategically and systematically. Moreover, it helped us align the broad data conceptually at the within-case and cross-case level (e.g., data sources variety, multiple levels of hierarchy, and diverging UBI maturity levels) into generalizable UBI sustainability transformation theory. Miles et al. (2013) and Eisenhardt (1989) methodologies guided the operational data analysis. They provided us with effective frameworks and tactics to systemize our evidence and triangulate the data at the within and cross-case levels. Combining these methodologies enabled us to effectively address various challenges of case study research methodologies. Concerning data extraction, one challenge comprises the retrospection bias, implying that interviewees provide an inaccurate and subjective account of the UBI sustainability transformation. This also involves the issue of time reliability, as interviewees might indicate an incorrect sequence of events. Moreover, data extraction is challenged by a potential social desirability bias, which implies that interviewees fail to express their genuine opinions about the sustainability transformations to protect themselves, their colleagues, or their organization. We address these issues in several regards to minimize the potential effect on our study. First, we collected multiple pieces of evidence to support our claims (Yin, 2017). All our cases include at least two interviewees at various hierarchical levels to not rely on one individual's perceptions. Second, we triangulated different data sources (Eisenhardt & Graebner, 2007; Street & Ward, 2012). For instance, time indications of internal documents, press releases, and mail correspondence enabled us to reconstruct the sequence of transformation activities reported in the interviews. When encountering conflicting evidence, we conducted

follow-up calls for clarification or addressed them throughout the sequential interview process. Third, we performed validation meetings before concluding the data analysis. Fourth, we tested and refined our interview protocol and interview process in preference for open-ended questions that stimulate a genuine of the past. We also signed interview privacy documents for each participant to ensure they could share genuine opinions. Furthermore, our study faces potential challenges concerning data analysis. One central issue is information-processing bias, given that our research design is subject to interpretation despite our systematic approach (Eisenhardt & Graebner, 2007). To minimize this bias, we maintained a collaborative approach to analysis. Here, each research team member performed the within-case and cross-case analysis separately before discussing the results until we reached a consensus (Eisenhardt, 1989). Moreover, we involved other experienced entrepreneurship scholars throughout the research process to continuously challenge our study. We attended various research colloquia and scientific conferences to receive feedback on our methodology and our (preliminary) results. This diversity of perspectives helped ensure a comprehensive evaluation of the data and a more balanced interpretation of the findings. Finally, having multiple data sources and pieces of confirming evidence also helped us enhance our study's construct validity (Yin, 2017).

4 Results

Reporting the results of multiple-case study research faces the challenge of staying "within spatial constraints while also conveying both the emergent theory that is the research objective and the rich empirical evidence that supports the theory" (Eisenhardt & Graebner, 2007, p. 29). Thus, given the vast amount of data and to ensure overall comprehension, we decided to develop the theory in sections at the cross-case level and support it with empirical evidence from the within-case level (Eisenhardt & Graebner, 2007). This section describes our analysis results, which explain UBI sustainability transformations within sequential stages. Table 8 summarizes each transformation stage.

Table 8 Stage overview of SAE transformation trajectories

	Nascent	Leadership-induced trajectory	Bottom-up-induced trajectory	Ambiguity	Maturity	Advocacy
Main goal	Supporting technology transfer	Transforming internal operations	Realizing sustainability projects	Continuing operations	Improving SAE activities	Scaling impacts
SAE startup offerings	- Occasional support of sustainable startups within the conventional technology transfer scheme	- Introduce various SAE support services - Amend the existing incubation model to focus on sustainability - Terminate unsustainable practices	- Introduce SAE support services along the sustainability project	- Continue, reduce, or terminate existing startup support operations	- Advance and customize existing startup offerings - Focus on specific societal challenges rather than generic sustainability	- Advance and scale startup support offerings internationally - Focus on advanced impact assessment
Transformation activities	-	- Prepare and plan the transformation by ensuring resources and leadership approval - Communicate an SAE mission internally and externally - Identify opportunities for SAE across the UBI operations - Grow organizational SAE capabilities	- Prepare, plan, and execute the sustainability project - Advertise the sustainable project externally - Collaborate with externals to realize the project - Discuss the role of the UBI in sustainability	- Suspend new transformation activities - New SAE opportunities are primarily externally driven	- Understand UBI impacts and effectiveness - Integrate sustainability in ways of working and organizational values - Engage in HEI organizational transformation	- Sustainability as a central decision criterion - Lead ecosystem sustainability transformation - Share knowledge and experiences with other UBIs - Diverse regional and international partnerships
Main barriers	-	- Lack of resources - Dominant culture vs. new culture - Fear of greenwashing - Internal regulations - Poor transformation management	- Lack of resources, particularly time - Dominant culture vs. new culture - Internal regulations	- Internal or external disruptions - Old conflicts reappear - Individuals retain sustainability projects among the team	- Lack of resources - Missing specialized knowledge - Progress is highly contingent on partnerships	- Lack of resources, particularly time - Increasing organizational complexity - Managing various stakeholder needs
Observed in case ¹	A, B, C	A, C	B	A, B, C, D	A, C, D	C, D

¹ The stages were not present in all cases. For more information, please see Sect. 3

4.1 Nascent stage

Our analysis showed that the SAE activities of UBIs extended to a time before sustainability became an explicit organizational objective. Across the cases studied, sustainability-driven startups emerged within the conventional, technology-transfer-oriented UBI model. Even if such SAE activities were unintended, they arguably indicate an early contribution of UBIs to the SEU. We observed three response patterns about nascent SAE activities in our interviews. On the one hand, most interviewees appeared unaware of them even though they had already joined the organization. On the other hand, if they were aware of such nascent support for sustainable startups, the interviewees either neglected their importance or used them as an example to retrospectively emphasize the UBI's tradition of fostering sustainability. Engaging in external SAE projects was another nascent transformation activity. For instance, case A consulted the development of a new green-tech incubator with their startup support expertise. Moreover, it contributed to a lecture on sustainable entrepreneurship by introducing startup support offerings to students and motivating them to engage in technology transfer. These nascent activities illustrate that UBIs can engage with external sustainability projects and stakeholders without pursuing SAE themselves. One interviewee expressed.

“(the sustainability approach) didn’t catch fire on us. Instead, it was the new incubator that profited due to all the know-how they absorbed. However, here nothing changed.” (Case A).

Another critical development during the nascent stage was the adoption of sustainability in the HEI's mission statements. In cases A and B, it later became a reference for change agents to justify their engagement for sustainability. For instance, case B expressed the need to align the UBIs' and HEIs' missions.

“Some years ago, our organization developed a vision statement that included things like sustainability, ecology, and social responsibility. However, no one really was or felt responsible. [...] They were mostly empty words. [...] Hence, what we did, was a starting point, which created some noise [...].” (Case B).

4.2 The trigger

An explication of sustainability eventually disrupted the nascent stage. In cases A, B, and C, the activities of committed individuals (change agents) enabled the

UBIs to abandon the nascent stage and start pursuing SAE. While external factors supported the developments, such as public recognition for sustainability (Case C), existing sustainable entrepreneurship teaching and research (Case A), or HEI leadership announcements (Case B), the change agents' activities were the main triggers. Colleagues perceived such individuals as advocates for sustainability and “engines” of the sustainability transformation. For instance, one interviewee remarked.

“So there were some activities at the organization before, but actually, he was the one (the change agent) who was the first to make sustainability explicit. He approached the university board with his ideas and demanded financial funding. [...] he wrote on his flag – this is my topic.” (Case A).

The change agent's SAE knowledge and position in the UBI organization vastly determined the nature of the trigger activities, thus shaping the transformation trajectory profoundly. If the change agent was in a leadership position, the trajectory became a holistic organizational transformation, which we term leadership-induced trajectory. In cases A and C, the change agents joined the UBIs as managing directors and immediately saw the opportunity to implement sustainability as an organizational objective and introduce SAE activities. Both had prior experience in sustainable entrepreneurship and an existing personal network, as they were either a university professor (Case A) or a leader of an NGO (Case C). In contrast, if the change agent was at the lower hierarchical level, the trigger activity resembled a niche project, which we term bottom-up-induced trajectory. In case B, the two change agents were a startup consultant, who suggested a CO₂-emissions compensation scheme for business trips, and a mid-level manager, who leveraged a funding opportunity for developing a “sustainability track” within the existing startup accelerator. Neither had profound knowledge about sustainability but expressed a strong personal interest in SAE.

4.3 Leadership-induced trajectories

In leadership-induced trajectories, change agents tended to be organizational leaders who implemented an SAE mission as a holistic organizational transformation. It comprised three trajectory stages: preparation, engagement, and execution, generally following a loose sequential order with overlaps and iterations.

4.3.1 Preparation

The preparation stage's main goal was to set the stage for the organizational transformation with several key activities: design the desired future state, develop a sustainability-driven strategy, get approval from the HEI's top-level management, and assemble resources. In case A, the change agent developed a triple-bottom-line strategy, which outlined the UBI's new mission, the need, and motivation for its implementation, and required organizational changes. He strategically allied with the HEI's entrepreneurship research chair and proposed the strategy to the HEI's governance board. Ultimately, the change agent received the approval and secured funding for the strategy's implementation. In case C, the change agent grew strategic alliances for implementing SAE activities "gradually." Her personal and the HEI's networks were valuable, e.g., she convinced an NGO to fund a sustainability-driven accelerator program.

"So I thought, let's bring these two worlds together in a new accelerator that combines impact and tech. I have also seen that there is no acceleration program like (Case C) yet, so we have joined forces with (NGO)" (Case C).

4.3.2 Engagement

While UBI continued most operations during the preparation stage, the engagement stage aimed to transform the organization's current practices to target an SAE mission. Its main activities comprised communicating the new vision within the organization, planning SAE activities, and advancing organizational capabilities. In case A, the change agent assembled all employees in a room and organized a two-hour kick-off event to announce the new SAE strategy. In the subsequent weeks, the UBI teams organized several workshops to identify opportunities to realize the strategy, such as adding new SAE training to the incubation program, hiring new startup coaches, including the SDGs within the startup coaching process, and inviting sustainability-driven alumni startups as speakers. Similarly, case C reviewed their existing support portfolio, searching for offerings "that weren't yet on the table."

Besides realigning the existing support offerings, case A enhanced its organizational capacities to implement the transformation. For instance, some employees attended sustainability training or scientific conferences focusing on sustainable entrepreneurship. Furthermore, the team identified existing sustainability tools and methods within desktop research. Moreover, they engaged with consultant companies and NGOs specialized in sustainable entrepreneurship to engage in partnerships and seek advice. Finally, the engagement stage also involved reflective activities. For instance, one employee reviewed the UBI's alumni startups and assessed their social and environmental contributions to calculate the UBI's previous SDG contributions.

Several transformation barriers emerged during the engagement stage. The first key issue was the divergence between the incumbent and the emerging culture. While most employees described the new strategy as "there was a buzz – it is really something new" (Case A), some raised concerns. A central discussion was how "radical" the UBI should pursue sustainability. One interviewee reflected:

"We didn't want to give startups the impression that if you do not address sustainability in your business model, you are out." (Case A)

The team perceived sustainability as conceptually ambiguous, which reinforced this issue. Another argument against the transformation was to "enslave startups at an early stage" (Case A). The opponents stressed that a commitment to sustainability would reduce a startup's flexibility during its business model development. Moreover, some questioned the overall need for a new strategy as the UBI had been successful in technology transfer in the previous years, which the transformation would jeopardize. To resolve the internal tensions, the UBI agreed to "meet in the middle," which implied fostering sustainability by *sensitizing* the startups and offering SAE services to them voluntarily. However, this approach created a comfort zone for transformation opponents to "look a bit more for sustainability, but generally leave everything as it was." (Case A). The second key barrier was the high workload and the "lack of time to get involved in a new topic" (Case A). A third barrier comprised the transformation management approach. For instance, one employee felt "left in the dark" because the

change agent failed to impose immediate activities upon his announcement (Case A).

4.3.3 Execution

Preparation and engagement finally resulted in executing the planned activities and thus implementing the SAE strategy. The execution stage was highly experimental, as the UBI “tried out” new practices. After identifying various opportunities for realizing the new strategy, case A gradually began its implementation. On the one hand, they extended existing offerings with new “sustainable elements.” For instance, new partnerships with sustainability-focused entrepreneurship organizations and research chairs enabled them to extend the incubation program with additional training, such as sustainable business model innovation workshops and impact assessment training. Moreover, sustainability-related investors were invited to advise on accessing sustainability funds. Similarly, case C added new workshops to the incubation program, such as mental health training and ethical team culture seminars. On the other hand, the UBIs realigned existing offerings with a sustainability focus. For instance, case A approached its coaches and asked whether they could address sustainability in the planned workshops. Moreover, the keynote during the biannual “startup day” was held by a sustainable entrepreneur, and sustainability became a startup selection criterion.

Implementing the new strategy transformed not only the startup offerings but also affected the UBIs’ practices and internal culture. The new strategy aligned the team on mutual goals and enforced the perception of a community. For instance, in case A, individuals started exchanging information and knowledge by sharing contact details of sustainability experts and startups, startup awards, or SAE tools. A key event in the organizational transformation was the opening ceremony of a new UBI facility on campus. During the opening ceremony, the change agent announced the vision to become a hub for sustainable innovation and displayed the SDGs on stage. Such public commitments accelerated the sustainability transformation.

“The launch (of the new UBI facility) had an immense internal and external effect. [...] Like, all right, we take the SDGs so seriously that we display them publicly and tell everyone, hey look, we

consider it (sustainability), and we want to contribute.” (Case A).

The execution stage activities also fostered organizational learning, particularly enhancing the collective understanding of sustainability. For instance, in case A, one team assigned each SDG to a team member who prepared short presentations. Moreover, some employees attached SDG posters and scientific articles on circular business models to their office walls, indicating their increasing personal identification with SAE. The organizational transformation also affected some employees’ attitudes and behaviors.

“It contributed to rethinking my daily life and considering such trivial things like paperless offices and how to communicate. For instance, we introduced a strict garbage separation.” (Case A).

The execution stage’s main barriers aligned with the engagement stage. First, the lack of time and resources delayed some planned SAE activities. Moreover, in case A, the new strategy was implemented heterogeneously among the UBI teams. While one team lead initiated many execution activities, another manager neglected to implement the strategy holistically. Finally, the fear of organizational greenwashing meant another critical barrier. In particular, communicating a sustainability mission publicly while the sustainability transformation was still emerging caused the fear of “not living up to one’s standards.”

4.4 Bottom-up-induced trajectory

In bottom-up-induced trajectories, change agents tended to be at lower hierarchical levels and triggered sustainability transformations by realizing sustainability-driven projects within the existing UBI structures. Similar to the leadership-induced trajectory, we observed preparation, engagement, and execution activity patterns, albeit in reversed order and with distinct dynamics.

4.4.1 Preparation

Preparation activities of the bottom-up trajectory tended to be less pronounced than their counterparts during the leadership-induced trajectory. Given the project nature of SAE, they centered on aligning the appropriate project resources, seeking supervisor

approval, and developing a project roadmap. For instance, in case B, one of the two change agents was approached by an NGO to introduce a sustainability track within the existing startup acceleration program. He discussed the idea with his supervisor, who approved the project. At this stage, case B perceived sustainability as yet another specialization that the UBI could operate within the existing incubation model.

“[...] in our set-up, it (sustainability) felt like any other accelerator track. [...] So, for me, it was merely another industry-specific track, and I viewed sustainability as the industry.” (Case B).

While case B had experience supporting tech startups, it lacked specific sustainability knowledge. Therefore, the change agent used his network to seek partners that could add “the sustainability part.” He collaborated with an open innovation platform provider that specialized in sustainability projects. It contributed to the project by providing the overall accelerator theme “reducing plastic” and connected case B with specialists for sustainable entrepreneurship. Moreover, the change agent engaged with a sustainability consulting company, which suggested a systematization for tracking and evaluating startup SDG impacts. Finally, a university chair consulted the overall process and suggested SAE tools and methodologies.

In retrospect, one of the preparation’s main barriers was establishing SAE within the existing UBI operations. As a result, both change agents in case B separated their engagement for sustainability from the conventional task. The first change agent conceptualized the sustainability track next to the other accelerator tracks. The second change agent developed the CO₂-emissions compensation scheme for business travel as a side project “independent of his regular job.” This separation enabled case B to maintain the conventional technology transfer identity, including the overall mission to “generate more startups.” When the first change agent questioned this mission during the project concept development, the UBI leadership prioritized research commercialization over sustainable impacts. Thus, he questioned the project’s overall “seriousness” and criticized its “political” motivation.

“We had many discussions about the funding strategy with the (NGO). [...] So, priority one is the commercial aspect, and priority two is that it looks nice and green and best also be green. However, please don’t compromise on the commercial side.” (Case B).

4.4.2 Execution

The execution stage focused on the implementation of the SAE project. While the preparation activities remained largely unnoticed by the UBI team, the execution stage activities raised the general awareness of sustainability and caused organizational tension. In case B, the sustainability accelerator track was launched as a four-month program with monthly meetings containing workshops, coaching, and peer-to-peer learning. Its participants were predominantly science startups but also included external sustainable startups, which the UBI had matched with scientists from the parent organization for collaboration. The sustainability accelerator launch was announced within several public events, such as a panel discussion with local politicians and ecosystem partners titled “Disrupt for Good—sustainability as a growth engine and entrepreneurial opportunity.” At that time, the board also accepted the CO₂ emissions compensation proposal suggested by the second change agents. Both projects, the sustainability track launch, the compensation proposal, and the widespread media attention for sustainability spurred awareness among the UBI employees. It triggered various internal discussions on the subject and the role of the UBI in a sustainable society.

The tension between the existing commercialization-focused regime and the emerging SAE aspirations increased and was a critical barrier to the execution stage. For instance, during the final stage of the sustainability track, some collaborations between scientists and external startups had to be discontinued as internal regulations for technology transfer had not been aligned with the project goals. Moreover, the UBI’s investment regulations were equal for sustainable and conventional startups, which some employees criticized.

“If we could just be more flexible concerning the financial resource and payback conditions when supporting sustainable startups, this would mean a big leap.” (Case B).

Another barrier to the execution stage was the lack of experience, preparation, and time when launching the sustainability track. Even though case B had acquired partners and expanded its knowledge base, the start was “chaotic” and “rushed,” with most elements adopted “ad-hoc.” A third barrier was the scouting for relevant sustainability startups within the

organization. The UBI realized that offering SAE services was insufficient for supporting sustainability but required uptake from academic entrepreneurs in the parent organization. As a consequence, case B convinced two startups with sustainability ambitions that had applied for the conventional startup track to join the sustainability track ex-post.

4.4.3 Engagement

The SAE project execution raised the UBI's awareness of sustainability and thus expanded its effect from the initial niche-based character to an overarching organizational topic. During this stage, the UBI discussed SAE as a potential opportunity for a holistic organizational transformation. It thus meant a turning point during the sustainability transformation as the UBI could either adopt SAE as an organizational priority or maintain its technology transfer focus. In case B, the UBI team organized a "strategy day" to discuss the UBI's vision and strategic objectives. During the workshop, the change agents and other employees suggested making sustainability a critical organizational priority. Some even proposed to "solely support sustainability startups." However, this proposal was criticized by "the other part of the team and specifically the leadership," who viewed it as "unrealistic and reasonable."

"[...] He was not generally against the idea but argued that sustainability is an optional criterion. Technology transfer is the UBI's key task. [...] Only supporting sustainability startups would imply to cease supporting some interesting spin-outs, which could develop into future unicorn startups." (Case B).

Ultimately, the leader of case B postponed the decision to adopt sustainability as an organizational goal and instead instructed a working group to conceptualize an SAE strategy. The absent leadership commitment to sustainability was the stage's key barrier and frustrated the change agents as they viewed the working group as "yet another concept paper that would lead to nothing." Hence, one change agent left the UBI (see Ambiguity stage).

Consequently, all subsequent SAE initiatives of case B maintained a niche-based project character and were primarily driven by individual interest. For instance, after the strategy day in case B, two UBI employees met with investors specialized in sustainability to learn about their investment strategies and

joined a local network for sustainable tech startups. Such examples illustrate that the previous developments had accelerated the UBI's sustainability transformation. They, however, did not readily advance into a holistic organizational transformation due to the absent leadership commitment. At the time of the data collection, case B had just started to engage in more strategic transformation tasks, such as assessing historical startup impacts, introducing sustainability-related yearly goals for UBI employees, and drafting a blueprint for future SAE operations. Thus, they indicate an inherent link between leadership-induced and bottom-up-induced trajectories. Nevertheless, the sustainability transformation remained dependent on leadership commitment. One interviewee remarked.

"I hope that it (the SAE blueprint) does not dilute too much and results in mere declarations of intent. Rather, the leadership should establish concrete guidelines, which we can trust." (Case B).

4.5 Ambiguity

Across the cases, sustainability transformations were occasionally disrupted by periods of intense organizational distress, indicating their iterative, non-sequential nature and exceeding the prevalent operational issues of UBIs. The transformation was suspended and deprioritized over more urgent issues during such times. We noticed two types of organizational distress. Internal disruptions emerged when the change agent left the UBI, which created a vacuum for sustainability transformation, given that this person was its driving force. In case A, the change agent resigned due to internal conflict with the HEI leadership, general frustration about public bureaucracy, and other career opportunities. As a result, case A remained without leadership for several months, and it was uncertain whether the successor would maintain the SAE strategy. After the strategy day, in case B, one change agent and some other team members resigned due to frustration about the leadership's unwillingness to change and continuous internal conflicts. Their absence caused a severe personnel shortage and demotivated all those employees that spurred SAE. The second disruption type was external and involved the COVID-19 pandemic. It shifted the UBI's attention toward digitizing the incubation program and internal processes while ensuring the employee's health.

The internal and external disruptions decelerated the sustainability transformation. Ongoing or previously planned SAE projects had to be adapted to the new context or were canceled. For instance, case B launched the second accelerator sustainability track virtually with a reduced support offering. New SAE projects, in turn, were delayed given the lack of resources. One interviewee remarked.

“That was a difficult time. Not much could be implemented. It was mostly about keeping the UBI up and running.” (Case A).

4.6 Maturity

The UBIs’ increasing experience with SAE eventually led to the maturity stage. Its main goal was to enhance existing SAE efforts with more advanced and tailored support services. For instance, case A developed a novel workshop for sustainable business model innovation. Moreover, the UBI extended the regular alumni startup survey with sustainability-related questions to better understand the UBI’s historical impacts on sustainability. Also, case D adapted more complex offerings during its transformation. While it “experimented” with different SAE formats during its formation, the UBI increasingly tailored its offerings based on startup feedback and experiences.

“In the beginning, there was the belief that there is a high correlation between climate impact and corporate growth. [...] Over the years, we have seen that this is not the case [...] So we have aligned the program with special training and methodologies to get better in identifying the startups that really create a positive impact.” (Case D).

While the UBIs still primarily relied on external partners to realize SAE, their relationships evolved from passive customers to active collaborators. For example, case A collaborated with the university’s entrepreneurship research chair to develop an impact assessment and reporting approach, which tracked the “startups’ sustainability potential” throughout the incubation program. They enabled them to provide startups with case-specific SAE offerings. Case A also strategically enlarged its network and invited celebrated sustainable entrepreneurs and known experts as speakers within their incubation program.

The UBIs’ activities increasingly expanded beyond the UBI and started to address the HEI level. For instance, case A organized a student ideation

challenge for greening the campus. Moreover, they realized two sustainability conferences with several research chairs visited by participants cross-campus. In cases C and D, sustainability was increasingly perceived as a holistic phenomenon that “pushes the climate problem also into the social sector.” Hence, its partnership strategy advanced from broad networking to seeking strategic alliances, e.g., with local municipalities and NGOs, to operate more specific topic-driven incubation programs. Moreover, case C engaged in regular sustainability meetups with other departments.

Finally, sustainability became more integrated within the UBIs’ culture and operating processes during the maturity stage. For instance, case A integrated sustainability into the annual employee goals to translate the organizational goal into individual activity and establish it as a norm. The resistance to the sustainability transformation generally ceased. However, not all employees prioritized it equally. In case A, this created some frustration for those employees who identified themselves strongly with sustainability values. Another barrier was the lack of specialized sustainability knowledge within the UBI despite the growing experience with SAE. For instance, case A expressed difficulties in formulating effective sustainability assessment criteria. Moreover, during their work with startups, the team criticized the previously adopted focus on the SDGs for its ambiguity and usefulness but struggled to develop a better approach.

4.7 Advocacy

The final sustainability transformation stage was Advocacy, in which the UBIs started proactively contributing to society’s sustainability transformation. One main focus was to scale the UBI’s impacts on sustainable development. For instance, cases C and D targeted specific “local market needs” and “adapting incubation programs to concrete real-world issues.” The UBIs also aspired to become “thought leaders” and inspire other entrepreneurial ecosystem organizations to engage with sustainability. For instance, case D launched a network to share its SAE experiences with other entrepreneurship support organizations. Case C published two books on sustainability for startups and venture capitalists. The UBIs also enhanced their programs with more valuable startup support services. For instance, case D introduced an

elaborated life-cycle analysis workshop to startups, which enabled them to align design eco-efficient product strategies, legitimize sustainability claims, and inspire a sustainable business model generation. Cases C and D leveraged their international network to offer speaker slots at major international sustainability conferences. Moreover, case C partnered with leading European NGOs to provide better intermediation services. Case D used subsidiaries in other European cities to link startups to other entrepreneurial ecosystems.

During Advocacy, the UBIs expressed to work increasingly “mission-driven.” The teams internalized sustainability as an organizational value affecting daily decisions and operational activities. For instance, case C considered sustainability when selecting new office furniture or engaging service suppliers for events. Moreover, its employees voluntarily started to write internet blog articles about the origins and complexity of sustainability issues.

The increasing involvement and number of partnerships challenged the UBI employees with additional stakeholder management tasks, and the general workload meant a key barrier to Advocacy. Moreover, in case D, the internationalization caused several reorganizations to streamline responsibilities and increase overall efficiencies.

4.8 A model for UBI sustainability transformations

Our analysis revealed the transformation stages’ inherent interrelation. Hence, we developed a stylized model for UBI sustainability transformations in Fig. 2, which illustrates the process, departing from the Nascent stage, moving through Leadership-induced or Bottom-up-induced Trajectories, to gradually reaching Advocacy. While the model suggests a sequential order, we emphasize that it is a stylized representation of reality. We illustrate sustainability transformations’ iterative, contextual, complex, and disordered nature by displaying the arrows in Fig. 2 in a bi-directional shape. They illustrate that UBIs may alternate between the transformation stages throughout the process with the possibility of stage loops. While the solid arrows represent the gradual sustainability transformation, the dashed arrows represent deviations, such as the critical decision point during the bottom-up-induced trajectory and Ambiguity (Table 8).

5 Discussions

We departed from the question of how UBIs transform to support SAE to understand the characteristics and emergence of the SEU. This section abstracts our insights on UBI sustainability transformations and develops five theoretical contributions to SEU theory. Table 7 supports our discussion by contrasting the identified transformation stages with respect to the theoretical contributions.

5.1 Sustainability impacts of the SEU alternate throughout sustainability transformations

In the early stages of sustainability transformations, UBIs primarily focused on narrow sustainable entrepreneurship activities, as illustrated in Sect. 4. The UBIs studied aimed to green established business incubation models and technology transfer schemes, sensitizing academic entrepreneurs to consider sustainability. During this phase, the perceived contribution to sustainable development was associated with the quantity of generated SAE output, positioning startups as impact surrogates (Karahan et al., 2022). However, as the sustainability transformations progressed to the Maturity and Advocacy stages, the UBIs expanded their understanding of sustainable impacts to align with a wider SEU perspective. They shifted their focus from the UBI level to transforming the entire HEI and local innovation ecosystems. For example, they organized cross-campus sustainability conferences and created regional networks for sustainable entrepreneurship.

Assuming this holds for the other organizational units of the SEU, one implication is that the SEU’s immediate impacts primarily occur within the HEI boundaries, influencing researchers, faculty staff, and students. Over time, these impacts may extend beyond the campus and contribute to broader societal sustainability. Our findings challenge the prevailing notion that SEUs are immediate co-creators of sustainability, a concept strongly advocated by policy-makers and scholars alike (e.g., Trencher et al., 2014). It takes time for niche projects or internal transformation activities to pave the way for a comprehensive SEU evolution (Verhulst & Lambrechts, 2015).

Thus, we call for stage-specific SEU theory building, assessment, and management to account for the different stages of transformation. Existing

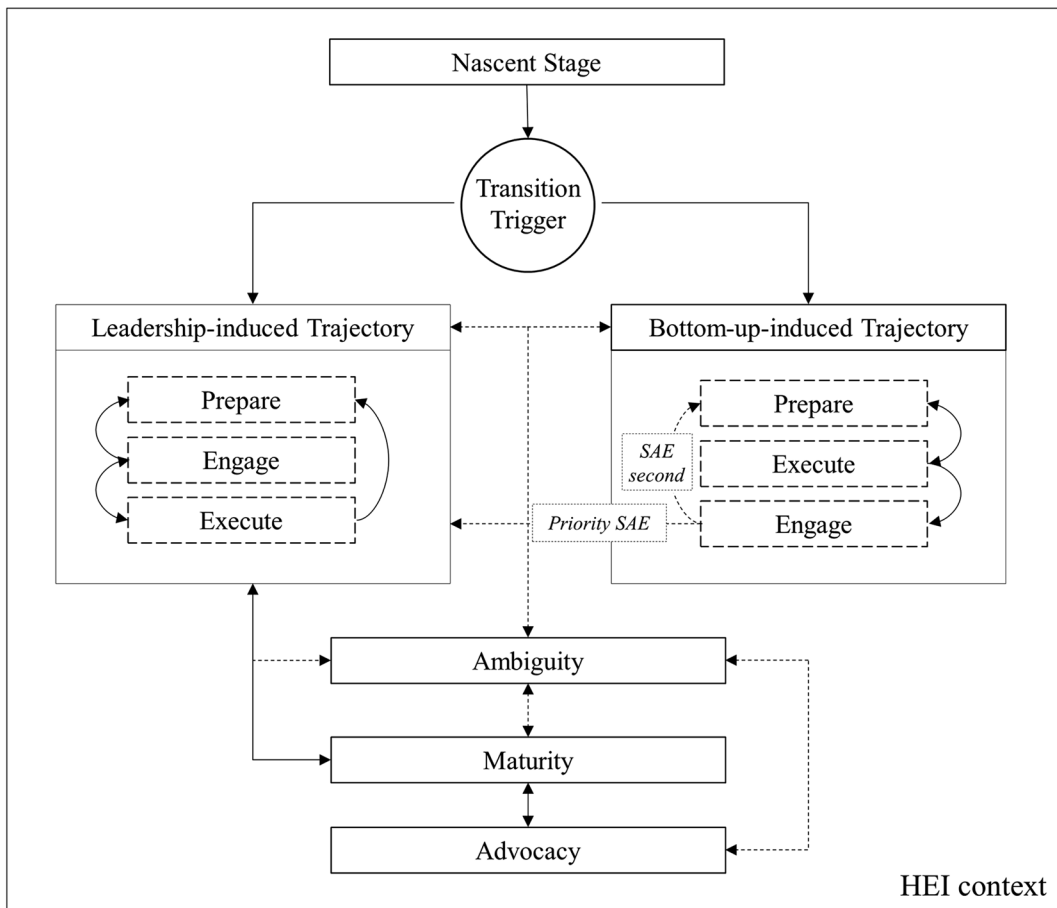


Fig. 2 Stylized model of UBI sustainability transformations. Source: authors

sustainability transformation management tools offer rather generic strategies, but they should consider the organization's specific transformation stage more effectively (e.g., Loorbach & Wijsman, 2013). For instance, if HEI leaders engage with more advanced transformation activities, such as organizing cross-campus sustainability conferences, while the SEU has not yet developed the appropriate organizational capabilities, governance mechanism, or resources, such activities may prove ineffective. Moreover, such activities would likely overwhelm SEU departments and create organizational tensions that may jeopardize the support for sustainability transformation. Finally, neglecting transformation stages may also create biased expectations for the SEU's transformation speed and the magnitude of its sustainability impacts among internal and external stakeholders, i.e., regulators and university leadership.

5.2 Leadership commitment as a mediating factor in SEU transformation trajectories

Our study examined the traditional distinction between bottom-up and top-down trajectories, as discussed by previous research on HEI sustainability transformation. We investigated whether these can be translated into the UBI context. Our results showed that such a distinction is generally too simplistic. Separating bottom-up and top-down trajectories is applicable at the early stages of sustainability transformations, informing about the origin of organizational change. However, as sustainability transformations progress, both trajectories ultimately merge, showcasing that they are inherently interconnected. Thus, our results confirm the findings of Verhulst and Lambrechts (2015) for the UBI context and underline the idea of combined trajectories proposed by Tiemann

et al. (2018). Moreover, our results provide additional insight into the intersection of both trajectories. Leadership commitment and approval emerged as central factors mediating the transformation process.

During bottom-up trajectories, the absence of leadership commitment hindered the strategic organizational pursuit of SAE. In leadership-induced trajectories, it resulted in UBI leaders leaving the organization and caused entering Ambiguity. Conversely, strong UBI leadership commitment empowered individuals to engage in SAE, accelerating the transformation. Thus, our results emphasize the pivotal role of leadership commitment during all stages of sustainability transformation. Our results also confirm previous research findings at the HEI level for UBIs (Ávila et al., 2017a, 2017b; Sammalisto et al., 2015; Tiemann et al., 2018). To cite Verhulst and Lambrechts (2015, p. 199), change agents require “empowerment to lower the resistance.” Thus, our results indicate continuous leadership commitment as an insufficient but necessary condition for holistic SEU transformations. Future research should examine the different functions of leadership throughout the various sustainability transformation stages. Indeed, it might entail different meanings depending on context. For instance, the lack of leadership commitment can manifest as a lack of authority in one situation, while it may imply failure to align internal policies or aversion to providing resources in another.

5.3 A combination of external and internal enablers induce SEUs

Previous research identified various enabling factors that can trigger SEU transformations (Table 2). Our results at the UBI level suggest that SEUs are initiated by a combination of them. In line with previous research, we found that UBI transformations are primarily governed by engaged individuals serving as change agents who seize opportunities for sustainability integration within the organization (Fichter & Tiemann, 2018; Verhulst & Lambrechts, 2015). Contextual factors, such as HEI mission statements and media awareness of sustainability, influence the likelihood of identifying and pursuing these opportunities, thus serving as moderators. For instance, in case B, the new HEI sustainability mission statement motivated the change agent to suggest the CO₂-emissions compensation proposal. However, contextual factors

may also inflict individual-level activity. Our analysis of cases A and B showed that the absence of coherent SAE policies or even conflicting regulations within and outside the HEI hampered the SEU transformations. Also, Kivimaa et al., (2017, p. 639) described that “not enough pressure on the part of the university” jeopardized the UBI’s sustainability transformation. To conclude, for inducing SEU transformations, it is essential to activate change agents, provide them with the appropriate resources, authority, and governance mechanisms, and support their opportunity discovery, such as screening for funding opportunities (Millette et al., 2020). Once the SEU transformation is initiated, the entity or factor that enabled it may become of secondary importance compared to strategies for achieving leadership commitment and building alliances for scaling activities. (Verhulst & Lambrechts, 2015).

5.4 The functions of external partnerships alternate during SEU transformations

Previous research found that external partnerships and collaboration with the larger ecosystem play a significant role in shaping SEU transformations (Lozano et al., 2013; Theodoraki et al., 2018; Tiemann et al., 2018), giving rise to new roles for SEUs (Cai & Ahmad, 2021). We add to the research by outlining the strategic rationale of SEU stakeholders to engage in partnerships throughout the SEU transformation trajectory. Our study revealed that UBIs engage in partnerships to internalize new knowledge and seek guidance on transforming their business incubation models in leadership-induced trajectories (Ávila et al., 2017a, 2017b). In contrast, in bottom-up induced trajectories, external partnerships are instrumental in realizing sustainability projects, complementing the UBI’s technology transfer scheme with SAE competencies, networks, and resources. As sustainability transformations progress to the Maturity and Advocacy stages, partnerships enable UBIs to enhance SAE offerings and scale their sustainability impacts, e.g., collaborating with NGOs and sustainable entrepreneurship networks to reach new target groups.

Our findings thus highlight that SEUs do not randomly engage in external collaboration. Instead, they indicate that partner selection and collaboration intensity are subject to the SEU’s strategic and functional benefit of the respective transformation stage

objective. This perspective shifts the focus from roles and benefits that SEUs can add to ecosystem collaborations (Cai & Ahmad, 2021) or their functional mechanisms (Theodoraki et al., 2018) to the reasons and motivations for engaging in them in the first place. Understanding the strategic rationale behind the SEUs' engagement in external partnerships can guide SEUs in selecting suitable collaborations that align with their transformation objectives. This highlights the importance of continuously exploring new partnerships for internal stakeholders, while external stakeholders should consider the timing and readiness of SEU collaborations.

5.5 Analytical perspectives determine SEU transformation insights

Previous research found key individuals who become change agents as primary drivers for the SEU (Ávila et al., 2017a, 2017b; Fichter & Tiemann, 2018; Wakkee et al., 2019), with the change agent's position in the organizational hierarchy determining the transformation trajectory and leading to the common distinction between bottom-up and top-down design strategies (Tiemann et al., 2018). Our results generally confirmed these findings but added a more nuanced perspective. We illustrated various roles of HEI leadership, UBI leadership, and UBI change agents, each being a potential driver for SEU emergence. Thus, multiple layers exist to understand SEU transformations that depend on the analytical angle. For instance, transformations triggered by UBI leaders can simultaneously be considered top-down by the UBI employees, bottom-up by HEI leadership, or both by externals. Moreover, from an HEI perspective, *bottom-up* could either refer to UBI change agents, UBI leaders, or both and vice-versa from the standpoint of UBI change agents. These examples illustrate that the simple bottom-up and top-down distinction is too narrow for modeling SEU transformations. Instead, they are subjected to the analytical perspective and must be understood as embedded within the specific organizational environment and context. Principal-agent theory and institutional theory can provide promising theoretical lenses.

Moreover, our results confirm the pattern of niche sustainability projects leading to strategic

organizational adoption commonly described within the sustainability literature as one transformation trajectory of the SEU (Geels & Schot, 2007; Verhulst & Lambrechts, 2015). Given that existing research focused primarily on the role of individuals in transformations, our findings add to the discussion by illustrating that not only isolated projects and individuals may induce SEU transformations but also HEI departments. Specifically, during Maturity and Advocacy, the synergy between UBI transformation activities effectively engaged faculties, other HEI departments, and external stakeholders to engage with sustainability. Moreover, UBI employees commonly referred to the UBI as the focal actor of transformation activities. While legitimization strategies might explain such behavior, they also emphasize the role of HEI departments as institutional entrepreneurs in SEU transformations.

6 Conclusions

6.1 Contributions

Our research has focused on investigating the sustainability transformations of UBIs to gain insights into the emergence and trajectories of SEUs. Our contributions to the field of study are twofold. Firstly, we addressed a neglected area in the UBI literature by describing the organizational change processes in UBIs. Specifically, we outlined different sustainability transformation trajectories and described six stages based on their goals, transformation activities, support for SAE, and barriers. Moreover, we demonstrated how these stages are dynamically interconnected and developed a stylized model for understanding UBI sustainability transformations.

Secondly, given that few studies on sustainability in HEIs have taken an entrepreneurial perspective, we contribute to the scarce SEU literature by uncovering novel characteristics and providing additional insights into the emergence of SEUs. Contrary to the narrow view that distinguishes top-down and bottom-up change processes, we argued for a more holistic understanding of the SEU, as both trajectories are inherently interconnected. Moreover, we hypothesized that the nature and magnitude of sustainability impacts change throughout SEU transformations.

We also found the role of leadership commitment as a mediating factor and underscored the importance of considering the institutional dimension in SEU transformations. Additionally, we presented evidence on the strategic rationale behind SEUs engaging in external partnerships and discussed the role of policy and enabling factors in inducing SEU transformations.

Given the pressing global environmental and social challenges, effectively integrating the SEU concept into practice is imperative. Our results contribute to this endeavor by providing a stylized systematization of sustainability transformations in SEUs and UBIs. This enables practitioners to develop superior transformation management strategies and offers regulators opportunities for more targeted support for SAE. By identifying and describing distinct stages of UBI transformation, managers can effectively introduce SAE activities and proactively address potential barriers through responsive policies. Based on our analysis, Table 9 summarizes the main recommendations to various SEU stakeholders.

6.2 Implications for SEU policy

Designing and implementing SEU policies is not without risks and challenges. First, there is the risk of absent contextualization. HEIs exhibit inherent diversity in their missions, resources, culture, and regional contexts. A rigid, one-size-fits-all policy approach thus would not accommodate the plurality of SEU variations. A second risk encompasses superficiality. SEU policies that effectively induce *greening* HEI operations might seemingly succeed in reducing negative environmental and social impacts. However, this apparent success may mask a failure to drive the profound and systematic changes needed for genuine sustainability transformation. The risk thus lies in mistaking surface-level improvements for meaningful, sustainable progress. Moreover, tying public funding schemes to SEU transformations carries the risk of *tokenism*. HEIs may be tempted to engage in surface-level efforts to secure rewards or recognition associated with sustainability goals. As a result, SEU policies can become

Table 9 Recommendations for EU stakeholders

Stakeholder	Recommendations
HEI leadership	<ul style="list-style-type: none"> • Fill vacant positions with people who have profound experience and networks in sustainable entrepreneurship • Dedicate sufficient resources to transformation activities • Maintain continuous support for change agents throughout the transformation trajectory • Enable cross-campus networking for connecting sustainability change agents • Screen for and apply for external funding opportunities dedicated to sustainable entrepreneurship • Collaborate with other HEIs and ecosystem stakeholders to advocate national policy frameworks in favor of SEU transformations • Adapt existing internal academic entrepreneurship policies to align with the context and requirements of sustainable entrepreneurship, such as incorporating sustainability metrics and objectives into existing policies
UBI leadership	<ul style="list-style-type: none"> • Empower and support sustainability champions prior to and during the transformation • Continuously advocate for the sustainability transformation throughout the trajectory • Seize external collaborations and joint projects for developing internal capacities • Leverage external collaborations to enhance societal impacts • Foster collaboration and participatory formats during the early stages of transformation trajectories
UBI employees	<ul style="list-style-type: none"> • Build momentum for triggering SAE transformations by collaborating with other change agents • Use existing tools and resources for sustainable entrepreneurship when accelerating the transformation, nurture strategic alliances with external organizations • Point towards HEI mission statements when arguing for transformations
Ecosystem and policy	<ul style="list-style-type: none"> • Assess and align existing academic entrepreneurship policies to fit with the context and requirements of sustainable entrepreneurship. Develop dedicated national or federal strategies dedicated to supporting SAE • Consider that the sustainability impact of SEUs is contingent on internal transformation stages. Develop stage-based SEU sustainability assessments • Introduce or align existing policies for SEUs with respect to sustainability transformations maturity levels. Thereby distinguishing policy interventions that support SEUs during their emergence, infancy, and maturity • Seize interdisciplinary ecosystem partnerships strategically concerning the transformation stages

a mere *checklist* approach, where institutions prioritize meeting sustainability targets without committing to substantive changes. Fourth, SEU policies risk sparking new competition between HEIs and faculties, preventing the establishment of cooperation needed to drive system change. Increased bureaucratism is another potential risk. Indeed, administrative hurdles and reporting requirements already challenge HEIs because they are time-consuming and resource-intensive. As SEU policies are likely to be complex, they could exacerbate the situation for HEIs. Lastly, as with all regulations, policymakers face the issue of opportunity costs. When policies allocate resources or funding based on sustainability performance, there is a potential risk that HEIs will divert resources away from core academic functions, such as teaching and research. It is crucial to balance sustainability initiatives and the quality of education and research. Policymakers must ensure that sustainability efforts complement, rather than undermine, the core academic mission of HEIs.

We recommend that policymakers follow a multi-faced approach to address the challenges mentioned above and establish a robust foundation for SEUs to ensure long-term sustainability commitments in HEIs. First, policymakers should adopt a hyper-regional policymaking approach considering the diversity of HEIs and regional contexts. SEU policies should be designed broadly to accommodate universal goals while allowing flexibility for contextual SEU adaptations. This approach respects institutional autonomy and each institution's unique circumstances, encouraging HEIs to address regional sustainability challenges, as highlighted by Wakkee et al. (2019). In this regard, policymakers should enable HEIs to formulate sustainability visions with stakeholders across campus and externals and foster their seamless integration into HEIs' core missions and strategic plans. Sustainability is less vulnerable to competing interests when it becomes intrinsic to an institution's identity. Second, policymakers should incentivize HEIs to adapt the SEU model by measures, such as offering sustainability awards, tying public funding to sustainability targets, or implementing faculty sustainability goals. However, given the urgency of the transformation, these activities should be accompanied by strict compliance measures for all ecologically harmful and resource-intensive activities, e.g., excessive energy consumption. Third, transparency about sustainability impacts is crucial. Establishing clear sustainability

performance indicators for SEUs, including targets for energy efficiency, waste reduction, and carbon neutrality, is essential. Regular reporting and public disclosure may maintain the institutional focus on sustainability. Policymakers should design funding, rewards, and recognition systems based on holistic sustainability metrics encompassing environmental, social, and economic dimensions. Expanding HEI rankings to include sustainability criteria could accelerate adoption. Fourth, collaboration among diverse stakeholders within HEIs and across the entrepreneurial ecosystem is vital for SEU's success. SEUs are closely linked to their communities and develop sustainable missions in response to local sustainability issues. Policymakers should actively promote partnerships between HEIs, local governments, businesses, and nonprofits to foster new sustainability projects. Measures like joint project proposals, project-based learning, and sustainable UBIs can foster such interdisciplinary collaboration. Establishing sustainability centers to coordinate SEU transformations, mediate disparities in interests between faculty and administrative units, and facilitate transparent communication among stakeholders can further support these efforts (Soini et al., 2018).

6.3 Future research and limitations

Our theoretical contributions open several promising future research opportunities, which enable new theoretical insights into UBIs and the SEU. Table 10 offers various research questions across four themes.

Our study has several limitations. First, our case study methodology relied on multiple data sources and validation steps, but our data is mainly cross-sectional and retrospective. Hence, longitudinal research designs are needed to validate our findings. A second challenge of our study is the limited generalizability, given that our study focused on a small set of four UBIs in the German context. Future research may replicate our approach in other contexts to increase our findings' external validity. Moreover, quantitative research may further assess the suggested theoretical propositions. Third, our study faces temporal constraints. Sustainability transformations are likely to evolve continuously over more extended periods. Thus, our study might not capture the full extent of the transformation process. While our research relied on dense data for describing early trajectory stages, the later stages of UBI SAE trajectories require more exploration

using other case studies. However, to realize such studies, frontrunner UBIs must reach the advanced trajectory stages in the first place. Fourth, given that our analysis focused primarily on transformation stages and activities, our insights on the implications for UBI culture mean only an indication. More rigorous assessment methods are required to analyze the complex cultural processes throughout sustainability transformations. Finally, our propositions for SEU in Sect. 5 were primarily developed based on insights at the UBI level. Thus,

they need to be tested and validated by future scientific inquiry.

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Declarations

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Appendix

Table 10 Future research avenues

Theme	Research question
Transformation activities	<ul style="list-style-type: none"> Given that the UBI leadership opposes transformation, what strategies do bottom-up change agents use to implement SAE missions? What are the different properties of change agents at the UBI leadership and UBI employee level in the SEU context? What activities and strategies do UBI leadership change agents use for (simultaneously) accelerating SEU transformations at the HEI and UBI levels? What tensions and barriers appear? Under which conditions do UBI employees engage in unsustainable behavior?
Transformation trajectories	<ul style="list-style-type: none"> How do trajectories develop if a new leadership opposes the former SAE mission or introduces a new strategy? What narratives do change agents and/or opponents use to transform and/or sustain existing institutions? What power relationships emerge between progressive and resistant UBI employees during sustainability transformations and across the trajectory stages? To what extent do strategic missions other than SAE follow different transformation trajectories? To what extent do previous successes and failures create path dependencies and affect transformation trajectories? Given that a UBI follows a bottom-up and then enters a leadership-induced trajectory, how does its transformation path differ from a UBI that directly emerges on a leadership-induced trajectory? What strategies do UBIs use to exit the Ambiguity stage? Does the Ambiguity stage differ depending on the previous trajectory? To what extent do transformation trajectories of private entrepreneurial support organizations differ from publicly funded UBIs? To what extent do other HEI departments follow different transformation trajectories?
Sustainable entrepreneurial university	<ul style="list-style-type: none"> How do UBIs create alliances with other EU institutions for mutually accelerating SEU transformations? What role do students play in triggering/advancing the SEU? How does an SAE strategy affect the UBI's abilities and strategies in generating interest in technology and knowledge transfer among scientists and students? How can SEU leaders align internal policies, processes, and regulations to trigger sustainability transformations in HEI departments?
Sustainable entrepreneurial ecosystems	<ul style="list-style-type: none"> In what way do greater societal transformations shape SEU sustainability transformations? To what extent does sustainability as a mutual strategic goal enable partnerships with competing UBIs? How do UBIs protect their business model from imitation while maintaining the ambition to enable other entrepreneurial support organizations to adopt SAE? How does the SEU leverage partnerships to scale sustainability impact?

Table 11 Interview protocol

Main questions	Follow-up questions
Intro	
Please introduce yourself briefly and outline how long you have been working for [name of the organization] and what position and responsibilities you take	
Could you please introduce your organization and describe the overall goals and purpose of [name of the organization]?	
Transformation enablers	
Let's turn back time. Could you please describe when and why your organization started to approach sustainability?	<p>Who are/were the main driving individuals behind a focus on sustainability orientation from the start?</p> <p>How did [Person X / Factor X] enable change toward sustainability in your organization?</p> <p>What organizational factors shaped the adoption of sustainability within the incubator?</p> <p>What external factors shaped the adoption of sustainability within the incubator?</p> <p>To what extent did external factors, e.g., public debates or politics, contribute to the incubator's focus on sustainability?</p>
Transformation activities	
Could you please describe how your organization started to approach sustainability?	
What were key achievements or events for [name of the organization] on the journey to becoming sustainability-focused?	What were particularly motivating / frustrating situations for the organization during the sustainability journey?
Strategic activities	
To what extent is sustainability part of the mission and vision for [name of the organization]?	<p>Do your colleagues share a vision for the organization? What are the differences and similarities?</p> <p>Has the relationship to sustainability in your organization changed over time? Why?</p>
How has the topic of sustainability changed [name of the organization] goals?	
How were the ideas and visions of sustainability for [name of the organization] considered and coordinated strategically?	Did [name of the organization] develop a strategic plan for approaching sustainability? What did it encompass?
Tactical activities	
How did [name of the organization] change its organizational structure, e.g., reporting lines or creating new teams?	
What new partnerships or collaborations has [name of the organization] established to strengthen sustainability in the incubator?	What is the relevance of these partnerships for fostering sustainability (within the incubator)?
Operational activities	
How did and does the issue of sustainability affect the everyday practices and organizational routines of [name of the organization]?	<p>Have you and your colleagues introduced new meetings or communication processes?</p> <p>What discussions has the topic of "sustainability" triggered internally? At what level did these take place?</p> <p>In which moments of everyday work does/did sustainability come up?</p> <p>How has the issue of sustainability shaped the organization over the past year?</p>

Table 11 (continued)

Main questions	Follow-up questions
What sustainability projects has [name of the organization] launched or participated in existing initiatives?	How do new project ideas and initiatives for sustainability emerge in the incubator?
How does [name of the organization] support the sustainability journey of its tenant start-ups?	What support services does [name of the organization] offer to help start-ups develop their business sustainably?
	How did [name of the organization] change its facilities and infrastructure to promote sustainability?
	What sustainability-related support services for networks and funding does [name of the organization] offer?
	How did [name of the organization] create the knowledge base to foster sustainability orientation?
	Did [name of the organization] of the incubator integrate new funding sources? If yes, which?
How did sustainability affect the internal culture of [name of the organization]?	
<i>Reflexive activities</i>	
How does [name of the organization] monitor achieving its sustainability-oriented goals?	Does [name of the organization] perform any form of sustainability reporting, e.g., integrated reporting?
What measures have been introduced to reflect the sustainability journey of [name of the organization]?	Please describe, from your point of view, the time after sustainability was communicated as a strategic goal
<i>Outro</i>	
How do you think [name of the organization] could embed sustainability even more strongly?	

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