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MASTER

Leveraging Collaboration to Transform TU/e Into a University Sustainability Change Agent

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EINDHOVEN UNIVERSITY OF TECHNOLOGY

Industrial Engineering and Innovation Sciences

Master Thesis

Leveraging Collaboration to Transform TU/e Into a University Sustainability Change Agent

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List of Abbreviations

AB   Advisory Board

CA   Change Agent

CEC   Communication Expertise Center

EB   Executive Board

ESA   Education and Student Affairs

EPC   Equipment and Prototype Center

FMC   Facility Management Center

GA   General affairs

GGO   Go Green Office

HRM   Human Resource Management

LIS   Library and Information Services

NGO   Non-governmental Organizations

P&CM   Procurement and Contract Management

RE   Real Estate

SA   Sustainability Ambassador

SCA   Sustainability Change Agent

SCT   Sustainability Core Team

SDGs   Sustainable Development Goals

ST   Sustainability Transition

SIA   Strategic Industry Alliances

UR   University Rebellion

USCA   University Sustainability Change Agent

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Preface

For six months, I have written my master's thesis to complete my master of Innovation Sciences at the Technical University of Eindhoven (TU/e). This would not have been possible without specific persons around me, which I would like to thank in this chapter.

TU/e and the Department of Industrial Engineering and Innovation Sciences

I start by telling my appreciation for the TU/e organisation, specifically the Industrial Engineering and Innovation Sciences department. The organisation and the department are both unique in terms of feeling at home due to the relatively small scale it has in itself. Furthermore, the university campus knows many facilities and events, contributing to finding friends and having fun. Next, the department knows many great researchers who are very rich in knowledge and are open to discussions. Moreover, I enjoyed every course I followed during my master's program. For me, it is important to stress the importance of the existence of the Innovation Sciences master program because it has a special place in a technical university environment, where there is looked critically towards technological developments, hence providing a deep understanding towards steering technological developments into the desired direction and being conscious about the choices to make, that have an impact on tomorrow's world.

Supervisors

The master's thesis period started very rough due to some unforeseen circumstances. This resulted in a significant amount of stress during the first period, wherein I needed to find a first supervisor on short notice. Anna Wieczorek, my first supervisor, was the person who agreed to supervise me during this stressful time. Moreover, Anna guided me throughout the research, provided me with feedback, encouraged me to think hard about the study, and felt perfect when I was almost reaching my limits of working. Therefore, I know Anna as a very intelligent, driven, passionate, and kind supervisor, and I am very grateful that Anna trusted me from the beginning. Next, I would like to thank my second supervisor Marcel Bogers, who also trusted me from the beginning of my research. Marcel is a tremendously intelligent and kind person who always had unlimited ideas and answered probably over a hundred e-mails from me, with always a positive reaction. Therefore, I also want to thank him for supporting me during the rough start, thinking along, and providing feedback. Last but not least, I want to express my appreciation to Heleen de Coninck, my third supervisor and mentor during my master's. I thank Heleen for reviewing my master's thesis and for her two years of mentoring. During this time, Heleen supported me in pursuing my ambitions and guided me in any direction I wished to explore. Heleen also posed critical questions and helped shape my development over these two years.

Interviewees, Friends, Family, Girlfriend, and Fellow Students

I want to speak words of thankfulness toward the interviewees that participated in this research. Furthermore, I would like to thank my friends, family, girlfriend, and fellow students for their support. Especially Lou Janssen, my fellow student and friend, who supported me from the beginning of this research. During my thesis, I spent more time with Lou than with my friends and family, as we worked together at TU/e daily. Lou provided comfort during times of stress, assisted me in conceptualisation, and encouraged critical thinking.

In conclusion, I am proud to present this master's thesis, and I am confident that this research will make a meaningful contribution to innovation sciences and help TU/e become a University Sustainability Change Agent.

Lucas Ramaekers
July 2023

Executive Summary

Society faces global environmental, social, and economic challenges due to overstepping the planetary boundaries (Purcell et al., 2019). To overcome these challenges, the world must move beyond business-as-usual practices and transition to sustainability practices (Markard et al., 2012). To achieve such a sustainability transition (ST), all members of society must be involved and collaborate to make optimal use of the specific capabilities and resources of various actors (Köhler et al., 2019).

The Sustainable Development Goals were developed to address such global challenges (UN, 2015) and universities are believed to be a key actor in achieving these goals (Findler et al., 2019; Trencher et al., 2014). One of the main reasons is that they are locally rooted and globally connected (Findler et al., 2019; Trencher et al., 2014). Moreover, they educate future generations and have the potential to establish a culture where sustainability is at the core of the university (Tilbury, 2022). However, to lead the transition, universities must collaborate to overcome resistance to change (Shiel, 2013).

To take the lead as university in the ST, they need to transform internally (Tilbury, 2013) from a 'business-as-usual university' into a 'sustainable university', where the organisation better integrates sustainability across its entire organisation (Kapitulčinová et al., 2018). To achieve this integration, different organisational levels must collaborate to achieve this internal change (Folke et al., 2005; Rijke et al., 2013).

The Technical University of Eindhoven (TU/e) has committed to sustainability through its Strategy 2030: Drivers of Change (TU/e, 2018b, 2021a). However, despite efforts, TU/e does not actively collaborate between the relevant actors. To address this issue, this research aims to provide insights and recommendations enabling TU/e to establish the necessary collaboration to lead the ST. This leads to the following research question:

'How could TU/e leverage collaborations between the relevant actors to become a University Sustainability Change Agent?'

To address this research question, the following three sub-questions are answered:

SQ1: 'What is University Sustainability Change Agent?'

SQ2: 'To what extent is TU/e acting as a University Sustainability Change Agent?'

SQ3: 'How can TU/e establish or enhance collaboration with the relevant actors to become a University Sustainability Change Agent?'

Methods

This research was divided into three sub-questions and employed a mixed-method approach. The first sub-question was answered by conducting a systematic literature review and a backward bibliographic search. This information was used to define a University Sustainability Change Agent (USCA). The definition served as a conceptual framework with three criteria to assess the extent to which a university is a USCA, using a three-point scale: Sufficient, Sufficient/Insufficient, and Insufficient. The second sub-question was answered through document analysis and semi-structured interviews, focusing on TU/e's context. The third sub-question was addressed using semi-structured interviews to indicate recommendations, after which a literature review validated the proposed recommendations.

Results and Conclusion

The first sub-question focused on defining USCA, resulting in the following definition:

A USCA actively strives for an entire system change from the old unsustainable socio-technical system towards a sustainable one. USCAs collaborate with diverse actors outside their organisation, such as universities, governments, companies, non-governmental organisations, and society. To achieve this sustainability transition, USCAs integrate sustainability into universities' four key activity categories (Higher-level management, Education, Research, Operations). Actor groups within these categories collaborate to navigate the transition to sustainability. Individuals in the actor groups possess sustainability change agent skills and characteristics to realise collaborations between the actor groups.

This definition serves as a conceptual framework to assess to what extent a university acts as a USCA. The conceptual framework typifies universities in four categories with specific key activities: Higher-level management, Education, Research, and Operations. Higher-level management involves the key activity of creating the university's strategies, policies, and long-term visions. Education involves key activities such as providing lectures and tutorials. Research involves advancing scientific boundaries and filling knowledge gaps by publishing peer-reviewed journal papers. Operations involves daily activities needed to run the organisation, such as heating buildings, waste management, catering, logistics, and more. Within these four categories, there are different actor groups. For example the Operations category has different support services, such as human resource management and general affairs. Furthermore, there are different roles within the different actor groups. For example, the category Education contains individuals that are either students or teachers. Universities can only become a USCA if the individuals within the actor groups possess Sustainability Change Agent (SCA) skills and characteristics. When these SCA skills and characteristics are present, the actor groups are more likely to collaborate on sustainability topics with other actor groups and external actors. When these collaborations are present, sustainability can be integrated into the categories. Therefore, a hierarchical order exists between individuals, actor groups, and categories.

The second sub-question converted the conceptual framework from the first sub-question to an assessment framework, to focus on the extent to which TU/e acted as a USCA. This framework identified three criteria to assess to what extent TU/e acted as a USCA. The first criterion, called the *skills and characteristics criterion,* focuses on the individuals within the actor groups and examines the extent the individuals within the actor groups possess SCA skills and characteristics. The second criterion, called the *collaborations criterion*, focuses on the actor groups within the categories and the extent to which they collaborated with actor groups and external actors to contribute to the goal of sustainability. The third criterion, called the *sustainability direction criterion*, focuses on the category and to what extent sustainability is incorporated into the goals and activities of each category and to what extent they try to transition towards sustainability, referred to as the internal ST. It also states to what extent it tries to influence the societal ST, referred to as the external ST.

Firstly, TU/e scored Sufficient on the *skills and characteristics criterion*, meaning that TU/e had a relatively strong basis of individuals with SCA skills and characteristics, creating a foundation to foster collaborations to support the internal and external ST. Secondly, TU/e scored Sufficient/Insufficient on the *collaborations criterion*, meaning that some actor groups within the different categories established collaborations for sustainability, but other actor groups did not establish these collaborations, which needed improvement. Thirdly, TU/e scored Sufficient/Insufficient on the *sustainability direction criterion*, meaning that the direction of change within the categories was somewhat towards sustainability. This showed that TU/e acknowledged the importance of sustainability, while this needed to be clearly articulated in the actions and goals in the different categories.

It is remarkable that the presence of individuals with SCA skills and characteristics did not result in a significant amount of sustainability collaborations. Possible explanations lay in time and resource constraints that limit the potential of the individuals. Another limiting factor could be that individuals need a place to establish these collaborations. Furthermore, this lack of employment of the SCA skills and characteristics and the lack of collaboration could also be seen back in the scores of the *sustainability direction criterion*, which indicates that there is a misalignment between the ambitions TU/e has to become a USCA and the goals and activities the categories show. Therefore, to become a USCA, TU/e primarily needs to intensify existing and set up new collaborations with other actor groups and external actors. This is pivotal to improve the direction of change towards sustainability, where TU/e aims to promote the internal and external ST.

The third sub-question focused on how TU/e could establish or enhance collaboration with relevant actors to become a USCA. This question was answered by focusing on improving the *collaborations criterion*, and the *sustainability direction criterion*. The *skills and characteristics criterion* was not addressed because the overall SCA skills and characteristics of individuals at TU/e were sufficiently present to improve the *collaborations criterion*. Next, four quadrants were established to distinguish the actor groups on the *collaborations* and *sustainability direction criteria*. The first quadrant, Limited impact changers, included actor groups with limited influence through collaboration on both the internal and external ST. The second quadrant, Internal changers, included actor groups with limited influence through collaboration on the external ST but scored high in influencing the internal

ST. The third quadrant, External changers, included actor groups with limited internal influence through collaboration but exerted a significant impact on the external ST. The fourth quadrant, Dual impact changers, included actor groups who could influence both the internal and external ST through collaboration.

The limited impact changers actor groups could mobilise actor groups to create a critical mass. This improves the *collaborations criterion* by strengthening collaborations on sustainability and improving the *sustainability direction criterion* by influencing the internal ST. The internal changers actor groups could create a physical meeting point for sustainability, improving the chances of establishing collaboration, and the *collaborations criterion*. It also improves the *sustainability direction criterion* because it increases the chances of creating actions towards sustainability at TU/e. The external changers actor groups could join network events and attend conferences, improving the chances of establishing collaborations and improving the *collaborations criterion*. It also improves the *sustainability direction criterion* because it helps to influence the external ST. The external changers actor groups could also utilise the buying and supplying power to influence external actor sustainability practices, which improves the *collaborations criterion* on collaborations and the *sustainability direction criterion* by influencing the external sustainability transition. The Dual impact changers actor groups could steer TU/e towards the fourth-generation university where the campus becomes a place for collaboration with actor groups and external actors, improving the *collaborations criterion* and the *sustainability direction criterion* by incorporating sustainability in the activities and goals of TU/e and influencing the internal and external ST.

Based on the findings obtained from the analysis of the three sub-questions, an answer to the main research question could be formulated, describing how TU/e could leverage collaborations between the relevant actors to become a USCA. Firstly, TU/e could provide individuals with SCA skills and characteristics time, resources, and space to employ these skills and characteristics. This could allow these individuals to focus on decreasing the language barrier between different categories and creating sustainable collaborations with actor groups and external actors. Secondly, TU/e could leverage collaborations between the relevant actors to become a USCA by encouraging the establishment of these collaborations between actors groups and external actors. The encouragement could be creating physical meeting spots, encouraging actor groups to join network events or attend conferences, utilising buyer and supplying power, and promoting the fourth-generation university. Next, by leveraging the collaborations between the relevant actors to become a USCA, TU/e could align its ambitions to become a USCA with its goals and activities present in the categories, hence steering actively towards sustainability. Last, when implementing these recommendations, TU/e could leverage the collaborations between the relevant actors and become a USCA.

Practical implications
The research findings have practical implications for TU/e, outlining key steps to be taken. Firstly, TU/e could promote a culture of collaboration throughout the organisation, where encouraging open dialogue, knowledge sharing, and interdisciplinary cooperation is crucial. To facilitate this culture, creating dedicated physical platforms that promote collaboration and the exchange of ideas about sustainability is recommended. These platforms could serve as meeting spots for actor groups from different levels of the organisation, where expertise is shared and where there is room to work on sustainability-related topics. By creating these spots, TU/e can increase their leverage of collective knowledge. Secondly, TU/e could actively collaborate with external actors, such as governments, non-governmental organisations, companies, and knowledge organisations of different sizes. Collaborating with these external actors provides valuable resources, expertise, and support to the internal and external ST. Thirdly, TU/e could transform their campus into a collaborative space that promotes collaborations with actor groups and external actors. This collaborative space could encourage interdisciplinary collaborations between academia, industry, government, and society. Fourthly, TU/e could influence the external ST by utilising its buying and supplying power through demanding sustainability requirements.

1 Introduction

1.1 Background

According to White (2013), the most known definition of sustainability is from the World Commission on Environment and Development (1987, P. 16), which is 'to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.' Currently, tipping points are overstepping the planetary boundaries, and society faces global environmental, economic, and social challenges (Purcell et al., 2019). The challenges stem from various factors, such as climate change impacts, ageing infrastructure, environmental degradation, and resource depletion (Mintrom & Rogers, 2022). In 2015, 193 countries set a step toward addressing these challenges by defining and adopting the Sustainable Development Goals (SDGs), which provide the first agreed actionable world community agenda for all people (UN, 2015). Achievement of the goals implies that the world must move beyond business-as-usual practices and transition towards sustainability practices (Markard et al., 2012).

Sustainability transitions (ST) are large-scale radical changes in technological, organisational, and institutional terms (Farla et al., 2012). One of the main characteristics of transitions is that they concern all members of society (Farla et al., 2012). Furthermore, these actors are necessary for mobilising a system change because they play different roles in the transition by bringing their different capabilities and resources together (Köhler et al., 2019). Universities are believed to be key in the ST because they are locally rooted and globally connected, providing significant possibilities for achieving the SDGs (Findler et al., 2019; Trencher et al., 2014). Moreover, universities possess a favourable position to catalyse the transition towards sustainability as they educate future generations and can foster a culture in which sustainability is deeply embedded within the university (Tilbury, 2022).

It is further argued by Sterling et al. (2013) that, to change the current scenario towards a more sustainable one, universities could focus on building leadership capabilities because change does not happen spontaneously (Scott et al., 2012). Leading this change for sustainability by a university requires more than the commitment to transform the higher education system or possessing knowledge of sustainability (Tilbury, 2013). According to Tilbury (2013), this change for sustainability necessitates the ability to navigate organisations through a change process that is political, slow, uncertain, and complex. To lead in the transition, next to showing passion and commitment, universities must collaborate to overcome resistance (Shiel, 2013). These collaborations facilitate sharing of feedback, support, experiences, and information (Sterling, 2013). Moreover, collaborations can combat isolation by building a sense of being part of a broader movement (Sterling, 2013), enabling the mobilisation of multi-stakeholder dialogues and exploring ways to promote multi-sectoral and interdisciplinary collaborations for sustainable development (Wade, 2013). Examples of actors that universities could collaborate with include other higher education organisations, industry, healthcare, business, entrepreneurs, and community partners (Findler et al., 2019; Stephen et al., 2008). Overall, these collaborations are considered as the critical driving force for starting and maintaining the momentum of change (Shiel, 2013).

To contribute to the sustainability challenges mentioned before and to become a university where sustainability is at its core, there is an urge for universities to transform internally, where sustainability ought to be more holistically and urgently considered instead of solely prioritising the delicate equilibrium between growth, quality, and reputation (Tilbury, 2013). In this process, they must transform from a 'business-as-usual university' into a 'sustainable university', where the organisation better integrates sustainability across its entire organisation, where different stages of integration need to take place from initiation, implementation, to institutionalisation (Kapitulčinová et al., 2018). Different administrative and organisational levels must collaborate to achieve internal transformation (Folke et al., 2005; Rijke et al., 2013).

The Eindhoven University of Technology (TU/e) is a technical university that has committed to sustainability by supporting the SDGs through its Strategy 2030: Drivers of Change (TU/e, 2018b, 2021a). Efforts towards sustainability at TU/e involve the active participation of multiple stakeholders, with various support services giving attention to this crucial topic (GGO, 2022). Furthermore, research groups, university institutes, and departments are also actively addressing the grand societal challenges that lie ahead, integrated into the educational program (Shindler, 2022). Initially, sustainability endeavours lacked coordination, but significant progress was made in 2022 by establishing a new

sustainability structure (GGO, 2022). This development facilitates interaction among different actors, potentially influencing the current sustainability practices and policies at TU/e. This is exemplified in a case study of TU/e which has a history of training engineers with the support of the multinational corporation Philips and the government (Romme, 2022). This unique combination of actors and Eindhoven's collaborative history fosters an open culture at the university, encouraging initiative-taking and idea exchange (TU/e, 2021a). Therefore, TU/e has shown its potential to become a leader in the ST.

1.2 Problem Definition

Despite considerable efforts to integrate sustainability into TU/e and involving multiple actors, the university needs more active collaboration between the relevant actors within and beyond its on-campus ecosystem. For example, research collaborations addressing sustainability challenges primarily involve universities and companies, overlooking the active engagement of other critical actors, such as non-governmental organisations (NGOs) (Shindler, 2022). Moreover, focusing narrowly on traditional triple helix collaborations (industry, academia, government) restricts the inclusion of diverse perspectives, resources, and expertise required for driving sustainable development. By confining collaborations to traditional triple helix models, TU/e fails to harness the full potential of a collaborative approach encompassing a wider range of actors.

To harness the full potential of collaboration and take a leadership role in the ST, TU/e first needs to transition internally towards sustainability, which could be possible if the on-campus actors collaborate, where individuals are needed that promote these collaborations. Moreover, a conceptual framework is missing in literature to determine to what extent TU/e is internally ready to become a leader in the ST, and to identify the actors for potential collaborations to become this leader. This thesis aims to answer this problem by applying the literature on change agents in the context of sustainability to universities. This literature is combined into a definition of the University Sustainability Change Agent (USCA). The definition serves as a conceptual framework, which is applied to analyse how TU/e is acting now, and how TU/e can take the next steps to become a leader in sustainability by leveraging their collaboration potential.

1.3 Research Questions

This research aims to assist TU/e in realising its ambitious goal of becoming a leader in sustainability by actively collaborating between the relevant actors. To achieve this, this thesis proposes TU/e should acts towards becoming a USCA. This leads to the main research question:

'*How could TU/e leverage collaborations between the relevant actors to become a University Sustainability Change Agent?*'

To address this main research question, the definition of USCA is developed with criteria to assess universities to what extent they act as USCA. Next, TU/e is evaluated on these criteria, and recommendations are provided on how TU/e could establish or enhance collaborations with relevant actors to become a USCA. Consequently, the following sub-questions have been formulated:

SQ1: 'What is University Sustainability Change Agent?'

SQ2: 'To what extent is TU/e acting as a University Sustainability Change Agent?'

SQ3: 'How can TU/e establish or enhance collaboration between the relevant actors to become a University Sustainability Change Agent?'

This thesis contributes to the research field of STs in universities, and can be regarded as a valuable case study. Moreover, the methods employed in this study can benefit other universities seeking to evaluate to what extent they are acting as a USCA. Last, *Figure 1* on page 12, provides an overview of the problem statement, the research question, and the sub-questions.
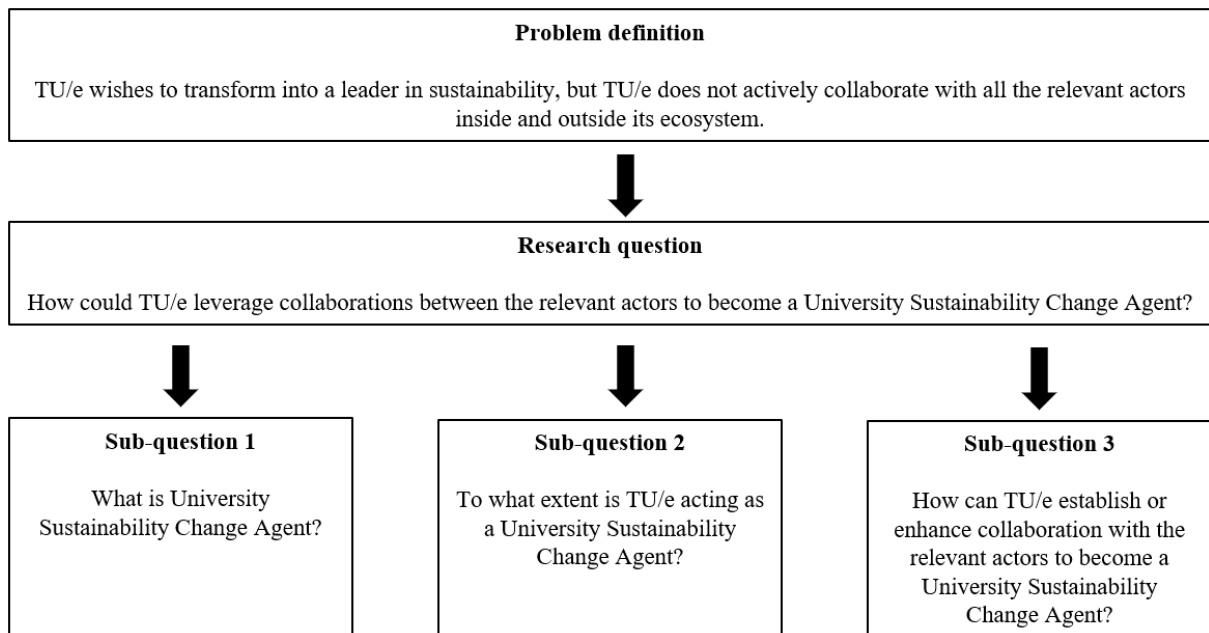
Figure 1: Overview of the Problem Definition, Research Question, and Sub-question

1.4 Report Outline

Chapter 2 outlines the methods used. Chapter 3 defines USCA, addressing sub-question 1. Chapter 4 assesses the level of TU/e becoming a USCA, answering sub-question 2. Chapter 5 presents recommendations on how TU/e could establish or enhance collaborations to become a USCA, answering sub-question 3. Finally, Chapter 6 concludes this master's thesis by addressing the main research question.

2 Research Methods

This chapter begins by discussing the ontological foundations employed in this research. It then introduces the research design and methodology to address the sub-questions. Additionally, it provides an overview of the research approach, data collection methods, and analysis techniques.

2.1 Ontological Foundations

This research adopted a constructivist worldview because it aimed to understand the meanings of multiple participants (Creswell & Creswell, 2018). Constructivism posits that the world consists of social constructs, with actors having different relations with each other. In this regard, it differed from post-positivism, which focuses on facts, numbers, and relationships. Other worldviews, such as transformative and pragmatism, were also considered. These worldviews differed in terms of ontology, the nature of the world; epistemology, the required knowledge and its acquisition; and methodology, the research process (Denzin & Lincoln, 2011).

This research drew insights from two bodies of literature: transitions studies to explore transition processes and innovation management to investigate ways of establishing or enhancing collaborations. Both bodies of research shared a constructivist ontology. However, they differed in terms of the epistemological communities they belonged to. The innovation management community primarily focuses on companies at all levels, ranging from individuals within a company to the broader ecosystem. On the other hand, transitions studies focused on broad socio-technical systems, where companies played a smaller role. Similarly, innovation management emphasised innovations related to the company level, such as product or process innovations, whereas transitions studies literature focused on system-level innovations or transitions. Another distinction was evident in the conceptualisation of value creation. Innovation management predominantly focused on monetary values, while transitions studies considered values encompassing monetary, societal, and environmental aspects.

2.2 Research Design

This study employed a case study approach to delve into the dynamics and complexities of STs within the specific context of TU/e. The aim of adopting a case study approach was to understand TU/e's potential to become a USCA and make recommendations to establish or enhance collaborations. The case study methodology allowed for integrating multiple sources, including interviews, academic literature, and document analysis, enabling a detailed and comprehensive analysis of the phenomenon researched, often referred to as a mixed-methods approach. The research design used in this study, including an overview of the methodology, is illustrated in *Figure 1*.

To address the first sub-question, '*What is University Sustainability Change Agent?*', a scientific literature study was carried out, followed by semi-structured interviews, leading to a definition of USCA. The definition served as a conceptual framework to explore to what extent TU/e is acting as a USCA. Moreover, following the definition, three criteria were established to assess universities to what extent they acted as USCA.

To address the second sub-question, '*To what extent is TU/e acting as a University Sustainability Change Agent?*' document analysis and semi-structured interviews were carried out. An overview of the TU/e organisation and its relevant actors was created, which divided TU/e into the four categories that typify universities, which was an iterative process between the results from the semi-structured interviews and the document analysis. Next, TU/e was scored on a three-point scale on the three criteria created in first sub-question to indicate to what extent TU/e acted as a USCA.

To address the third sub-question, '*How can TU/e establish or enhance collaboration with the relevant actors to become a University Sustainability Change Agent?*' semi-structured interviews and a literature review were carried out. The semi-structured interviews indicated the recommendations, after which the literature review validated the proposed recommendations.

Last, this led to the overall answer to the main research question on how TU/e could leverage collaborations with all the relevant actors to become a USCA. An overview of the data sources, data analysis methods, and results per sub-question can be found in *Table 1* on page 14.

Table 1: Overview of the Data Sources, Analysis Methods, and Results per Sub-question

Sub-question	Data sources	Data analysis methods	Results
SQ1. The USCA definition	Scientific literature	Review & Coding	USCA definition and three corresponding criteria serving as conceptual framework
SQ2. The extent to which TU/e is acting as a USCA	Grey literature, Semi-structured interviews	Coding	Table with TU/e's USCA criteria scores
SQ3. The recommendations for establishing or improving collaborations to become USCA	Scientific literature, Semi-structured interviews	Review & Coding	Table with TU/e recommendations for establishing or improving collaborations to improve on USCA criteria

2.3 Methods Sub-Question 1

To answer the first sub-question: *'What is University Sustainability Change Agent?* a comprehensive literature review was conducted, starting with a systematic literature review followed by a backward bibliographic search.

Systematic Literature Review

A systematic literature review distinguishes itself from a traditional literature review by emphasizing the following four features: 'As far as possible, it should be comprehensive in its coverage of the literature; pay careful attention to the quality of included evidence; take a clear, systematic approach to the synthesis of the data; and generally follow transparent and rigorous processes' (Victor, 2008, P. 1). Taking these features into account, the systematic literature review began within the Scopus database using the following search string: TITLE-ABS-KEY (("sustainab* " OR "sustainable development " OR "sustainable growth" OR "sustainable business" OR "sustainable practices" OR "sustainable solutions" OR "sustainable initiatives" OR "sustainable strategies" OR "SDG ") AND ("change agent" OR "change-maker" OR "change leader" OR "change catalyst" OR "change influencer" OR "change champion" OR "change advocate" OR "sustainability advocate" OR "sustainability leader") AND ("universities" OR "higher education" OR "college" OR "academia" OR "research institution" OR "academic institution")) AND (("transition" OR "transf*")). This search yielded 74 articles. Next, to ensure the quality, the ten most cited articles were selected for analysis, however, arbitrarily and based on the time and resources available for this research.

Another search string was established to complement the transitions studies literature with insights from the management literature. For that purpose, the string was adjusted, with "transition" OR "transf*" replaced for ("manag*"). This additional search string yielded 77 results, from which the ten most cited articles were selected for further analysis. As shown in *Table 2* on page 15, the management search query yielded the following papers: Kapitulčinová et al., Hesselbarth and Schaltegger (2014), Lozano and Lozano (2014), Lozano et al. (2015), and Rodriguez et al. (2009) (*Table 2*). Next, the transitions string query included Blanco-Portela et al. (2018), Lozano et al. (2013), Moore (2005), Ralph and Stubbs (2014), and Wanner et al. (2018) (*Table 2*). Last, the following five papers overlapped in the search queries focusing on transitions and management literature: Beringer (2007), Dobson & Tomkinson (2012), Kapitulčinová et al. (2018), Peer & Stoeglehner (2013), Stephens et al. (2008) (*Table 2*).

Articles from both search strings were read and coded using an inductive approach called the grounded theory approach. This approach directly generates codes from the data (Linneberg & Korsgaard, 2019). This was established by creating nodes in NVivo 20 when re-emerging themes. The

use of two different types of literature strengthened the coverage of the literature, thereby increasing the validity and credibility of the research. For example, the transitions studies search string focussed more on external and radical changes in transitions. In contrast, the management string had a stronger focus on internal organisational changes and how they could be influenced by actors across the organisation.

Table 2: Allocation of Analysed Papers per Literature Body: Transitions and Management

Paper	Transitions string	Management string
Beringer, 2007	X	X
Blanco-Portela et al., 2018	X	
Dobson & Tomkinson, 2012	X	X
Filho et al., 2020		X
Hesselbarth & Schaltegger, 2014		X
Kapitulčinová et al., 2018	X	X
Lozano et al., 2013	X	
Lozano & Lozano, 2014		X
Lozano et al., 2015		X
Moore, 2005	X	
Peer & Stoeglehner, 2013	X	X
Ralph & Stubbs, 2014	X	
Rodriguez et al., 2009		X
Stephens et al., 2008	X	X
Wanner et al., 2018	X	

Backward Bibliographic Search

An additional literature review commenced with two pivotal publications on transformative research and sustainability change agent (SCA) typologies to reduce the risk of bias in the search string and avoid missing relevant studies or information. A backward bibliographic search was employed to identify other relevant articles. The researcher selected these key publications and consulted with an expert in transitions studies.

The backward bibliographic search began with the paper of Mintrom and Rogers (2022) as the starting point. After analysing this paper, six additional papers were chosen for further detailed study: Fayez et al. (2018), Novalia et al. (2020), Brown et al. (2013), Wittmayer et al. (2017), Castan et al. (2019), and Raven et al. (2012). Subsequently, the paper of Van Poek et al. (2017) was analysed, resulting in the selection of four additional papers for further analysis: Caldwell (2003), Ginsberg & Abrahamson (1991), Tichy (1975), and Saravanan (2015). The decision to analyse twelve papers was somewhat arbitrary and based on relevance, the saturation of emerged criteria, and the available research time and resources.

The papers were subjected to coding using an inductive approach to identify new themes emerging from the data. It is important to note that while the systematic literature review focused explicitly on USCAs, the backward bibliographic search adopted a broader perspective, encompassing the wider literature on transitions and USCAs. A list of identifiers was compiled from the results of both

analyses, and an overview of these identifiers is shown in *Appendix B*. These identifiers ultimately contributed to developing the USCA definition and three criteria to indicate the USCA level of universities.

2.4 Methods Sub-Question 2

To answer the second sub-question: '*To what extent is TU/e acting as a University Sustainability Change Agent?*' TU/e was assessed according to the three criteria of a USCA identified in the first sub-question. For the assessment, empirical data was gathered from documents analysis, and semi-structured interviews.

Document Analyses

According to Bowen (2009), data concerning the context in which a study is performed can be obtained through document analysis. To increase the validity of the results, the document analysis included TU/e policy documents, the TU/e's website, and internal research documents. An overview of the analysed documents can be found in *Appendix C*, and the coding was done according to the assessment criteria of a USCA as identified by the first sub-question.

Semi-Structured Interviews for Sub-Question 2

According to Gill et al. (2008), semi-structured interviews are designed to incorporate targeted questioning in specific areas that require exploration. They also argue that these interviews offer flexibility for the interviewer and interviewee to delve into new topics and request more details on areas of interest, unlike structured interviews, which lack this adaptability. In this study, semi-structured interviews were considered the most suitable approach because the interviewees needed knowledge about the TU/e's specific context, including the collaboration structures.

The interviews were approximately one hour, following a specific structure. The session began with a five-minute introduction, providing an overview of the interview process. The main portion of the interview lasted approximately fifty minutes. Finally, a concluding five-minute session was allocated for participants to ask any remaining questions they might have had. Conducting the interviews face-to-face in a private room at the TU/e campus was chosen to establish trust and encourage open communication, ensuring convenience for the interviewees. *Appendix A* contains the specific interview questions.

In qualitative studies, purposive sampling is often employed to select a relatively small sample size to deepen the understanding of the research topic (Miles & Huberman, 1994; Palinkas et al., 2015). In this research, a total of thirteen interviewees participated, and their positions, departmental affiliations or roles, and interview dates are provided in *Appendix D*. The selection of interviewees was diverse, covering various roles such as students, researchers, teachers, and employees, which strengthened the validity of the research outcomes. Purposive sampling allows for selecting respondents who are likely to provide relevant information and effectively utilises limited research resources by identifying individuals who are deemed interesting (Palinkas et al., 2015). It is important to note that the purposive sampling strategy does not involve random sampling and ensures that selected cases have the potential to contribute to the final sample of the research study (Campbell et al., 2020). This sampling strategy is based on the assumption that the objectives and aims of the study require the inclusion of specific individuals who hold important or different views on the research topic (Mason, 2002; Robinson, 2014; Trost, 1986). The purposive sampling method was deemed appropriate because the interviewees needed knowledge about the TU/e's specific context, including the collaboration structures.

2.5 Methods Sub-Question 3

The third sub-question is: '*How can TU/e establish or enhance collaboration with the relevant actors to become a University Sustainability Change Agent?*' Firstly, semi-structured interviews were performed to indicate ways to establish or improve collaborations. Secondly, academic literature validated the suggestions from the interviews.

Semi-Structured Interviews for Sub-Question 3

To research the third sub-question, semi-structured interviews have been conducted, explained in the sub-section *Semi-structured Interviews for Sub-Question 2*.

Literature Review

An additional literature review focused on the recommendations for establishing or enhancing collaborations with the relevant actors to become a USCA. The literature review targeted the semi-structured interview recommendations to indicate if these recommendations could be linked to literature to provide some validity to the interview results. It was not meant to embed the recommendations in the literature or to extend the literature. Therefore, this literature did not have a strictly structured approach, but used keywords that were deemed interesting from the semi-structured interview. Last, the literature review was conducted within the Scopus database.

3 The University Sustainability Change Agent Defined

This chapter addresses the first sub-question: *'What is University Sustainability Change Agent?'*. To address this question, the papers from the systematic literature review, and the backward bibliographic search were analysed, which resulted in a list of identifiers that identify themes linked to USCAs, shown in *Appendix B*. This analysis led to the identification of four categories that typify universities, shown in the following section. The next section also indicates who is present in these categories. After identifying the four categories, three main themes defining USCAs that emerged from the analysed papers are elaborated on. After this, USCA is defined, after which a conceptual framework is created from this USCA definition.

3.1 The Four Categories That Typify Universities

Universities consist of four categories with specific key activities. The first category is Higher-level management which involves key activities of creating the university's strategies, policies, and long-term visions. The second category is Education, which involves key activities such as providing lectures and tutorials. The third category is Research which involves key activities such as advancing scientific boundaries and fills knowledge gaps by publishing peer-reviewed journal papers. The fourth category is Operations which involves key activities such as the daily activities needed to run the organisation, such as heating of buildings, waste management, catering, logistics, and more. Next, within these four categories, there are different actor groups. For example, the Operations category has different support services, such as human resource management and general affairs. Furthermore, there are individuals with different roles within the different actor groups. For example, the category Education contains individuals that are either students or teachers.

3.2 SCA Skills and Characteristics

This section examines the skills and characteristics that SCAs possess to foster change; first, the concept of change agents (CAs) will be explained to connect it with SCAs. Next, Lewin (1947) started with the work on change theory and used it to identify a specific social category of actors that play a significant role in launching, directing, and implementing change (Caldwell, 2003). Through his research, Lewin (1947) identified a specific social category of actors that play a significant role in initiating, directing, and implementing change. However, this initial definition received criticism from subsequent researchers such as Ottaway and Cooper (1976), Ottaway (1983), and Caldwell (2003) for its vague nature, leading to efforts in developing more refined classifications of CAs (Van Poek et al., 2017). For instance, Tichy (1975) suggested that CAs could manifest as teams, groups, or individuals possessing specific skills, such as visionary leadership or expertise in managing change processes (Behling & McFillen, 1996). Furthermore, leadership is an important fundamental driver of change (Mintrom & Rogers, 2022), and previous studies have acknowledged the significance of leadership in broader system transformation and local innovation (Mohr, 1969; Mintrom, 1997; Taylor et al., 2011). Moreover, researchers identified CAs as individuals within and outside specific organisations or systems, responding to external pressures and exhibiting task and process-oriented approaches (Ginsberg & Abrahamson, 1991; Saravanan, 2015).

Other researchers apply the concept of CAs in relation to sustainability, which can be called SCAs. SCAs are often described as personally engaged, non-neutral, and driven by idealism (Walker, 2007). They possess a deep commitment where the issue at stake becomes intertwined with their identity (Wickenberg, 2004). However, balancing this personal involvement with the risk of fanaticism is crucial, which can inadvertently neglect the ambitions of minority groups striving for change mobilisation (Wickenberg, 2004; Marimaa, 2011). Last, SCAs exist along a spectrum between intense personal involvement and detachment, revealing a nuanced reality where they can exhibit varying degrees of engagement (Van Poek et al., 2017).

SCAs are driven by an instinct for collaboration, providing platforms for others to influence change, and possessing positional power (Mintrom & Rogers, 2022). Furthermore, SCAs possess the skills to discover innovative ways of mobilising others for collaborative efforts, acknowledging that they are not solitary heroes (Mintrom & Rogers, 2022). To support transformative change, involving diverse actors becomes vital, facilitating interactions across multiple administrative and organisational levels and prioritising self-organisation over hierarchical steering (Folke et al., 2005; Rijke et al., 2013).

Therefore, SCAs, as loosely connected frontrunners, significantly impact multiple sectors by disrupting existing institutional strategies and managing diverse actor networks that guide systemic transformations (Brown et al., 2013).

It is demonstrated that fostering transformative change necessitates a focus on the transformation process, practical knowledge, intervention within existing systems, consideration of normative aspects, adjustments to prevailing mindsets, multi-faceted approaches to change shaping and understanding, recognition of alternative researcher roles, stimulation of second-order experimentation, and reflection (Fayez et al., 2018). Therefore, SCAs could balance co-producing governance innovations while challenging the existing regime to drive long-term societal change and foster transitions (Novalia et al., 2020). Sometimes, it is advisable not to centralise leadership in a single individual but to distribute it across a larger community or organisation, known as distributed leadership (Bolden, 2011). In other cases, a team of champions working closely together continuously proves to be the most effective approach (Mintrom & Rogers, 2022). Finally, the roles and nature of the essential capabilities of CAs are determined by their specific contexts (Wittmayer et al., 2017), and transformative capacities vary across localities and jurisdictions (Castán Broto et al., 2019).

To summarise, SCAs are critical in initiating, directing, and implementing change processes. They are described as personally engaged, non-neutral, and driven by idealism. SCAs can manifest as individuals, teams, or groups and possess skills such as visionary leadership and change management expertise. They can be formally or informally invited from within or outside an organisation or system, responding to external pressures and exhibiting task- and process-oriented approaches. SCAs are seen as leaders, frontrunners, or champions who create awareness, foster collaboration, provide platforms for influence, possess positional power, participate in deliberative processes, and promote sustainability. The skills exhibited by SCAs include creativity, innovation, critical thinking, complex problem-solving, self-reflection, systems thinking, and excellent communication. However, it is important to note that the roles and skills of SCAs are context-specific, and there is no universally applicable skill set for them. Last, *Table 3* provides an overview of the key insights of this part.

Table 3: Overview of the Key Insights of SCA Skills and Characteristics

Key insights	Leading sources
The SCA role is context-specific.	Castán Broto et al. (2019); Wittmayer et al. (2017)
SCAs are personally engaged, non-neutral, and idealism-driven.	Walker (2007)
Leadership is a fundamental driver of change, and SCAs exhibit transformative capabilities and visionary leadership styles.	Mintrom and Rogers (2022)
SCAs possess creativity, innovation, critical thinking, problem-solving, self-reflection, systems thinking, and communication skills.	Behling & McFillen, (1996); Castán Broto et al., (2019); Mintrom & Rogers, (2022); Van Poek et al., (2017); Walker, (2007); Wickenberg, (2004)

3.3 Collaboration as a Way to Navigate Change

This section examines the importance of collaborations between universities and external actors and between actor groups within a university. Next, collaborations are essential between universities, civil society, governments, and for achieving sustainability because this collaborative approach acts as a navigational compass, guiding the change process toward a more sustainable future (Lozano & Lozano, 2014). Building on this notion, dynamic interaction between society and universities is important, meaning that knowledge could flow freely between actors (Peer & Stoeglehner, 2013). Moreover, Peer & Stoeglehner (2013) argue that higher levels of participation enhance knowledge exchange and increase the likelihood of translating knowledge into regional sustainable development actions. Furthermore, exchanging knowledge or students through partnerships can advance sustainable education (Kapitulčinová et al., 2018; Blanco-Portela et al., 2018). These collaborative efforts foster the

sharing of experiences and knowledge among universities, promoting sustainability within and outside the academic community (Stephens et al., 2008).

Collaborations could not be limited to external actors because internal collaborations within campus communities hold significant value (Blanco-Portela et al., 2018). Therefore, within universities, it is also important to collaborate (Kapitulčinová et al., 2018; Beringer, 2007; Blanco-Portela et al., 2018). Moreover, collaboration is essential for problem-solving and innovation (Lozano et al., 2013; Wanner et al., 2018) and includes co-decision-making, co-design, co-planning, co-production, and co-evaluation (Peer & Stoeglehner, 2013; Wanner et al., 2018) and could thereby be prioritised by organisations (Ralph & Stubbs, 2014; Filho et al., 2020). Last, transdisciplinary is important in these collaborations and has gained particular prominence in university action on sustainable development (Peer & Stoeglehner, 2013).

A distinction between the two types of collaboration can be made. The first type concerns collaborations outside an organisation with external stakeholders, such as universities, governments, society, companies, and NGOs, called external collaborations. The second type is about collaboration between actor groups within the university, called internal collaborations. Next, collaboration is present if there is a bidirectional information or resource exchange, such as exchanging experiences, values, visions, or scientific information. Furthermore, the collaboration process can entail co-decision-making, co-design, co-creation, co-planning, co-production, or co-evaluation. To create collaborations for the direction of sustainability, different actor types must be involved, such as internally different disciplines or externally different actor types, such as NGOs, companies, and the government, with preferably an international dimension to create intercultural learning. Last, Table 4 provides an overview of the key insights of this part.

Table 4: Overview of the Key Insights of Collaboration as the Navigation of Change

Key insights	Leading sources
External collaboration between universities, civil society, governments, and companies is essential for achieving sustainability. It enhances knowledge transfer, creates awareness, shares values and visions, and provides research outcomes and scientific information.	Lozano & Lozano (2014); Peer & Stoeglehner (2013)
Internal collaboration holds significant value and is important to foster change across different actor groups, where transdisciplinary is essential.	Blanco-Portela et al. (2018); Peer & Stoeglehner (2013)
Collaborations are bidirectional and involve co-decision-making, co-design, co-creation, co-planning, co-production, or co-evaluation.	Peer & Stoeglehner, (2013); Wanner et al. (2018)

3.4 Sustainability Providing Directionality for Change

This section examines the role of sustainability as the desired direction of change for USCA, which aims to steer society towards a sustainable trajectory. It is important to note that transitions literature often focuses on aspects such as incumbencies, changing systems, and the process of change while assuming the concept of sustainability without explicitly delving into its meaning. This observation highlights the unique perspective of transition scholars who primarily concentrate on the dynamics of change rather than providing an extensive exploration of sustainability as an independent concept.

USCAs actively promote long-term and transformative STs to facilitate the transition towards sustainability. These transitions involve challenging existing systems and creating opportunities for innovative niches to emerge. They leverage landscape pressures and navigate the integration of these niches into the broader system. Scholars such as Mintrom and Rogers (2022) emphasise the necessity of fundamental reconfigurations in regulations, policies, institutions, cultures, and routines to support STs. Next, at the core of STs lie the seeds of system change, ignited by local innovations, demonstrations, and experiments (Geels & Raven, 2006; Nevens et al., 2013). These initiatives act as catalysts for broader transformations, although further research is needed to understand the scaling and

replication of these innovations (DeSantola & Gulati, 2017; O'Reilly & Binns, 2019; Raven et al., 2012). While there is increasing recognition among citizens and politicians of the need for transformative action, translating this awareness into meaningful change remains challenging (Mintrom & Rogers, 2022).

Achieving sustainability internally as a USCA entails adopting sustainable principles throughout the four categories, encompassing a transformative journey between multiple stages, from initiation to implementation and institutionalisation (Kapitulčinová et al., 2018). For the Higher-level management category, this could be in the form of articulating the importance of sustainability in strategies, policies, and long-term visions (Blanco-Portela et al., 2018; Filho et al., 2020). For the Education category, this could be in the form of incorporating sustainability into the curriculum and academic assessment (Filho et al., 2020) and by establishing collaborations that focus on sustainability knowledge diffusion in education (Filho et al., 2020; Kapitulčinová et al., 2018). For the Research category, this could be in the form of focusing on sustainability-related research or establishing collaboration focused on sustainability knowledge diffusion (Filho et al., 2020; Kapitulčinová et al., 2018). For the Operations category, this could be in the form of incorporating sustainability in the daily operations and demonstrating the universities frontrunner role and effort to promote sustainability (Blanco-Portela et al., 2018; Filho et al., 2020; Kapitulčinová et al., 2018). Last, *Table 5*, provides an overview of the key insights of this part.

Table 5: Overview of the Key Insights of Sustainability as the Directionality of Change

Key insights	Leading sources
Fundamental reconfigurations in regulations, policies, institutions, cultures, and routines are necessary to support STs.	Mintrom and Rogers (2022)
STs represent radical shifts in normative orientation and require systemic reconfigurations.	Filho et al. (2020); Lozano et al. (2013); Lozano et al. (2015); Stephens et al. (2008)
Achieving sustainability requires adopting sustainable principles throughout institutions and organisations.	Kapitulčinová et al. (2018)
The Higher-level management category could articulate the importance of sustainability in the strategies, policies, and long-term visions.	Blanco-Portela et al. (2018); Filho et al. (2020)
The Education category could incorporate sustainability into the curriculum and academic assessment.	Filho et al. (2020)
The Research category could focus on sustainability knowledge diffusion.	Filho et al. (2020); Kapitulčinová et al. (2018)
The Operations category could incorporate sustainability into the daily operations and demonstrate the universities effort to promote sustainability.	Blanco-Portela et al. (2018); Filho et al. (2020); Kapitulčinová et al. (2018)

3.5 The Definition

This sub-section answers the first sub-question: '*What is University Sustainability Change Agent?*'. This is answered by combining the findings from the sections *The Four Categories That Typify Universities, SCA Skills and Characteristics, Collaboration as a Way to Navigate Change, and Sustainability Providing Directionality for Change*. Firstly, it became clear that universities have four categories: Higher-level management, Education, Research, and Operations, with actor groups in the categories that exist of individuals. Secondly, it became that USCAs have individuals across the whole organisation that possess SCA skills and characteristics. Thirdly, it became clear that there are actor groups present that could navigate towards this sustainability change by collaborating with other actor

groups. Fourthly, it became clear that the categories must provide sustainable direction to become a USCA. Therefore, the definition of USCA is as follows:

A USCA actively strives for an entire system change from the old unsustainable socio-technical system towards a sustainable one. USCAs collaborate with diverse actors outside their organisation, such as universities, governments, companies, non-governmental organisations, and society. To achieve this sustainability transition, USCAs integrate sustainability into universities' four key activity categories (Higher-level management, Education, Research, Operations). Actor groups within these categories collaborate to navigate the transition to sustainability. Individuals in the actor groups possess sustainability change agent skills and characteristics to realise collaborations between the actor groups.

3.6 The Conceptual Framework

The definition of USCA allows for the creation of a conceptual framework (*Figure 2)*, which is explained in this section. First, the hierarchy within the conceptual framework is explained, after which three criteria are explained that allow the assessment to what extent universities are a USCA.

Universities can only become USCA if individuals within the actor groups possess SCA skills and characteristics. When these SCA skills and characteristics are present, the actor groups can collaborate on sustainability with other actor groups and external actors. When these collaborations are present, sustainability can be integrated into the categories. Therefore, a hierarchical order exists between individuals, actor groups, and categories, shown in *Figure 2*. Furthermore, to know to what extent a university is acting as a USCA, these three levels need to be assessed by three different criteria. The first criterion focuses on the individual level, the second criterion on the actor group level, and the third criterion on the category level (*Figure 2)*.

The first criterion, the *SCA skills and characteristics criterion*, examines to what extent the individuals within the actor groups possess SCA skills and characteristics. The second criterion, the *collaborations criterion*, focuses on the actor groups within the categories and examines to what extent collaborations with other actor groups and external actors contribute to the goal of sustainability. The third criterion, the *sustainability direction criterion,* evaluates to what extent sustainability is incorporated into the goals and activities of each category and to what extent they try to transition towards sustainability, referred to as the internal ST. It also assesses to what extent the category tries to influence the societal ST, referred to as the external ST. Overall, this chapter defined USCA, after which a conceptual framework was established about USCA. The next chapter will, for practicality reasons, convert the conceptual framework to an assessment framework, and use the assessment framework to assess to what extent TU/e is acting as a USCA.
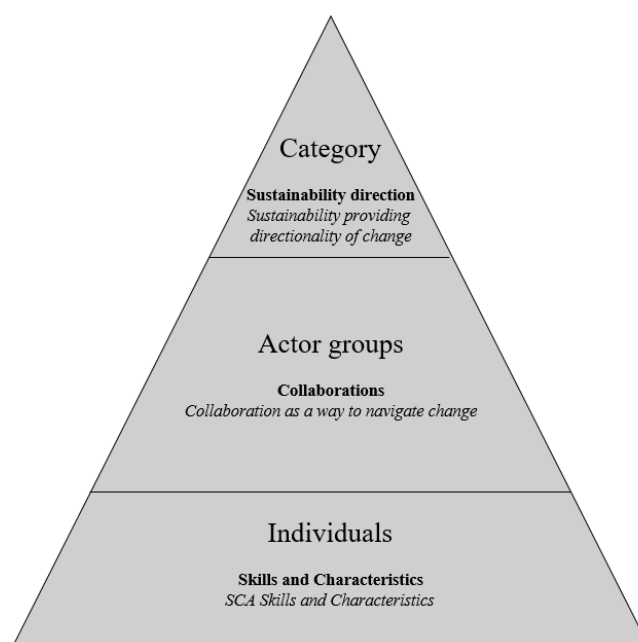

Figure 2: The USCA Conceptual Framework

4 The Extent to Which TU/e is Acting as a USCA

This chapter answers the second sub-question: *'To what extent is TU/e acting as a University Sustainability Change Agent?'*. To address this question, this chapter converts the conceptual framework from section *3.6 The Conceptual Framework*, to an assessment framework. Following, the TU/e case is introduced, after which the assessment framework is used to analyse TU/e.

4.1 The Assessment Framework

A difference between the conceptual framework and the assessment framework is that the category level from the conceptual framework is shown in the assessment framework with the name of the four categories that typify universities (Higher-level management, Education, Research, Operations). Next, the conceptual framework showed that the three criteria are linked to the levels: category, actor groups, and individuals, which is shown in the assessment framework with an 'X', indicating that a score needs to be filled in for the three criteria (*skills and characteristics, collaborations,* and *sustainability direction*) (*Table 6*). These scores are based on the results from the semi-structured interviews and documents analysis, and each criterion is scored on a three-point scale: Sufficient, Sufficient/Insufficient, or Insufficient. A category scored Sufficient on the *skills and characteristics criterion* if an individual showed evident SCA skills and characteristics, Sufficient/Insufficient if an individual showed somewhat SCA skills and characteristics, and Insufficient if there were no individuals possessing evident SCA skills and characteristics. A category scored Sufficient on the *collaborations criterion* if the actor groups within the category collaborated with other actor groups and external actors to steer towards sustainability, Insufficient/Sufficient if they somewhat collaborated to steer towards sustainability, and Insufficient if they did not collaborate to steer toward sustainability. A category scored Sufficient on the *sustainability direction criterion* if they showed that the direction of change was clearly towards sustainability, Sufficient/Insufficient if the direction was somewhat towards sustainability, and Insufficient if the direction of change was not towards sustainability. Next, the subsequent parts of the chapter elaborate on the context of TU/e and divide the TU/e organisation into four categories (Higher level management, Education, Research, Operations). The results for each category are presented, leading to the answer to the second sub-question.

Table 6: The USCA Assessment Framework

Level/ Criteria	Skills and Characteristics	Collaborations	Sustainability Direction
Higher-level management			X
Actor groups		X	
Individuals	X		
Education			X
Actor groups		X	
Individuals	X		
Research			X
Actor groups		X	
Individuals	X		
Operations			X
Actor groups		X	
Individuals	X		

4.2 The Case of TU/e

TU/e serves as a valuable case study to research the effect of collaborations on the role of becoming a USCA, due to its rich history of strong collaborations with the Eindhoven region. According to Romme (2022), South-East Brabant, or the Eindhoven region, was unsuitable for agriculture because of its sandy soils, characterising harsh living conditions. This formed the basis for various cooperative organisations where inhabitants collectively addressed these harsh living conditions (Romme, 2022). The region became attractive in the 19th century for industrial companies because of the significant labour supply, low wages, and the construction of canals and roads (Stam et al., 2016). In 1892, the company Philips was founded and later evolved into a multinational corporation due to its successful light bulb manufacturing and sales (Romme, 2022). During their growth, Philips started investing in schools, infrastructure, buildings, and other social facilities to attract thousands of employees from European regions (Heerding, 1986). This attractiveness also benefited other large regional companies (Romme, 2022). After the Second World War, Philips gained support from the Dutch government to establish an institute for the training of engineers, known today as TU/e (Romme, 2022).

Founded in 1956, TU/e is still a relatively young university that fostered an open culture for taking the initiative and exchanging ideas, which could be attributed to the collaboration between academia, local governments, and industry when the university was established (TU/e, 2021a). This could still be observed on campus, the centre of the regional ecosystem, where TU/e stood out in collaborations with industry and other organisations (TU/e, 2021a). This was all aimed at improvement through sustainable innovations and the quality of life (TU/e, 2021a). Furthermore, in the Netherlands, 25% of all R&D investments by industrial firms were accounted for in the Brainport-Eindhoven region (CBS, 2022), while the population accounted for less than 5% of the total Dutch population (Romme, 2022).

To assess TU/e to what extent they are acting as a USCA, it is essential to provide an overview of the organisation and its relevant internal actors, as depicted in *Figure 3*. In *Figure 3*, the internal actors are categorised into two groups. The first group is labelled 'Other internal actors' and comprises internal actors outside the TU/e organisation. This category includes University Rebellion, Associations, Valorisation support entities, and knowledge organisations (*Figure 3*). The second group is labelled 'TU/e organisation' which is divided into four categories: Higher-level management, Education, Research, and Operations. Additionally, external actors are located outside the on-campus ecosystem. The external actors encompass the government, society, NGOs, knowledge organisations, and companies, and have various sizes. For example, the government includes the national, regional, and local governments. Since the analysis focuses on the on-campus ecosystem, these actors are not shown individually in *Figure 3*. However, it is important to recognise that the on-campus ecosystem is located with external actors around them and that USCAs collaborate with external actors to lead the external ST.
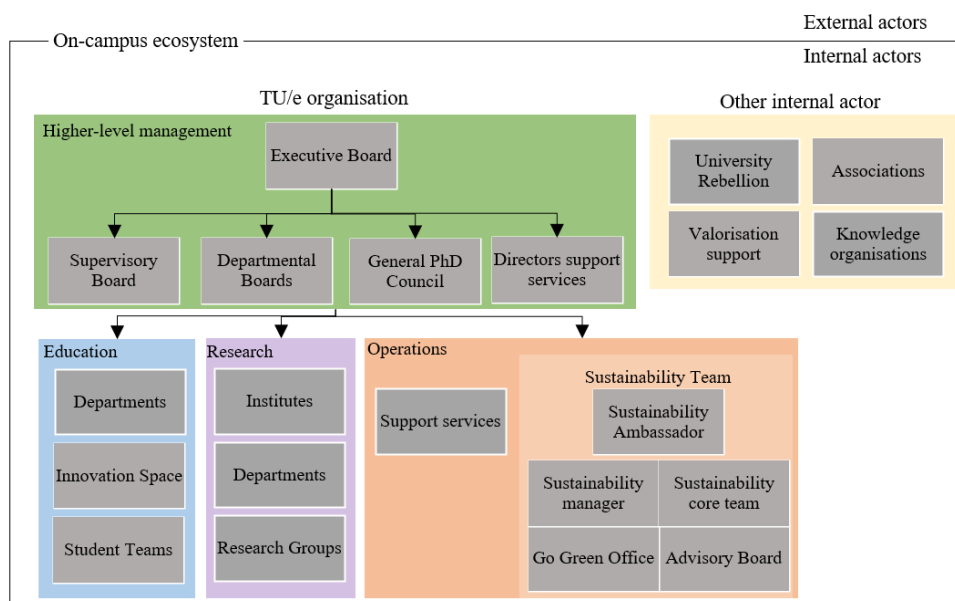

Figure 3: Internal and External Actors

4.3 TU/e Analysed per Category

This section analyses to what extent TU/e is acting as a USCA by evaluating TU/e per category on the three criteria. Next, the other internal actors are discussed to what extent they are influenced or try to influence the TU/e organisation. Last, an answer to the research question is provided.

Higher-Level Management

The Higher-level management category comprises five actor groups: Executive Board (EB), Supervisory Board, Departmental Boards, General PhD Council, and Directors support services. Firstly, the executive board manages the university and handles all administrative matters (TU/e, n.d.-j). Secondly, the supervisory board oversees the entire university's management and administration tasks (TU/e, n.d.-k). Thirdly, the Departmental Boards consist of a dean, a vice-dean, and a managing director, serving as the administrative body at the departmental level (TU/e, n.d.-j). Fourthly, the PhD-PDEng council, comprised of PhD candidates and PDEng trainees, discusses relevant topics of PhD students with the graduate school dean (TU/e, n.d.-n). Fifthly, the Directors support services are in charge of the different support services at TU/e. Together, they are responsible for shaping the university's policies and strategies.

The *skills and characteristics criterion* evaluates the extent to which individuals from the Higher-level management actor groups possess SCA skills and characteristics. The new rector magnificus demonstrated a non-neutral stance towards sustainability, advocating for the university to set an example for society and considering sustainability a no-brainer:

'For me, sustainability is a no-brainer. To my mind, as a university, we should be setting an example for society. We have our own excellent science and fabulous technologies, but we must listen to want society wants, what is needed. So that working with citizens, businesses, and policymakers, TU/e can come up with sustainable solutions.' (Silvia Lenaerts, TU/e, 2023, p. 1)

Interviewee 12 served as an example of an individual within the Directors support services actor group possessing SCA skills. Interviewee 12 personally engaged with sustainability, possessed positional power, demonstrated excellent communication skills, and previously initiated, implemented, and managed change by successfully realising a sustainable building project involving various actors and securing funding from the European Union. Therefore, they receive a score of Sufficient on the *skills and characteristics criterion*.

The *collaborations criterion* evaluates the extent that Higher-level management actor groups collaborate with other actor groups and external actors to navigate the change towards sustainability. It is important to note that the primary influence of Higher-level management actor groups occurred through one-directional means, where policies are implemented across different categories, thereby influencing external collaborations across various actor groups in different categories. For instance, a policy specified the collaborators with whom actor groups in the Research category could engage (Interviewees 4, 6). One notable example was the recent policy change stipulating that internal actor groups must ensure that collaborations with Shell are related to sustainability (Interviewees 4, 7, 9, 10, 13). This policy change likely resulted from public attention surrounding Shell (Interviewee 4) and the actions of University Rebellion at the university (Interviewees 4, 9). The topic of external collaborations with the fossil fuel industry, particularly Shell, was a prominent discussion point during the interviews, with approximately half of the interviewees mentioning it as a subject of scrutiny (Interviewees 4, 5, 7, 9, 10, 13). An example where Shell was mentioned would be the new rules about collaboration:

'If we want to do a project with Shell, ... that it has to be a green project, right? That kind of that kind of requirements, those are there from the university. ... We do not want to turn away from the thorny issues, But we do want to contribute to the solution. So with Shell, we can do good projects, but it has to be the green projects.' Interviewee 10

Higher-level management actor groups also engaged in bidirectional collaborations with actor categories actor groups (Interviewees 12, 13). For example, student teams had informal contact with

Higher-level management actor groups regarding sustainability ideas (Interviewee 11). However, there were indications from Interviewees 2 and 8 that there is a lack of clarity regarding which actor group to contact within Higher-level management for information exchange. Overall, the Higher-level management actor groups collaborated on sustainability, but there is room for improvement. Therefore, they receive a score of Sufficient/Insufficient on the *collaborations criterion*.

The *sustainability direction criterion* evaluates the extent to which the Higher-level management category at TU/e drives sustainability initiatives, thereby stimulating the sustainability direction of change. The commitment of Higher-level management towards sustainability is evident in Strategy 2030, where TU/e explicitly demonstrates its support for the SDGs (TU/e, 2018b). Interviewees emphasised the importance of Higher-level management providing clear visions, guidance, strategies, and policies to enable other categories to align their actions accordingly (Interviewees 2, 3, 4, 6, 8, 10, 11, 12, 13). For example, Interviewee 6 emphasised the essential role of the executive board's support in transitioning the university towards sustainable practices. Interviewee 8 highlighted the need for TU/e to establish concrete steps for achieving sustainability in campus operations and student activities while finding a balance between preserving student associations' autonomy and implementing sustainability policies, which is lacking. Institutes and departments also expressed their desire for guidance and policies in terms of sustainability while remaining receptive to such initiatives (Interviewee 6, 10). On a positive note, the executive board had implemented policies for sustainable procurement (Interviewee 3). This indicated a step in the right direction towards promoting sustainability within the university's operations. Overall, Higher-level management demonstrated a clear direction towards sustainability, although there is still room for improvement. Therefore, they receive a score of Sufficient/Insufficient on the *sustainability direction criterion*. Last, *Table 7* provides an overview of the main results.

Table 7: Overview of the Higher-level Management Category Results

Criterion	Key findings	Score	Leading sources
Skills and Characteristics	• The new rector magnificus possessed <u>SCA characteristics</u> and demonstrated a non-neutral stance towards sustainability; • An individual within the Directors support services actor group <u>possessed SCA skills</u>, including <u>personal engagement</u> with sustainability, excellent <u>communication skills</u>, and previous experience <u>initiating</u>, <u>implementing</u>, and <u>managing change</u>.	Sufficient	TU/e (2023), Interviewee 12
Collaboration	• Collaboration within Higher-level management actor groups primarily occurred through <u>one-directional</u> means, with policies being implemented across different categories; • There were also <u>bidirectional</u> collaborations, but there was a need for improved clarity and information exchange.	Sufficient/ Insufficient	Interviewees 2, 4, 6, 7, 8, 9, 10, 11, 12, 13
Sustainability direction	• The Higher-level management category demonstrated a <u>clear direction towards sustainability</u>, as stated in Strategy 2030, while there was room for improvement.	Sufficient/ Insufficient	TU/e (2018b)

Research

The Research category consists of three different actor groups: Institutes, Departments, and Research Groups. Firstly, TU/e comprises the following four institutes: Eindhoven Artificial Intelligence Systems Institute, Eindhoven Hendrik Casimir Institute, Institute for Complex Molecular Systems, and Eindhoven Institute for Renewable Energy Systems. These institutes are umbrella organisations of different departments and research groups and try to facilitate collaborative development (TU/e, n.d.-l) by connecting researchers, students, and companies (TU/e, n.d.-m). Secondly, there are nine departments at TU/e: Applied Physics and Science Education, Built Environment, Industrial Design, Electrical Engineering, Chemical Engineering and Chemistry, Mathematics and Computer Science, Biomedical Engineering, Mechanical Engineering, and Industrial Engineering and Innovation Sciences (TU/e, n.d.-o). Thirdly, research groups are in the same or different departments and focus on understanding complexity, developing methodologies, and enhancing system thinking as an essential prerequisite for interdisciplinary research (TU/e, n.d.-p).

The *skills and characteristics criterion* evaluates the extent to which individuals from the Research actor groups possess SCA characteristics or skills. Actors within the institutes actively strived to initiate change and promote sustainability initiatives. For example, they implemented measures such as providing vegetarian food as a standard option and implementing operational energy-saving activities (Interviewee 6):

'We have now introduced as a policy of, we are not going to do any more meat at get-togethers. ... And not because we are against meat, but just that we think of yes, you know, is it a bad message? Yes.'
Interviewee 6

These actions demonstrated their commitment to driving change and taking initiatives in the sustainability domain. Therefore, they receive a score of Sufficient on the *skills and characteristics criterion*.

The *collaborations criterion* evaluates the extent that Research actor groups collaborate with other actor groups and external actors to navigate the change towards sustainability. Interviewee 6 emphasised the importance of collaboration among departments, support services, companies, and politics to become a USCA. However, it was challenging to realise this collaboration due to departments working separately, conflicting goals, and language barriers (Interviewee 6). Additionally, external collaborations were limited to the usual suspects in the region, such as companies and governmental organisations (Interviewee 10). However, these departments had the influence to steer research toward sustainability and could potentially stimulate education and research partnerships based on sustainability. Next, some institutes were enthusiastic about sustainability and actively promoted it by collaborating with various actor groups, including other institutions, student teams, valorisation support, facility management, and real estate (Interviewee 6). However, it is mentioned that the institutes are willing to collaborate and participate more in sustainability initiatives, particularly when Higher-level management actor groups mandate them to do so (Interviewee 10). Regarding external collaborations, they were not based on sustainability but rather on monetary terms, involving primarily companies and governments (Interviewee 4, 10). Overall, the level of collaborations in terms of sustainability differed substantially. Therefore, they receive a score of Sufficient/Insufficient on the *collaborations criterion*.

The *sustainability direction criterion* evaluates the extent to which the Research category at TU/e drives sustainability initiatives, thereby stimulating change direction. The *sustainability direction criterion* varies significantly among the actor groups. One example is the department of the built environment, where sustainability was declared as the fundamental aspect of their research and education (TU/e, n.d.-o). However, in contrast, other departments did not prioritise sustainability structurally (Interviewee 13). According to Interviewee 13, people within these departments were generally open to sustainability, suggesting potential for future developments and integration of sustainability practices.

'Of course, you can see that people are basically open to sustainability, but it is not a priority within the faculty. It is more of a theme, like diversity, that I get more people to my desk for.' Interviewee 13

Interviewee 13 provided the following explanation for this:

'There are scientists in our faculty who would like to see some kind of proof on the board of 'This is right, and that is wrong' for sustainability issues. But for sustainability issues, it is not always so easy to make it completely conclusive. It is often not about the extremes, but much more about a bit in the middle.' Interviewee 13

Overall, the Research actor groups differ to what extent they stimulate the change direction towards sustainability. Therefore, they receive a score of Sufficient/Insufficient on the *sustainability direction criterion*. Last, *Table 8* provides an overview of the main results.

Table 8: Overview of the Research Category Results

Criterion	Key findings	Score	Leading sources
Skills and Characteristics	• Despite the challenges, individuals within the actor groups strived to <u>initiate change</u> and <u>promote sustainability initiatives</u>.	Sufficient	Interviewees 4, 6, 13
Collaboration	• Collaboration within the institutes varied. Some institutes <u>actively collaborated</u> with various actor groups, including other institutions, student teams, and support services, while others were more <u>limited in their collaborations</u>; • Collaboration among departments and external actors is <u>challenging</u> due to departments <u>working separately, conflicting goals, and language barriers</u>.	Sufficient/ Insufficient	Interviewees 4, 6, 10, 13
Sustainability direction	• Some actor groups <u>prioritised sustainability</u>, while others did <u>not prioritise sustainability</u>.	Sufficient/ Insufficient	Interviewees 6, 10, 13

Education

The Education category comprises three actor groups: Departments, Innovation Space and student teams. Firstly, Departments are explained in *4.2 Research*. Secondly, TU/e Innovation Space is a community that facilitates and promotes interdisciplinary challenge-based learning, entrepreneurship, and engineering design (TU/e, n.d.-f). Additionally, it provides a platform for addressing complex industrial and societal challenges by developing innovative projects involving various stakeholders, including businesses and researchers (TU/e, n.d.-f). Moreover, the Innovation Space coordinates and supports student teams. Thirdly, twenty-four student teams actively address challenges related to health and mobility, artificial intelligence, and sustainability, resulting in remarkable projects such as bio-composed cars, renewable energy sources, and future living solutions (TU/e, n.d.-c). This hands-on involvement enables students to apply their knowledge to innovative projects and further develop their skills (TU/e, n.d.-c).

The *skills and characteristics criterion* evaluates the extent to which individuals from the Education actor groups possess SCA skills and characteristics. In sub-section *Research,* the departments scored Sufficient on the *skills and characteristics criterion*. Next, individuals within the student teams show significant leadership and commitment towards the sustainability direction and thereby try to actively collaborate with external actors and actor groups (Interviewees 1, 4, 6). Moreover, Interviewee 11 indicates that individuals in the Innovation Space take a leadership role and try to collaborate with

actors groups and external actors to take the lead in sustainability. Therefore, they receive a score of Sufficient on the *skills and characteristics criterion*.

The collaborations criterion evaluates the extent that Education actor groups collaborate with other actor groups and external actors to navigate the change towards sustainability. Regarding the role of Innovation Space in the ST and the significance of collaborations, Interviewee 11 made the following statement:

'Our focus is on educational innovation, and we are mainly involved in supporting and setting up education where students from different institutions can come together. I strongly believe that the challenges in society, especially sustainability, which is huge and all-encompassing, cannot be solved from one discipline or by engineers alone. We need each other to tackle these challenges. Looking at my own role and that of the university as an Innovation Space, I think we need to offer a new kind of education for the engineers of the future, who are able to make connections and innovate from a societal responsibility and not just based on technological developments. If we focus only on technological developments, we will not get there, and our globe will not survive either, I think.' Interviewee 11

Collaboration with Education and Student Affairs was emphasised, recognising its importance when working with students and teachers (Interviewee 11). Furthermore, TU/e has established strategic partnerships with other technical universities worldwide as part of the EuroTech University Alliance (TU/e, n.d.-h; EuroTech Universities Alliance, n.d.). This alliance aimed to address major societal challenges through technological solutions (TU/e, n.d.-h). Building on this collaboration, TU/e initiated another alliance called EuroTeQ, involving six other leading science and technology universities, to promote responsible value co-creation in technology and foster a paradigm shift in engineering education (TU/e, n.d.-h). Innovation Space leveraged these partnerships to offer educational opportunities through challenges, drawing attention from external actors. For instance, Interviewee 11 mentioned that the European Union supports the EuroTech alliance and recognises its significance. Furthermore, other higher education institutions sought guidance from TU/e on implementing the concept of challenge-based learning, given their position as a frontrunner in this field worldwide and their role in initiating this program at the university. Next, internal collaborations involved student teams assisting one another, receiving funding from the TU/e organisation, or seeking support from Innovation Space (Interviewees 1, 6, 11). Furthermore, Interviewees 1 and 4 mentioned that student teams collaborate with companies, primarily focusing on sponsorship, resource acquisition, product purchases, and knowledge sharing. Although these collaborations were not explicitly targeted at supporting sustainability.

Overall, the different actor groups collaborate with both actor groups and external actors but vary significantly in collaborating for sustainability. Therefore, they receive a score of Sufficient/Insufficient on the *collaborations criterion*.

The *sustainability direction criterion* evaluates the extent to which the Education category at TU/e drives sustainability initiatives, thereby stimulating the direction of change. Regarding sustainability, Innovation Space played a crucial role in the educational approach of challenge-based learning, where various actor groups and external actors, including companies and governments, can become challenge owners, bringing in real-world challenges for students to solve (Interviewee 4, 11). The challenge owners encompassed external actors such as companies (Interviewee 4, 11) and governments (Interviewee 11), as well as individuals like teachers, student teams (Interviewee 11), and the sustainability team (Interviewee 9, 11). Additionally, student teams within Innovation Space had access to support, including coaching and connections to the Equipment and Prototype Center located within the Innovation Space building (Interviewee 11). Next, among the various student teams, there are notable examples related to sustainable real estate. One example is the Student Team CASA, which focuses on smart cities and energy transitions, aiming to create sustainable, affordable, and comfortable alternatives for the Dutch social housing sector (TU/e, n.d.-b). Another example is Student Team Energy (STE), which organises events to foster connections, inspiration, and information sharing among professionals, researchers, and students involved in the energy transition (Team Energy, n.d.-a). These examples show that specific student teams prioritise sustainability. For example, Interviewee 1 highlighted that they aim to influence sustainability from a broader perspective, inspiring society to believe in the possibility of achieving sustainability even when other actors claim it is impossible:

'We are actively promoting ... that the world can be more sustainable ... that we can accelerate that energy transition. ... on the one hand, the main focus of us is to inspire the industry to, uhm, more rapidly innovate towards more sustainable future ... and on the other hand, inspire society to also think, hey, what can I do? What role can I play in the energy transition, and how can I make the world a little bit better?' Interviewee 1

Overall, the Education category shows a mix of actor groups that steer actively towards sustainability while others do not. Therefore, they receive a score of Sufficient/Insufficient on the *sustainability direction criterion*. Last, *Table 9* provides an overview of the main results.

Table 9: Overview of the Education Category Results

Criterion	Key findings	Score	Leading sources
Skills and Characteristics	• Innovation Space played a <u>leading role</u> in integrating sustainability into education through challenge-based learning; • Student teams tried to influence the <u>external transition</u>.	Sufficient	Interviewees 1, 4, 6, 13
Collaboration	• Collaboration among departments <u>was challenging</u> due to separate <u>departmental work, conflicting goals</u>, and <u>language barriers</u>; • Student teams and Innovation Space collaborated with <u>internal</u> and <u>external actors</u>.	Sufficient/ Insufficient	Interviewees 1, 4, 6, 10, 11, 13; TU/e, n.d.-h
Sustainability direction	• Department commitment to <u>sustainability varied</u>; • Some student teams focused on <u>sustainability</u>; • Innovation Space focused on <u>sustainability challenges</u>.	Sufficient/ Insufficient	Interviewees 1, 4, 6, 10, 11, 13

Operations

The Operations category comprises two main actor groups: Support Services and the Sustainability Team. Under these main actor groups, other actors groups are present. Firstly, TU/e has ten support services: Library and Information Services (LIS), Communication Expertise Center (CEC), General Affairs (GA), Real Estate (RE), Facility Management Center (FMC), Human Resources Management (HRM), Equipment and Prototype Center (EPC), Education and Student Affairs (ESA), and Finance and Control (F&C) (TU/e, n.d.-q). LIS is responsible for the standardisation and customisation areas, such as data management, privacy, cybersecurity, library services, and IT, and CEC is responsible for the communication policy (TU/e, n.d.-q). Next, the GA includes the board staff and secretariat and is involved in executive board matters. RE is responsible for the real estate development and the park management, and FCM advises and offers primary processes of TU/e (TU/e, n.d.-q). HRM is responsible for the working environment, The EPC for technical research support for industry and external institutes, and TU/e and ESA are the support services for education (TU/e, n.d.-q). Furthermore, F&C are responsible for managing the financials and economics of the affiliated organisations and TU/e itself (TU/e, n.d.-r). Next, Procurement and Contract Management (P&CM) and Strategic industry alliances (SIA) are part of the support service GA, and the CEC is responsible for realising the communication policy (TU/e, n.d.-q), which is why the Higher-level management category is the leading factor in the operations happening in the CEC. Secondly, the Sustainability Team consists of the actor groups sustainability ambassador, the sustainability core team, the sustainability manager (SM), the advisory board, and the Go Green Office (GGO). They are responsible for TU/e's sustainability strategy (TU/e, n.d.-a) and try to initiate, implement, and manage the change.

The *skills and characteristics criterion* evaluates the extent to which individuals from the Operations actor groups possess SCA characteristics or skills. There were prominent examples of actor groups with individuals who showed SCA skills and characteristics. One of the most prominent examples is an individual that works both at the FMC and RE. The individual was committed to implementing sustainability in FMC and RE projects and had experience in realising sustainable building projects through collaborations with internal and external stakeholders and securing European Union subsidies (Interviewee 12). Therefore, they receive a score of Sufficient on the *skills and characteristics criterion*.

The *collaborations criterion* evaluates the extent that Operations actor groups collaborate with other actor groups and external actors to navigate the change towards sustainability. The ESA and EPC actor groups work with Innovation Space (Interviewee 11). However, these collaborations are not related to driving sustainability (Interviewee 11), which was the same for the actor groups ESA, F&C, LIS, HRM, EPC, and GA without SIA and P&CM. Next, the advisory board comprises representatives from Innovation Space, Support Services, the IPCC, 4TU.Federation, and they advise the SA (TU/e, n.d.-a). They are in close contact with actor groups of the sustainability team but have no other linkages. Furthermore, P&CM collaborated and had contact with every actor group that needed to procure goods, and the main collaborating partners in terms of sustainability are the sustainability ambassador, RE, and FM (Interviewee 3, 12). For example, they were involved in initiatives related to circular buildings and housing on campus (Interviewee 3, 12). Their three main pillars of focus were real estate and housing, facilities, and ICT (Interviewee 3). Next, external actors were mainly knowledge organisations, such as PIANOo, buyer groups, and other universities, via the University Purchasing Platform because they had the knowledge and they shared knowledge about sustainable procurement. Furthermore, they collaborated with companies that supply the university, such as caterers, coffee suppliers, building maintenance companies, and building companies (Interviewee 3).

FMC and RE closely collaborated with the P&CM actor group, which is responsible for external partnerships and facility procurement. These collaborations involved working with external companies to develop facilities and real estate projects (Interviewees 3, 12). Notably, these procurements incorporated sustainability award measures that push the boundaries of what the market can offer, requiring extra effort from suppliers. However, companies were willing to bid on these contracts because TU/e is recognised as a reliable, loyal, and prestigious organisation (Interviewees 3, 12).

When FMC and RE aimed to incorporate sustainability into their projects, they established communication with the sustainability team (Interviewee 12). Additionally, they collaborated with various actor groups, particularly the department of the Built Environment and other entities such as the Eindhoven Institute for Renewable Energy Systems or valorisation support, depending on the specific project requirements (Interviewee 12). Next, the SIA works for the executive board, and their task is to maintain relationships with strategic industry parties and establish new external actors TU/e considers important (Interviewee 4). Interviewee 4 mentioned that companies were already working for a significant time on sustainability topics and that TU/e came later in this arena. Furthermore, Interviewee 4 stated that there was a difference in the impact that companies created by making products with impact, while TU/e measured impact in terms of publications that are created, which is subordinate to the impact that companies had:

'We (TU/e) also sell that [Science] as impact, but by impact, I mean that you can actually demonstrate that you have an effect in markets by selling products that are biodegradable. That is what I call impact, not that you do research and demonstrate that it is relevant. Then I think, I do not consider that impact.' Interviewee 4

Interviewee 4 acknowledged that sustainability was not a theme that is discussed with companies:

'It is not a theme; how should I put it? If I am honest, that [Sustainability] is not a theme that really comes to the fore now in discussions with companies' Interviewee 4

However, sustainability had increasingly become a prominent subject of discussion in the collaborations with companies for the executive board, and thereby for the SIA, because activist groups,

such as university rebellion, created awareness, which led to the urgency to put systems in place that can check if new projects were sustainable (Interviewee 4). Therefore a system was brought in place that stated that new collaborations with Shell need to be based on sustainability topics (Interviewees 4, 6, 7, 9), and would soon count for other companies (Interviewee 4). Except for this matrix, the collaborations were primarily based on monetary terms, where companies paid the university for research, human-resource, or marketing purposes (Interviewee 4). For example, companies paid research seats of part-time professors (Interviewee 4) to be present at career events (Interviewees 2, 4, 5, 7), be a co-owner of a challenge (Interviewees 4, 11), or sponsored student teams to get their logo on the car (Interviewees 1, 4).

The collaborations that the SIA tried to establish were primarily focused on research, so the main actor groups were the institutes and the departments. Furthermore, before these research collaborations, there were collaborations with valorisation support about intellectual property. Because the main focus was on research collaborations, Interviewee 4 stated that the collaborations were with large companies because they could afford to have an internal research and development department. Furthermore, collaborations also occurred in consortia with other knowledge institutes or with the government or the European Union providing subsidies for research (Interviewee 4). Next, it was stated that lower level, the individual research scale, society was involved in the collaborations between companies and the university by using living labs because it was important for companies to know what the demand of customers was (Interviewee 4):

'Living labs in which you actually test new concepts together with the residents themselves: does that work? And that is also very interesting for the industry because ultimately, they have come up with something that is in demand.' Interviewee 4

Next to actor group collaboration within the sustainability team and the connection with the executive board, the SA is a connector for different actor groups, ranging from institutes (Interviewee 6) to student teams (Interviewee 1) to support services in PCM (Interviewee 3), SIA (Interviewee 4), with RE and FM (Interviewee 12). Externally, Interviewee 4 stressed that the added value of the SA lay in making it visible to the outside world what TU/e was executing in terms of sustainability. This was believed to be something important in the future, which companies and society were demanding from TU/e:

'That is where Anna (SA) adds a lot of value, is to make that (Sustainability efforts) more and more visible to the outside world. That they (companies) see that: 'hé verhip', Oh, you are really active in sustainability. I think this is something we will do a lot more of in the future, we should do it, but we will also do it because you see that the whole environment is increasingly demanding it.' Interviewee 4

When implementing sustainability principles, the SM and the SCT must work with many actor groups, including Innovation Space, institutes, valorisation support, departments, and operations, such as RE, FM, and SIA. Moreover, they tried to showcase themselves by introducing themselves in green week and by organising with the GGO in the green office room a museum of the future, where sustainability-related projects were showcased to get attention to this subject for internal and external actors (Interviewee 9). External actors were also requesting the SM for possibilities of collaborations or ideas about sustainability (Interviewee 9). For example, Interviewee 9 mentioned that the waste processing company Renewi was asking for a research collaboration on circular waste, where the SM could play a matchmaker role between Renewi and the research actors. Next, via LinkedIn or during external conferences, the SM received messages from external actors with ideas regarding sustainability (Interviewee 9).

GGO collaborated with associations to promote sustainability, such as organising a vegan cooking workshop with the vegan cooking organisation (Interviewees 7). Furthermore, they collaborated with study associations where sustainability directors were assigned to motivate and encourage their members in sustainability behaviour and activities, where the GGO led this initiative and had meetings with these managers (GGO, n.d.-c). These initiatives were important to create support for sustainability at TU/e:

'But in the end, I think staff and students also have to want it because, yes, I am just saying, standard Vega lunch, for example, at a catering company, that is more sustainable, of course, but if no one has an appetite for it, then you do not get much use out of it either, and then you have a lot of resistance.' Interviewee 7

Overall, the different actor groups collaborated with actor groups and external actors but varied significantly in collaborating for sustainability. Therefore, they receive a score of Sufficient/Insufficient on the *collaborations criterion*.

The *sustainability direction criterion* evaluates the extent to which the Operations category at TU/e drives sustainability initiatives, thereby stimulating change direction. The actor group CEC had the potential to provide a direction of change. However, it was hard for the sustainability team to communicate the sustainability efforts internally and externally on, for example, the TU/e website or the electronic boards on the university campus (Interviewee 9), which was indicated by the following quote:

'We then have the website, but that is quite complex, because ... asking permission from communication whether that news item can be shared ... there are several links to it before I can share anything at all on the website. That is super cumbersome, and I actually hope we can shorten that process as well, say, I have already asked if I am not allowed to just authorise myself from the website to edit things, but then I had to do a two-week course, and even then I could not actually do it was all difficult.' Interviewee 9

Interviewees 4 and 12 stated that TU/e realised many sustainability-related projects, but TU/e was not showing it. Therefore, it was believed by Interviewee 12 that TU/e had a significant opportunity to communicate its sustainability efforts to carry out a role model function. However, Interviewee 12 also acknowledged that this effort to use marketing efforts in a university might have a negative connotation because it sounds too commercial (Interviewee 12):

'*We as a university could have much more exposure in what we do. Really, if I also sometimes tell friends or family ... those people have no idea what we do, right, while so many cool things are happening.*' Interviewee 12

When asked how to create this exposure, Interviewee 12 suggested creating a marketing and communication department:

'*Then you should actually, besides communications, have a marketing and communications department. ... You understand, of course, that for many people, marketing is, of course, a too commercial word, and that is not what you are, so it is complicated in a culture like this. But yes. I do think you could do much more and should do. And also, my purpose for that exposure because you do not have to do it with a commercial purpose. You do it with a purpose to carry out, to expose yourself as role model*' Interviewee 12

Taking this position as a role model by showcasing what TU/e is working on could attract talent and inspire companies and society (Interviewee 12). However, the CEC was not following the direction towards sustainability, which was the same for the actor groups ESA, F&C, LIS, HRM, EPC, and GA without SIA and P&CM.

The P&CM, FMC, and RE actor groups were enthusiastic about sustainability and had sustainability requirements within their procurement procedures (Interviewee 3), contributing to the sustainability direction. Next, the direction of sustainability is also shown in the university's status in terms of prestige and trustworthiness (Interviewee 3, 12):

'*Universities obviously do stand out and have a certain status ... companies are often keen to get contracts from universities and will go along with that*' Interviewee 3

The Sustainability Ambassador (SA) advises the EB (TU/e, n.d.-a) and helps the university uphold its sustainability commitments (TU/e, 2021b). This indicates that the direction of change in this

actor group is towards sustainability. Next, the sustainability core team (SCT) has a broad role and operates at the research level consisting of SM (TU/e, n.d.-a). Next, the SCT had no strict processes for implementing sustainability within TU/e. However, resources will be reserved in the future to implement sustainability within TU/e. Furthermore, the SM assisted with other tasks wherever possible and was involved in the assets: involvement and transparency, implementation and monitoring, and policy and strategy (TU/e, n.d.-a). Firstly, the SCT tried to map the sustainability level of TU/e, after which they tried to envision where TU/e wanted to go (Interviewee 9). Secondly, the task was to translate the sustainability principles and the vision into a roadmap showing how TU/e can reach the envisioned sustainability stage (Interviewee 9). Furthermore, the SCT is getting to the implementation phase, where they are trying to implement sustainability principles in the organisation (Interviewee 9), contributing to the direction of sustainability.

'Well, basically, in the first instance, I think mapping out where we are now and where do we want to go that is the whole visioning process we have already gone through as well. And then so on all those in all those areas actually keeping an eye on, hey. How do we do that, and how can we ensure that this core, these principles, from the vision are also integrated into the university, eh? So eventually, we also want to work towards a kind of roadmap ... We are now increasingly entering the implementation phase. Uhm, which of course, takes some doing to achieve that change, but I hope we can offer some kind of, yes, a path in that.' Interviewee 9

The first Green Office started in September 2010 at Maastricht University (Studenten voor Morgen, 2018), now spread worldwide with 71 offices in 2022 (GGO, 2022). The Green Office is a staff-supported institute and student-driven with the primary goal of helping universities improve on all dimensions of sustainability (Studenten voor Morgen, 2018). One of these dimensions is about the operations of the campus, hence focusing on the University's footprint on different levels, such as building regulations, energy consumption, and catering (Studenten voor Morgen, 2018). Furthermore, in 2016 the GGO was founded at TU/e (GGO, 2022) and has the ambition to make TU/e by 2030 the most sustainable university in the Netherlands by supporting the Green Student Community in increasing awareness and building on governance, education, and sustainable operations (GGO, n.d.-a). In addition, the green student community falls under the GGO. This community can be joined by every student at TU/e, where people share topics on sustainability, such as ideas, tips, and initiatives (GGO, n.d.-b). Next, the GGO's primary focus is to bring the voices of the students and the student associations to the places where the decisions are made (Interviewees 7). They indicated that this included the AB but also support services, such as the FMC, where they looked for the implementation of initiatives, such as banning disposable cups or setting up a zero waste campaign (Interviewee 7), contributing to the direction of sustainability.

Overall, the Operations category shows a mix of actor groups that actively steer towards sustainability while others do not. Therefore, they receive a score of Sufficient/Insufficient on the *sustainability direction criterion*. Last, *Table 10* on page 35, provides an overview of the main results.

Table 10: Overview of the Operations Category Results

Criterion	Key findings	Score	Leading sources
Skills and Characteristics	• P&CM, FMC, and RE showed <u>SCA skills</u> and <u>characteristics</u>.	Sufficient	Interviewees 7, 9, 12
Collaboration	• Collaborations were primarily based on <u>monetary values</u>; • <u>Sustainability</u> was incorporated as a <u>requirement</u> for new collaborations.	Sufficient/ Insufficient	Interviewees 1, 2, 3, 4, 6, 7, 9, 11, 12
Sustainability direction	• P&CM, FMC, and RE incorporated <u>sustainability</u> in the <u>procurement process</u>; • The sustainability team is a prominent example of <u>changing</u> the <u>direction</u> towards <u>sustainability</u>.	Sufficient/ Insufficient	Interviewees 3, 4, 6, 7, 9, 12

Other Internal Actors

The three criteria assess to what extent TU/e is acting as a USCA. The other internal actor category consists of actor groups not part of the TU/e organisation but inside the on-campus ecosystem. Therefore, these other internal actor groups are not scored on the three criteria. However, because of their geographical proximity, and in this case thereby their interwovenness with the university, they are discussed to what extent they try to influence or are influenced by the TU/e direction towards sustainability and to what extent they collaborate with TU/e. Last, the actor groups in this category are Associations, University Rebellion, Valorisation Support, and Knowledge organisations.

Associations

TU/e recognises nine different types of associations: sport, culture, study, life questions, international, career, representative, hobby, and fraternity. These associations play a significant role within the TU/e community (TU/e, n.d.-d). Additionally, six umbrella organisations, such as the Federation of Study Associations Eindhoven (FSE), represent students' interests through their respective study associations (FSE, n.d.). Next, the study associations at TU/e were willing to adopt sustainability practices and sought assistance from the GGO more frequently (GGO, n.d.-c). To support this, the GGO initiated a program involving eleven study associations (Konings, 2021a). Each association was assigned a sustainability director to motivate and encourage members to engage in sustainable behaviours and activities (GGO, n.d.-c). This initiative demonstrated the collaboration between the GGO and study associations in promoting sustainability. Moreover, it highlighted the importance of collaboration and proactive measures these associations took to foster sustainable behaviour and contribute to the overall sustainability goals of the university.

A frontrunner association in terms of sustainability awareness and initiatives was interviewed. Examples of initiatives were provided in terms of choosing a sustainable bank, making declarations digitally, having a sustainable fund for sustainable alternatives, and having a waste reduction initiative:

'For example, we made changes to a sustainable bank already, so we are now in Triodos instead of ABN. We also do all our declarations and those kind of things, uhm, digitally, and we were one of the first doing that. We always try to, for example, offer money for choosing the sustainable alternative a lot, so we have a sustainability fund for that. ... those are some big changes, but I think it is also incorporated in a lot of small things ... We always try to innovate and try to think of what is best for our students, but also for in in the longer term, so food waste is some example of a topic that is not that you have a big change or something, but the awareness it brings us a lot I think, So we have a food waste, uhm, drawer in the refrigerator that people can put their leftover food in and they others can take it out, and that is not making such a big impact, but it is a lot in the fact it makes a lot of sense in awareness I would say.' Interviewee 2

Interviewee 2 also indicated that they cut ties themselves with external actors they believed to be unsustainable, and they addressed that their members would hold them accountable if they chose to support unsustainable practices. Interviewees 2, 7, and 8 indicated that not every study association had sustainability as a priority and that it depended on the study association. However, Interviewee 7 stated that during career events, their study association decided to accept the WWF as a participant in the career event, while they did not have the monetary resources to participate initially. Interviewee 7 indicated that it was important to find the balance between companies that can pay this monetary fee while having places reserved for companies or NGOs that cannot afford it but positively impact the world.

Interviewee 2 indicated that they shared ideas with other organisations regarding sustainability and had good contacts with the GGO. Furthermore Interviewee 2 stated that they missed a clear place where they could articulate ideas about sustainability to the places where they make decisions because they could help in making the university more sustainable because of their awareness and engagement of their students:

'We are the, I think, maybe the closest organisation towards our students within the university, uhm, and I think that is not really used by the university yet. For example, the things that we do during such a sustainability brainstorm could be very relevant for the university as well. But yeah, we do not know to take to invite for that or something from the university itself. ... I think it never reaches the university as an organisation like the people that make decisions here because I think some problems that we have can be solved by the people that made the decisions about the university-wide.' Interviewee 2

Because this association was a frontrunner in sustainability at TU/e and only allowed sustainable companies as sponsors, it tried to influence actor groups and external actors somewhat, but in general, are the associations primarily steered by the policies of the Higher-level management. Last, *Table 11* on page 38, provides a summary of the main findings mentioned above.

University Rebellion

University Rebellion (UR) is a grass-root decentralised organisation with a local group in different universities in the Netherlands, such as on TU/e (University Rebellion, n.d.). They organise rebellion actions against the universities on topics related to the emissions of the universities and the climate and ecological crisis (University Rebellion, n.d.). At TU/e, they are a student-led activist group trying to pressure the organisation to change the direction of sustainability by using occupation and demonstration methods (Interviewee 5):

'We all try and see if we have the capacity to get on the table. Right, be it either by putting pressure, it could be via occupying, it could be with just outreach and dialogue. It is just any kind of thing that we we use direct action as our way of getting stuff done.' Interviewee 5

According to Interviewee 5, UR aimed to maintain independence from TU/e while actively working to foster change. They conversed with the sustainability team, students, and staff within the university. Externally, UR collaborated with other activist groups and individuals willing to support their cause (Interviewee 5). Next, UR's actions influenced TU/e. They created awareness among the executive board about the urgency of sustainability, leading to the development of a policy that new collaborations need to be based on sustainability (Interviewee 4, 9). Interviewee 9 further explained that due to UR's actions, the TU/e organisation had become more willing to provide information to the sustainability team and had shown a more cooperative attitude towards them. Last, *Table 11* on page 38, provides a summary of the main findings mentioned above.

Valorisation Support

TU/e recognise the importance of fostering innovation and invests in developing technologies with solid application potential. To achieve this, TU/e creates and facilitates numerous start-ups and spin-offs, even for concepts that may be too early for the industry (Den Ouden et al., 2017). The university stimulates around 200 start-ups annually based on generic TU/e knowledge while collaborating with strategic partners to create at least 40 spin-offs per year based on unique TU/e knowledge. These spin-offs receive support from TU/e up to five years (Den Ouden et al., 2017).

The campus itself plays a crucial role in this innovation ecosystem. It provides an environment where entrepreneurs, researchers, and students can easily connect, inspire, and collaborate (Den Ouden et al., 2017). Two notable initiatives that foster innovation valorisation on campus are 'The Gate' and 'Eindhoven Engine'. The Gate is a collaboration between TU/e, Fontys, Summa College, Brabantse Ontwikkelings Maatschappij, and the regional ecosystem. Located on the TU/e campus, it offers support and advice to students, tech starters, and researchers on various aspects of developing a start-up, including financing, accommodation, coaching, training, and collaboration opportunities (Brainport Development, n.d.). On the other hand, Eindhoven Engine is a joint initiative of TU/e, TNO, and Fontys, also situated on the TU/e campus. It focuses on co-creation, multidisciplinarity, and challenge-based projects (TU/e, n.d.-i).

Valorisation support is essential to promote initiatives, such as sustainable start-ups. The Gate is an example of such a valorisation support actor, and Interviewee 6 indicated that the government and companies showed particular interest in this type of internal actor. Furthermore, Interviewee 4 indicated that companies sometimes suggested to the university to start a firm in a domain they find too long-term development to invest in initially, so they could buy it when the technology is successful:

'And sometimes they [companies] see new opportunities in the market, of which they think, yes, that would have a chance, but our company itself is not going to put money into it because it takes too long. And then they look at us (TU/e) like gosh, couldn't you start a startup in that, because if it is successful, then it is a party we could take over.' Interviewee 4

In these initiatives, the valorisation actors, such as the gate, were the leading actors in helping these start-ups (Interviewee 4). Furthermore, these valorisation actor groups were in close contact with a multitude of actor groups, such as RE (Interviewee 12), Innovation Space, institutes (Interviewee 6), or the Sustainability team (Interviewee 9). Last, *Table 11* on page 38, provides a summary of the main findings mentioned above.

Knowledge Organisations

Examples of knowledge organisations located within the TU/e ecosystem are DIFFER and Fontys. DIFFER is part of the Dutch Research Council and works on fundamental scientific research on energy-related issues, such as solar fuels and ways to transport or store this energy (DIFFER, n.d.). Next, TU/e and Fontys collaborate in terms of harmonising the study programs, collaborating closely with Eindhoven Engine in research, and facilitating student cooperation with industry and hospitals (TU/e, 2020). Next, Interviewee 11 mentioned that Innovation Space started collaborating with Fontys because they wanted to stimulate the participation of diverse actors within the challenges. Furthermore, Interviewee 9 mentioned that the sustainability core team sometimes had contact with Fontys, which was not intensive but sporadic. The same was stated for the knowledge organisation DIFFER, where it was indicated that they would like to have more contact with DIFFER:

'With DIFFER ... I would like some more contact with it myself, I made contact with it somewhere last year, but is good to pick that up again.' (Interviewee 9)

An overview of the key findings can be found in *Table 11* on page 38.

Table 11: Overview of the Other Internal Actors Results

Actor	Key Findings	Leading sources
Associations	• TU/e has nine types of associations representing <u>various interests and fields</u>; • FSE advocated for <u>students' interests</u>; • Some study associations incorporated <u>sustainability practices</u>.	FSE (n.d.); GGO (n.d.-c); Interviewees 2, 7, 8; TU/e (n.d.-d, n.d.-e)
University Rebellion	• UR is a <u>grassroots organisation</u> at TU/e organising <u>rebellion actions</u>; • UR collaborated <u>internally</u> and <u>externally</u> to <u>pressure</u> the university on sustainability issues; • UR's actions created <u>awareness</u> and <u>influenced policies</u>.	Interviewees 4, 5, 9; University Rebellion (n.d.)
Valorisation Support	• TU/e supports <u>start-ups</u> and <u>spin-offs</u> through <u>valorisation</u> initiatives like The Gate and Eindhoven Engine; • Valorisation actors play a crucial role in <u>supporting sustainable start-ups</u>.	Brainport Development (n.d.); Den Ouden et al. (2017); Interviewees 4, 6, 9, 12; TU/e (n.d.-i)
Knowledge Organisations	• DIFFER focuses on <u>energy-related research</u>; • Collaboration between TU/e and Fontys in <u>study programs</u> and <u>industry cooperation</u>.	DIFFER (n.d.); Interviewees 9, 11; TU/e (2020)

Overall Scores of the Categories

This chapter addressed the sub-question: '*To what extent is TU/e acting as a University Sustainability Change Agent?*'. The chapter provided an overview of the actors within the TU/e on-campus ecosystem context. Next, TU/e scores on the *skills and characteristics criterion* four times Sufficient (*Table 12*). This means that TU/e had a relatively strong basis of individuals with SCA skills and characteristics, creating a basis to foster collaborations to support the internal and external ST. However, when looking at the *collaborations criterion*, TU/e scores four times Sufficient/Insufficient (*Table 12*). This is remarkable because it was expected that individuals with SCA skills and characteristics would be able to create these collaborations. A reason could be that the individuals possessing SCA skills and characteristics lack the time and resources to utilise these skills and characteristics to create collaborations (Interviewee 6). In line with this, it could be that individuals do not have a place to collaborate for sustainability, limiting the potential to employ these individuals' SCA skills and characteristics (Interviewees 1, 2, 8). Furthermore, it is believed that if these hurdles could be addressed, the individuals with SCA skills and characteristics could solve the most significant hurdle in the lack of collaboration, the language barrier between the different categories (Interviewee 6). Last, the overall scores of TU/e on the three indicators can be found in *Table 12* on page 39.

The presence of individual SCA skills and characteristics indicate that TU/e has the potential to become a USCA, while the actor groups did not collaborate sufficiently with other actor groups and external actors to navigate the change towards sustainability. This can be seen back in the score on the *sustainability direction criterion*, where TU/e scores four times Sufficient/Insufficient (*Table 12*). On the one hand, the scores on the *sustainability direction criterion* show that TU/e is acknowledging the importance of sustainability and recognising that they could have a prominent role in the external ST. On the other hand, the scores also indicate room for improvement and that the goals and activities are internally not aligned with the ambition to become a USCA. This might not be aligned because TU/e is a large organisation, and it needs time to align the ambitions with immediate clear goals and activities that direct change towards sustainability across the different categories (Interviewee 6). To become a USCA as TU/e, they primarily need to improve collaborations focused on sustainability. Furthermore,

they need to improve the direction of change towards sustainability, where TU/e should promote the internal and external ST. Therefore, the next chapter provides recommendations on how TU/e can establish or enhance collaborations to facilitate the internal transition towards becoming a USCA.

Table 12: The USCA Assessment Framework Applied to TU/e

Level/ Criteria	Skills and Characteristics	Collaborations	Sustainability Direction
Higher-level management			Sufficient/ Insufficient
Actor groups		Sufficient/ Insufficient	
Individuals	Sufficient		
Education			Sufficient/ Insufficient
Actor groups		Sufficient/ Insufficient	
Individuals	Sufficient		
Research			Sufficient/ Insufficient
Actor groups		Sufficient/ Insufficient	
Individuals	Sufficient		
Operations			Sufficient/ Insufficient
Actor groups		Sufficient/ Insufficient	
Individuals	Sufficient		

5 The Recommendations on Establishing or Improving Collaborations

This chapter addresses the third sub-question: '*How can TU/e establish or enhance collaboration with the relevant actors to become a University Sustainability Change Agent?*'. As concluded in the *Overall Scores of the Categories* sub-section, this question can be answered by focusing on the actor groups to see where they could improve when establishing or enhancing collaborations with relevant actors to facilitate the internal or external ST. Therefore, the focus lies on improving the *collaborations* and *sustainability direction criteria*. The *skills and characteristics criterion* is not addressed because the overall skills and characteristics scores of TU/e were sufficiently present, to improve the *collaborations criterion.*

To recommend how TU/e improves its USCA status, it is essential to recognise that the actor groups differ in two main ways. Firstly, they differ to what extent they can influence the direction of sustainability within their category, so their influence on the internal and external ST, corresponding to the *sustainability direction criterion*. Secondly, they differ to what extent they collaborate with actor groups and external actors, corresponding to the *collaborations criterion*. To account for these differences, this chapter positions the actor groups along the 'Internal ST Influence' and 'External ST Influence' axes, ranging from 'Low' to 'High'. The 'Internal Influence' axis indicates to what extent the actor groups influence the internal ST by collaborating with other actor groups and external actors. The 'External Influence' axis indicates to what extent the actor groups influence the external ST by collaborating with other actor groups and external actors.

The chapter begins with an explanation of the different quadrants and their characteristics. This classification helps understanding the roles and influence of actor groups. Furthermore, the chapter presents the proposed recommendations for each quadrant, tailored to each actor group's specific characteristics and influence. Finally, the chapter concludes with a summary of the findings per quadrant, highlighting the key recommendations and insights.
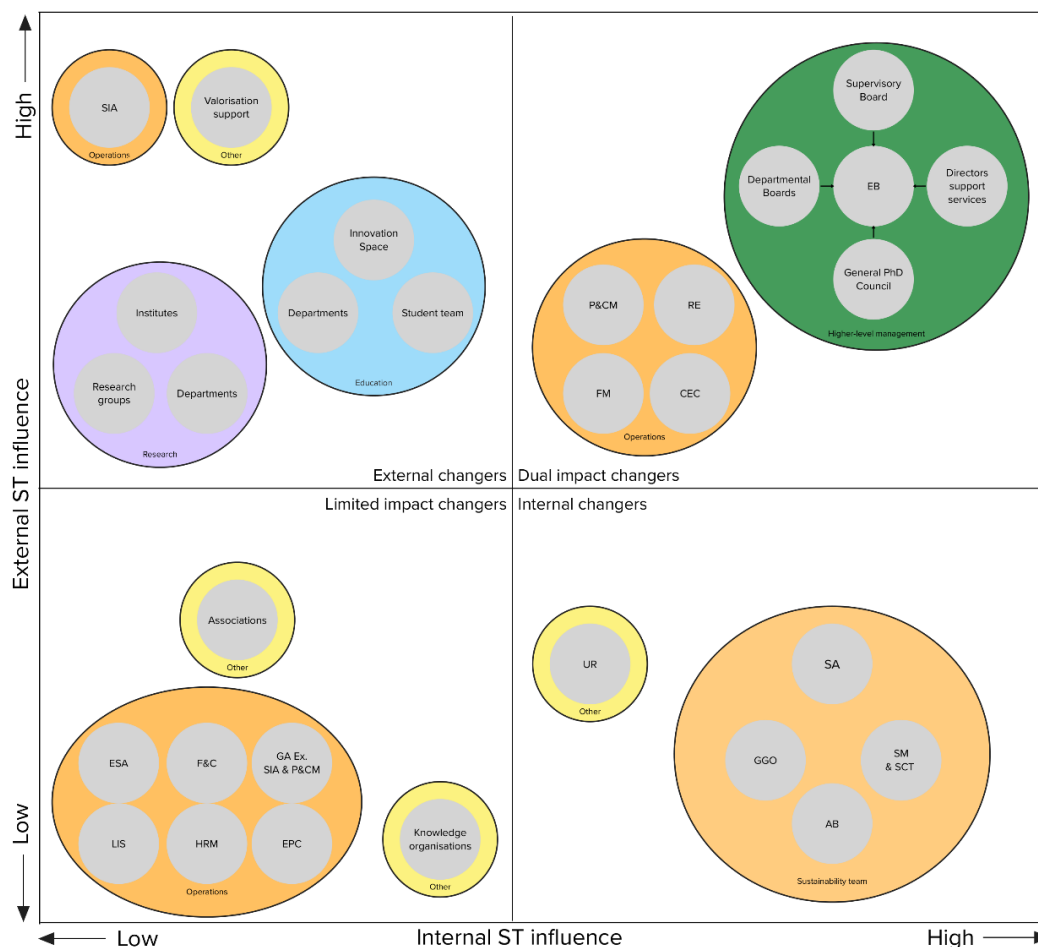

Figure 4: The Actor Categorisation Quadrant

5.1 The Four Quadrants and the Actor Groups

This section introduces and discusses the quadrants and clusters of actor groups, after which the proposed recommendations per quadrant are provided. The first quadrant, 'Limited impact changers', includes actor groups with limited influence on the internal and external ST through collaboration. The second quadrant, 'Internal changers', comprises actor groups with limited influence on external ST through collaboration but score high in influencing the internal ST. The third quadrant, 'External changers', consists of actor groups with limited internal influence through collaboration but significantly impact the external ST. The fourth quadrant, 'Dual impact changers', encompasses actor groups that have the potential to influence both internal and external transitions through collaboration.

Figure 4 visually represents these four quadrants, revealing that certain actor groups from the same category are concentrated in specific quadrants. The first cluster is situated in the Dual impact changers quadrant, where the Higher-level management actor groups are positioned. Furthermore, the operations cluster emerges within this same quadrant and in the Limited impact changers quadrant. The sustainability team is clustered within the Internal changers quadrant, whereas the actor groups from the Research and Education category are clustered in the External changers quadrant. Lastly, the actor groups from the Operations category are dispersed across the following three quadrants: External changers, Limited impact changers, and Dual impact changers.

Limited Impact Changers

The actor groups associations, internal knowledge organisations, ESA, LIS, HRM, F&C, EPC, and GA ex. SIA & P&CM belong to the Limited impact changers quadrant because they did not have specific sustainability collaborations internally or externally, and it is assumed that this will change when the Higher-level management actor groups create policies for this:

'Of course, if ... they would put .. some legislation for us [study associations] that we we have to follow ... A good example would be that the university wants to, I think, uhm, stop with the single-use cups or those kind of things ... study associations ... will change because of the the the policy of the university will change, so it can influence it.' Interviewee 2

Internal Changers

The actor groups SA, GGO, AB, SM & SCT, and UR belong to the Internal changers because they tried to impact the internal ST through collaboration. Moreover, the SA could also influence external actors by communicating to the outside world the role TU/e plays in the external ST and has the potential to collaborate more with external actors (Interviewee 6). Therefore, this actor group is placed higher in *Figure 4* than the other actor groups in the sustainability team. On the other hand, the AB is placed lower than the other actor groups of the sustainability team because they advised the SA and did not directly collaborate with other actor groups to influence the internal ST.

UR tried to create awareness of the need for TU/e to change towards a more sustainable direction, executed by occupations and demonstrations, which enabled them to have conversations with Higher-level management actor groups (Interviewee 5). Furthermore, they are placed higher on the 'External ST influence' axis because they collaborated with external activist actors to influence the external ST:

'We speak to other activistic groups because basically how the Netherlands kind of, you know, the pressure from the university network, right? So when we got the transparency mandate granted, there was this kind of wave of quaking a little bit from other unis being like, oh shit, we have to get our systems in order to be transparent, right? So it is it is really just a matter of one win in one university, just kind of being a big pressure influence on other universities.' Interviewee 5

External Changers

The actor groups SIA, valorisation support, innovation space, student teams, institutes, departments, and research groups belong to the External changers quadrant because they tried to influence the external ST through collaboration. Innovation Space is categorised as an external changer because they collaborated with various external actors, offering solutions to real-world problems (Interviewees 4, 11). Moreover, they connected different actor groups and wanted to collaborate with

an even wider variety of actor groups and external actors in the future (Interviewee 11). Next, student teams tried to showcase to the outside world how challenges can be overcome, although they were thought impossible to overcome (Interviewee 1). They did this mainly by collaborating with internal actor groups and external actors but were focused on changing the external ST, which is why they are categorised as External changers:

'We also help a lot of a lot of other teams in being more sustainable or in their innovations achieving them. Uhm, but our main focus is the world, and the TU/e falls within our ecosystem, of course, but more on the partnership side and be partners to fight for sustainability and also when we have other teams yet we have that goal in mind.' Interviewee 1

Institutes, departments, and research groups could have the possibility to collaborate with a diverse set of external actors to stimulate the external ST. However, the collaborations were not explicitly focused on sustainability or a wide range of actors. One of the influencing factors in these collaborations was the actor group SIA. The main focus of SIA is research collaborations with companies where sustainability was not a prominent theme in these conversations (Interviewee 4). However, the institutes, departments, research groups, and the SIA could significantly impact the external ST by collaborating with external actors.

Valorisation support is important in supporting start-ups, connecting them with external stakeholders, and facilitating collaborations. By doing this, the external environment was influenced by the impact of these start-ups.

Dual Impact Changers

The actor groups P&CM, RE, FM, CEC, EB, supervisory board, departmental boards, general PhD council, and directors support services belong to the Dual impact changers quadrant because they tried to influence the internal and external ST through collaboration. The Higher-level management actor groups belong to the Dual impact changers quadrant because together, they could change the direction of TU/e towards sustainability via policies and collaborations. Furthermore, they could stimulate the internal transition by setting a vision, providing guidance, and developing strategies and policies for TU/e that supported the internal ST:

'We need to move towards that step [Transforming towards becoming a USCA] ... And, you can do that faster by indeed first that it comes from a higher power ... that the executive board says ... this is really important. ... And I think we have enough experience ... within the ... TU/e to be able to do that [Transforming towards becoming a USCA.' Interviewee 6

Furthermore, with these same policies, TU/e could determine the collaborations created with external actors across TU/e. Next, the P&CM, RE, and FMC actor groups were trying to influence the internal ST by collaborating with actor groups to realise projects that have included sustainability measures in the procurement process. By including these sustainability measures, they also influenced the external actors. Companies wanted TU/e as a client because TU/e was a trustworthy and prestigious actor (Interviewees 3, 12). This allowed TU/e to demand that companies deliver products and services at the edge of what the market could deliver regarding sustainability, hence steering the market to sustainability improvements (Interviewees 3, 12). Furthermore, these facilities shared information with external actors, such as other universities, and collected information from external actors.

The CEC was responsible for the internal and external communication of TU/e. Although they followed the communication policies of the Higher-level management actor groups, they had the potential to actively communicate the sustainability efforts of TU/e internally and externally. This could be in the form of collaborations with actor groups that promoted and communicated their sustainability efforts through the CEC or by TU/e itself that took a frontrunner role in stimulating the ST by actively communicating their efforts regarding sustainability, hence inspiring other external actors and inviting them to collaborate on this topic.

5.2 The Recommendations for Creating or Improving Collaborations

This section indicates where each quadrant could improve in establishing or enhancing collaborations with relevant actors to facilitate the internal or external ST. The semi-structured interviews indicated these recommendations, after which academic literature validated the suggested improvements.

Limited Impact Changers

Although this quadrant might have a limited impact on the internal and external ST, there are still specific actions that might help to stimulate the internal and external ST through collaboration, thereby improving the *collaborations* and *sustainability direction criteria*. Internally, Interviewees 3 and 6 indicated that when individuals, such as students, teachers, and employees, would mobilise each other and start demanding change from the Higher-level management actor groups, would help accelerate the internal ST. However, it is acknowledged by Interviewee 6 that a large organisation as TU/e, will always have a certain inertia in itself in terms of change, and that this is not because of the unwillingness to change of individuals but just a lack of resources, focus, and a shortcoming of a large organisation. An example of an actor group trying to mobilise these people and that attempts to change the ST is UR, which achieved some success in changing policies by the Higher-level management actor groups (Interviewees 4, 9). Interviewee 9 explained that to foster change, it is essential that actor groups do not always need to provide the opposition, but that change needs to be brought in a subtle way, which ensures that the critical mass will be created that helps build a supporting base for the internal ST:

'You cannot go every time against someone's grain, so to speak. ... You have to bring it in a very subtle way, and ultimately so first, I think the usual suspects that you actually already have in your constituency come along, and then at some point, you do get a kind of critical mass, and then the ball starts, starts rolling, so to speak.' Interviewee 9

Based on the findings from the interviews, the most effective way to improve the *collaborations criterion* is to mobilise internal actor groups and to create a critical mass. According to theory, mobilisation refers to the process by which a disaffected group gathers and invests resources to pursue common goals (Tindall et al., 2008). This mobilisation could aim to achieve a critical mass, which refers to an initial group of actors sufficiently large to bring about social change. It relates to social movements and how interdependent decisions accumulate to form collective action (Oliver, 2022). The mobilisation theory helps explain the emergence, development, and outcome of social movements by addressing the resources and capacities of disadvantaged groups (Jenkins, 2001). The theory suggests that to mobilise actor groups, individuals need to take the lead (Spier, 2017), and it is crucial to consider aspects such as culture in the mobilisation process (Kendall, 2006). Additionally, resources play a significant role, as defined by the rational choice approach, which encompasses tangible resources like facilities and money and intangible resources like cultural commitments, solidarity, and identity networks that facilitate the pooling of resources among groups (Jenkins, 2001).

To effectively mobilise these actor groups and leverage the resources they possess, the identified actors must collaborate and seek opportunities to connect with other actor groups (Jenkins, 2001). This implies that the limited impact changers could actively strive to establish connections with other actor groups, thereby improving the *collaborations criterion*. It is essential to collaborate with experienced and successful actor groups who have demonstrated the ability to mobilise people to stimulate change (Jenkins, 2001). Collaborating with UR could be helpful in this context, as they have experience mobilising individuals to drive change.

By collaborating with other actor groups and drawing on their expertise, the limited impact changers can mobilise actor groups and pool their resources to achieve a critical mass, hence improving the *collaborations criterion* with actor groups to contribute to the goal of sustainability. Moreover, this collective effort will strengthen their capacity to drive social change and improves their effectiveness in addressing sustainability challenges at TU/e, which improves the *sustainability direction criterion* by incorporating sustainability into the goals of TU/e and influencing the internal ST.

Internal Changers

One of the most prominent issues indicated by the interviewees is that actor groups at TU/e do not know where to go if they want to collaborate on or exchange information about sustainability, hence blocking the improvement of the *collaborations* and *sustainability direction criteria* because it hinders sustainability collaborations. This information exchange is either in the form of receiving information or guidance related to sustainability, such as actor groups that could help them with improving the sustainability status of a department (Interviewees 10, 13):

'I am not an expert, and we are actually all not experts here per se, so then yes, a kind of external ... is doing a zero measurement of hey on this point, do you actually score very well and on this point, you score actually very poorly in terms of sustainability, wouldn't you even want to develop a policy for it to do it better?' Interviewee 13

Another important perspective to consider is the desire of actor groups to share sustainability improvements but often lack guidance on where to share these ideas (Interviewees 1, 2, 8). Next, feedback was collected through an email address managed by the SM, where ideas are documented. However, these interactions cannot be seen as true collaborations. On the other hand, collaboration holds significant value as it allows individuals with different perspectives to share resources and information, fostering innovation and addressing complex problems (Bouty, 2000; Ahuja, 2000). Literature suggests that increasing physical proximity is one approach to encouraging collaborations across and within organisational boundaries. Physical proximity enhances the likelihood of chance encounters and facilitates collaborative interactions (Bernstein & Turban, 2018; Boutellier et al., 2008; Kabo, 2016). Collaboration theory also emphasises the role of physical proximity and the creation of physical meeting spaces in facilitating collaboration and chance encounters (Bridwell-Mitchell, 2016; Feller et al., 2013), thereby improving the *collaborations criterion*.

While creating physical meeting points increases the likelihood of collaborations, challenges arise due to the diverse perspectives, power dynamics, and goals that collaborators bring to the process (Phillips et al., 2000). However, literature identifies three key factors that facilitate collaboration and help overcome these challenges (Irving et al., 2019). Firstly, collaborators must harmonise the differences between actor groups (Huq et al., 2017; Majchrzak et al., 2012; Baunsgaard & Clegg, 2013). Secondly, chance meet-ups and unplanned face-to-face interactions can foster established and new collaborations (Boutellier et al., 2008; Kabo, 2016). Thirdly, physical and relational spaces can support collaborations by facilitating interactive and collaborative encounters (Bridwell-Mitchell, 2016; Kellogg, 2009). These spaces enable interactions that lead to collective understanding (Bridwell-Mitchell, 2016), drive collective changes in practices and policies (Kellogg, 2009), and allow for the extension and combination of knowledge (Dolfsma & van der Eijk, 2015; Feller et al., 2013), thereby improving the *collaborations criterion*.

Considering the role of physical proximity in increasing the likelihood of collaborations, along with the three main facilitating factors, it is recommended that the internal changers create a physical meeting point. This meeting point would be a central hub where actor groups can access relevant information and share sustainability-related ideas. By providing a dedicated space for interaction, actor groups would increase opportunities to exchange information and ideas, thus enhancing the likelihood of finding collaborative partners to address sustainability issues and facilitating the internal ST. This would improve the *collaborations criterion* because it stimulates actor groups to collaborate to the goal of sustainability, which helps the *sustainability direction criterion* because it allows sustainability to be incorporated in the goals and actions of TU/e.

External Changers

The first possibility to improve the collaborations criterion is by joining network events to increase chances for collaboration. This aligns with the second factor for establishing collaboration, mentioned in the Internal Changers sub-section, which stated that unplanned face-to-face interactions could facilitate new collaborations (Boutellier et al., 2008; Kabo, 2016). For example, Interviewee 3 indicated that the procurement department is part of certain buyer groups and sometimes joins events or workshops to learn more about sustainability. Another possibility is attending conferences (Interviewee 9). This increases the chances of meeting other people with the same interests, which could lead to

fruitful collaborations or contacts, hence improving the collaborations criterion by improving collaboration on the goal of sustainability. Moreover, it could improve the sustainability direction criterion because it could influence the external ST. An example of attending conferences and how useful they are is provided by Interviewee 9:

'About a year back, there was an energy café in Boxtel ...That was organised by the province, so to speak, and there ... people approached me with interesting ideas from which ultimately the idea of that Museum of the future also arose, so I definitely listen to input I get. ... also people from the province and the municipality were there. I had another walk-around with ... an official from the municipality of Nuenen ... to hear from how are things going here in terms of sustainability? ... Can we maybe look for collaboration opportunities? Is there an option for some kind of ... café where you can tinker with your heat pump or something like that, hey, that kind of thing.' Interviewee 9

TU/e is seen as trustworthy (Interviewees 3 and 12), and they have the power to influence other collaborating external actors (Interviewee 14). Therefore, TU/e is also well-positioned to influence other external actors to collaborate. Interviewee 14 indicated that TU/e has more power than usually thought and that the main reasons are around the students that external actors want to hire after graduation and the knowledge that TU/e creates and possesses:

'I sometimes think we have more power the power than we think ... In the region but also with our cooperation partners. We are a major player, so we all have students running around, and we train them, and people want them when they graduate, so that is important. We develop knowledge that is important.' Interviewee 14

Therefore, by capitalising on TU/e's reputation and influence, TU/e can actively promote collaboration among other external actors, further enhancing its ability to drive sustainable initiatives within its network and improving the *sustainability direction criterion*. Moreover, TU/e has superior resources compared to smaller companies and exposure to external pressures, which provides TU/e with the capability to implement sustainability practices and enforce codes and requirements on its suppliers (Zhu et al., 2008; Crane et al., 2008; Ciliberti et al., 2009; Vurro et al., 2009). However, balancing utilising power effectively is crucial and avoiding hindrance to knowledge diffusion and interfirm learning (Hall & Matos, 2010).

Through collaborative engagements with TU/e's suppliers, TU/e can enhance communication, foster knowledge sharing, and drive environmental innovation (Rao, 2004; Verghese & Lewis, 2007; Cheng et al., 2008; Alvarez et al., 2010). These collaborations are pivotal for establishing sustainable supply chains (Pagell & Wu, 2009). By embracing a cooperative approach, TU/e can facilitate improved supplier performance (Vachon & Klassen, 2006a, 2006b, 2007, 2008; Klassen & Vachon, 2009), influencing the external ST and thereby improving the *sustainability direction criterion*. Such cooperation also ensures an equitable power balance, facilitating knowledge exchange and pursuing sustainability goals (Burt et al., 2003; Hall & Matos, 2010). Within these collaborations, TU/e can effectively employ its power attributes as a dominant buyer and knowledge supplier (Cox, 2001). This allows TU/e to ensure high-quality performance and enforce compliance with relationship-specific requirements, including ambitious sustainability goals (Cox, 2001). Furthermore, TU/e can harness its power to promote inclusivity and address underrepresentation by entering agreements that involve information sharing or the involvement of underrepresented external actors, such as NGOs, in collaborative initiatives. By establishing and strengthening these collaborations, the *collaborations criterion* is improved because the collaborations contribute to the goal of sustainability, which also improves the *sustainability direction criterion* by influencing the external ST.

Dual Impact Changers

Multiple interviewees suggested that TU/e could lead the external ST by bringing many different actors groups and external actors together on campus. This also resonates with the TU/e institutional plan of 2020-2025, stating that TU/e want the campus to become a vibrant and attractive hotspot for companies, researchers, entrepreneurs, scientists, and students (TU/e, 2021a). This also means that according to Interviewees 3, 7, and 12, the campus could become a place that showcases

state-of-the-art sustainability projects. Interviewee 7 described a utopian view that when someone comes to the TU/e campus, they feel and see that they are in the future where everything is sustainable. Interviewee 9 suggested that if realised, it could inspire other universities to create ecosystems where different actor groups and external actors work together, and ecosystem bubbles emerge on multiple university campuses. TU/e influences the external ST by inspiring these universities, improving the sustainability direction criterion. Interviewee 11 indicated that to initiate change, TU/e could be open and inclusive, which is not reached at the moment:

'Of course, we are a bubble here [TU/e campus] with each other, and all kinds of things happen in it, but if you want to initiate change, I think you have to be much more open and inclusive, and there is not a lot of attention to that yet I think.' Interviewee 11

One of the mentioned ways for TU/e to involve multiple actor groups and external actors on the TU/e campus and to stimulate collaborations is by creating on-campus living labs (Interviewees 6, 9, 12). Interviewee 6 even suggested that the university could aim for the creation making the whole TU/e campus a living lab, which is complex and challenging, but that it is possible if TU/e wants it to happen:

'But what I also see is if you really see that TU/e as a testing ground ... if you see that whole area as a kind of mega big lab at the disposal of education and research puts and valorisation. Then you have something that nobody has, right? That is a living lab or living lab 4.0. ...People are now thinking, say, in other places 2.0, we are then already in 4.0. I do think we all need to think about that and move towards that. And we actually have a great example, the Atlas building. I think that is also the largest living lab ... building in the world is even called. ... That is say so unique that, in my opinion, if you can do that at building level, you can also do that at campus level. It is even more complex, even more challenging, but well, the people who have realised this are on campus, ... so I am positive.' Interviewee 6

TU/e is positioned to be at the forefront of establishing a fourth-generation university, aligning with this emerging field of research. Creating a living lab that encompasses the entire campus or transforming it into an ecosystem involving external actors is intrinsically linked to the concept of fourth-generation universities (Wissema, 2009; Zuti et al., 2015). The fourth-generation university possesses a unique strategic approach, actively shaping its environment (Pawlowski, 2009), which improves the *sustainability direction criterion* by influencing the external ST. The strategy entails that one of the focal points in education and research becomes enabling value creation by multi-actor innovation through open innovation.

Extensive literature exists on universities and open innovation. Open innovation offers the advantage of integrating complementary capabilities by engaging in internal-external and external-internal knowledge flows with various stakeholders such as other universities, suppliers, collaborating organisations, technology centres, institutes, government institutions, and users (De Las Heras-Rosas & Herrera, 2021). Consequently, innovation within organisations can arise from collaborative networks and knowledge distributed among diverse agents (Coombs et al., 2003; Powell et al., 1996), where collaborative networks improve the *collaborations criterion*. The relationships between universities and businesses differ from typical business-enterprise relations due to the universities' trusted intermediary role in innovation (Striukova & Rayna, 2015). Additionally, universities have academic commitments that involve collaborative knowledge-sharing between academic and non-academic entities (Perkmann & Walsh, 2007). These collaborations improve the *collaborations criterion* and encompass informal activities like professional networks, personal advice, and formal activities like consultancy, collaborative research, and contract research (Perkmann & Walsh, 2008; Abreu et al., 2009).

Besides the focal point for education and research, Steinbuch et al. (2022) propose several additional ingredients universities could incorporate alongside their regular research and educational tasks to pursue becoming fourth-generation universities. Firstly, universities could transform into dynamic, open innovation spaces, accommodating part-time positions for external actors and scientists outside the university (Steinbuch et al., 2022). This could stimulate collaborations that contribute to the goal of sustainability, and influence the internal and external ST, thereby improving the *collaborations* and *sustainability direction criteria*. Secondly, students and PhD candidates could engage in global

games or benchmarks focused on addressing societal challenges, forming interdisciplinary teams (Steinbuch et al., 2022), which improves the *sustainability direction criterion* by influencing the external ST. Thirdly, while the university's focus could have a global outlook, it should also establish a robust local network and actively contribute to the local ecosystem. This means partly influencing the external ST, improving the *sustainability direction criterion*. Fourthly, universities could empower and motivate the ecosystem to generate value (Steinbuch et al., 2022), where it is essential to emphasise that value creation in this context extends beyond monetary aspects and encompasses societal and environmental values, improving the *sustainability direction criterion*.

Given TU/e's location in the Brainport region and its involvement in challenge-based education, TU/e holds great potential to lead the establishment of a fourth-generation university (Steinbuch et al., 2022). TU/e already enjoys close connections within a networked environment, facilitating the transition towards collaborative research with the local community (Steinbuch et al., 2022). The dual impact changers can spearhead the creation of a fourth-generation university, where the campus becomes a collaborative space for various actors to address significant societal challenges. Therefore, the focus on a fourth-generation university would improve the *collaborations criterion* because it would stimulate collaboration with actor groups and external partners toward the goal of sustainability. Moreover, it would improve the *sustainability direction criterion* because it would demand the incorporation of sustainability into the goals of TU/e and influence the internal and external ST.

An Overview of the Recommendations per Quadrant

The first quadrant, Limited impact changers, could prioritise establishing a critical mass internally by collaborating with various actor groups, especially with UR (*Table 13*), thereby advancing sustainability goals within TU/e, improving the *sustainability direction criterion*. The second quadrant, Internal changers, could focus on creating a physical meeting space where actor groups can exchange and acquire information about sustainability. This dedicated space would increase the likelihood of fostering collaborations on sustainability topics, thereby improving the *collaborations criterion* (*Table 13*). By providing a platform for knowledge sharing, the internal changers actor groups can facilitate effective communication and collaboration among actor groups, thereby improving the *collaborations criterion*. The third quadrant, External changers, could concentrate on two key pillars (*Table 13*). The first pillar: external changers and actor groups could actively participate in various events, such as networking events or conferences, to increase opportunities for collaboration. By engaging in these external gatherings, they can establish connections and collaborations with relevant external actors, thereby improving the *collaborations criterion*. The second pillar: the external changers actor groups could leverage their purchasing power to demand ambitious sustainability requirements from suppliers. Additionally, they could incorporate these sustainability requirements into negotiations regarding research and education collaborations, utilising their position as suppliers to drive sustainability efforts, thereby influencing the external ST and improving the *sustainability direction criterion*. The fourth quadrant, Dual impact changers, could strive towards realising a fourth-generation university. In this vision, the university serves as the enabler and motivator of collaboration for sustainability, and the campus transforms into an ecosystem where diverse actor groups and external actors engage in these collaborations, which would improve the *collaborations* and *sustainability direction criteria* by influencing both the internal and external ST through collaboration (*Table 13*). By embracing this approach, TU/e can position itself as a catalyst for sustainable initiatives and create an environment conducive to collaborative efforts.

It is important to note that while the recommendations are presented per quadrant for simplicity, they may also apply to certain actor groups in other quadrants. Moreover, actor groups may transition between quadrants as their position and influence on the *collaborations* and *sustainability direction criteria* evolve over time. Next, the ideal scenario for TU/e to become a USCA through collaboration with actor groups and external actors is for all actor groups to move towards the upper-right quadrant. In this quadrant, the recommendations proposed for limited impact changers, internal changers, external changers, and dual impact changers align with the principles of a fourth-generation university. Limited impact changers actor groups actively become part of the ecosystem, internal changers actor groups establish a physical meeting point for sustainability, external changers actor groups foster connections and demand sustainability commitments, and dual impact changers actor groups promote collaboration for sustainable development within an ecosystem involving a wide array of external actors (*Table 13*).

By working together towards establishing a fourth-generation university, TU/e enhances its potential to become a USCA, and collaborative efforts across all quadrants contribute to the university's overall sustainability objectives and increase the position of a leader in sustainability. Last, an overview of the recommendations per quadrant can be found in *Table 13* on page 49.

Table 13: Overview of the Recommendations per Quadrant

Quadrant	Actors	Recommendations	Leading sources
Limited impact changers	Associations, Education and Student Affairs, Equipment and Prototype Center, Finance and Control, Human Resources Management, Knowledge organisations, Library and Information Services, Other General Affairs	• Mobilise actor groups to create a <u>critical mass</u> and <u>collaborate</u> with university rebellion. This improves the *collaborations criterion* strengthening collaborations on sustainability, and the *sustainability direction criterion* by influencing the internal ST.	Interviewees 3, 4, 6, 9; Jenkins, 2001; Kendall, 2006; Oliver, 2022; Spier, 2017; Tindall et al., 2008
Internal changers	Advisory Board, Go Green Office, Sustainability Ambassador, Sustainability Core Team, Sustainability Manager, University Rebellion	• Create a <u>physical meeting point</u> for <u>sustainability</u>, improving the *collaborations criterion* by increasing the chances for collaborations and the *sustainability direction criterion* by allowing sustainability into the goals and actions of TU/e.	Ahmadjian & Robinson, 2001; Ahuja, 2000; Baunsgaard & Clegg, 2013; Bernstein & Turban, 2018; Boutellier et al., 2008; Bouty, 2000; Bridwell-Mitchell, 2016; Dolfsma & van der Eijk; Feller et al., 2013; Huq et al., 2017; Interviewees 1, 2, 8, 10, 13; Kabo, 2016; Kellogg, 2009; Majchrzak et al., 2012
External changers	Departments, Innovation Space, Institutes, Research groups, Strategic industry alliances, Student teams, Valorisation support	• Join <u>network events</u> and <u>attend conferences</u>, improving the chances of meeting other people, improving the *collaborations criterion* and the *sustainability direction criterion* to influence the external ST; • Utilise the <u>buying</u> and <u>supplying power</u> to <u>influence external actor sustainability practices</u>, thereby influencing the external ST through collaboration, improving the *collaborations* and the *sustainability direction* criteria.	Alvarez et al., 2010; Boutellier et al., 2008; Burt et al., 2003; Cheng et al., 2008; Cox, 2001; Cox, 2004; Interviewee 3, 7, 9, 14; Kabo, 2016; Klassen & Vachon, 2009; Pagell & Wu, 2009; Rao, 2004; Vachon & Klassen 2006a, 2006b, 2007, 2008; Verhese & Lewis, 2007
Dual impact changers	Departmental boards, Directors support services, Executive Board, General PhD Council, Supervisory board	• Steer towards the <u>fourth-generation university</u> where the campus becomes a collaboration place for <u>actor groups</u> and <u>external actors</u>, improving the *collaborations criterion* and the *sustainability direction criterion* by incorporating sustainability in the activities and goals of TU/e and influencing the internal and external ST.	Abreu et al., 2009; Coombs et al., 2003; De Las Heras-Rosas & Herrera, 2021; Interviewees 3, 6, 7, 9, 11, 12; Pawlowski, 2009; Perkmann & Walsh, 2007; Perkmann & Walsh, 2008; Powell et al., 1996; Steinbuch et al., 2022; Striukova & Rayna, 2015; TU/e, 2021a; Zuti et al., 2015

6 Conclusion

This master thesis aimed to understand how TU/e could leverage collaborations with all the relevant actors to become a USCA. The research consisted of three sub-questions that answer the main research question:

'How could TU/e leverage collaborations between the relevant actors to become a University Sustainability Change Agent?'

This chapter answers the main research question by reflecting on and summarising the findings of the three sub-questions. Next, the practical implications are provided, followed by a framework evaluation, and the contribution to literature. Last, this chapter ends with the limitations of the research and avenues for future research are provided.

6.1 Answer to the Main Research Question

The main research question was answered based on the three sub-questions:

SQ1: 'What is University Sustainability Change Agent?'

SQ2: 'To what extent is TU/e acting as a University Sustainability Change Agent?'

SQ3: 'How can TU/e establish or enhance collaboration with the relevant actors to become a University Sustainability Change Agent?'

To answer the first sub-question, a definition of USCA was developed from academic literature, including three criteria to evaluate the extent to which TU/e was reaching the status of becoming a USCA. The definition of USCA is:

A USCA actively strives for an entire system change from the old unsustainable socio-technical system towards a sustainable one. USCAs collaborate with diverse actors outside their organisation, such as universities, governments, companies, non-governmental organisations, and society. To achieve this sustainability transition, USCAs integrate sustainability into universities' four key activity categories (Higher-level management, Education, Research, Operations). Actor groups within these categories collaborate to navigate the transition to sustainability. Individuals in the actor groups possess sustainability change agent skills and characteristics to realise collaborations between the actor groups.

This definition served as a conceptual framework to assess to what extent a university acts as a USCA. The framework typifies universities in four categories with specific key activities: Higher-level management, Education, Research, and Operations. Higher-level management involves the key activity of creating the university's strategies, policies, and long-term visions. Education involves key activities such as providing lectures and tutorials. Research involves advancing scientific boundaries and filling knowledge gaps by publishing peer-reviewed journal papers. Operations involve the daily activities needed to run the organisation, such as heating buildings, waste management, catering, logistics, and more. Within these four categories, there are different actor groups. For example the Operations category has different support services, such as human resource management and general affairs. Furthermore, there are different roles within the different actor groups. For example, the category Education contains individuals that are either students or teachers. Next, universities can only become USCA if the individuals within the actor groups possess SCA skills and characteristics. When these SCA skills and characteristics are present, the actor groups can collaborate on sustainability with other actor groups and external actors. When these collaborations are present, sustainability can be integrated into the categories. Therefore, a hierarchical order exists between individuals, actor groups, and categories.

The second sub-question converted the conceptual framework from the first sub-question to an assessment framework, to focus on the extent to which TU/e acted as a USCA. This framework identified three criteria to assess to what extent TU/e acted as a USCA. The first criterion, called the *skills and characteristics criterion* focuses on the individuals within the actor groups and whether they

possess SCA skills and characteristics. TU/e scored Sufficient on the *skills and characteristics criterion*, meaning that TU/e had a relatively strong basis of individuals with SCA skills and characteristics, creating a foundation to foster collaborations to support the internal and external ST. The second criterion, called the *collaborations criterion*, focuses on the actor groups within the categories and the extent to which they collaborate with actor groups and external actors to contribute to sustainability. TU/e scored Sufficient/Insufficient on the *collaborations criterion*, meaning that some actor groups within the different categories established collaborations for sustainability, but other actor groups did not establish these collaborations, which needed improvement. The third criterion, called the *sustainability direction criterion*, evaluates to what extent sustainability is incorporated into the goals and activities of each category and to what extent they try to transition towards sustainability, and to what extent it tries to influence the societal ST. TU/e scored Sufficient/Insufficient on the *sustainability direction criterion*, meaning that the direction of change within the categories was somewhat towards sustainability. This showed that TU/e acknowledged the importance of sustainability, while this needed to be clearly articulated in the actions and goals in the different categories.

In contrast to what the conceptual framework suggests, the presence of individuals with SCA skills and characteristics did not result in a significant amount of sustainability collaborations. Possible explanations lay in time and resource constraints that limit the potential of the individuals. Another limiting factor could be that individuals need a place to establish these collaborations. Furthermore, this lack of employment of the SCA skills and characteristics and the lack of collaboration can also be seen in the scores of the *sustainability direction criterion*, which indicates that there is a misalignment between the ambitions TU/e has to become a USCA and the goals and activities the categories show. Therefore, to become a USCA, this research suggests that TU/e primarily needs to intensify existing and set up new collaborations with other actor groups and external actors. This is pivotal to improve the direction of change towards sustainability, where TU/e aims to promote the internal and external ST.

Focusing on external actor collaborations, it is valuable to reflect on how the strong triple helix presence in the Brainport region is set up and how that might have influenced the direction of change towards sustainability and how collaborations. In this respect, it could be that TU/e provides a path towards sustainability for companies and the government through collaborations. Still, it could also be the other way around that companies and the government steer TU/e towards sustainability through collaborations. Moreover, it could also be that a lack of sustainability direction by either TU/e companies or the government slows the collaborations on sustainability, thereby slowing the direction of sustainability change.

The third sub-question focused on how TU/e could establish or enhance collaboration with relevant actors to become a USCA. As concluded in the second sub-question, the answer should focus on the *collaborations criterion* of collaboration between different actor groups and external actors to improve the *sustainability direction criterion*: the direction of change towards sustainability. The *skills and characteristics criterion* were not addressed because the overall individual SCA skills and characteristics of TU/e were of sufficient level to improve the *collaborations criterion*. Four quadrants were established to distinguish the actor groups on these two criteria. The first quadrant, Limited impact changers, included actor groups with limited influence through collaboration on both the internal and external ST. The second quadrant, Internal changers, included actor groups with limited influence through collaboration on the external ST but scored high in influencing the internal ST. The third quadrant, External changers, included actor groups with limited internal influence through collaboration but significantly impacted the external ST. The fourth quadrant, Dual impact changers, included actor groups who could influence both the internal and external ST through collaboration.

The limited impact changers actor groups could mobilise other actor groups to create a critical mass and collaborate with successful actor groups in mobilisation. This improved the *collaborations criterion* by strengthening collaborations on sustainability and improving the *sustainability direction criterion* by influencing the internal ST. The internal changers actor groups could create a physical meeting point for sustainability, which improved the chances of establishing collaboration and improving the *collaborations criterion*. It also improved the *sustainability direction criterion* because it increased the chances of creating actions towards sustainability at TU/e. The external changers actor groups could join network events and attend conferences, improving the chances of establishing collaborations and improving the *collaborations criterion*. It also improved the *sustainability direction criterion* because it helped influence the external ST. The external changers actor groups could also

utilise their buying and supplying power to influence external actor sustainability practices, which improved the *collaborations criterion* and the *sustainability direction criterion* by influencing the external sustainability transition. The dual impact changers actor groups could steer TU/e towards the fourth-generation university where the campus becomes a place for collaboration with actor groups and external actors, improving the *collaborations criterion* by stimulating collaboration on sustainability and the *sustainability direction criterion* by incorporating sustainability into the activities and goals of TU/e and influencing the internal and external ST.

Based on the findings obtained from the analysis of the three sub-questions, an answer to the main research question can be formulated, describing how TU/e could leverage collaborations between the relevant actors to become a USCA. Firstly, TU/e could provide individuals with SCA skills and characteristics time, resources, and space to employ these skills and characteristics. This could allow these individuals to focus on decreasing the language barrier between different categories and creating sustainable collaborations with actor groups and external actors. Secondly, TU/e could leverage collaborations between the relevant actors to become a USCA by encouraging the establishment of these collaborations between actors groups and external actors. The encouragement could be creating physical meeting spots, encouraging actor groups to join network events or attend conferences, utilising buyer and supplying power, and promoting the fourth-generation university. Next, by leveraging the collaborations between the relevant actors to become a USCA, TU/e could align its ambitions to become a USCA with its goals and activities present in the categories, hence steering actively towards sustainability. Last, when implementing these recommendations, TU/e could leverage the collaborations between the relevant actors and become a USCA.

6.2 Practical Implications

The findings of this research have important practical implications for TU/e seeking to become a USCA. Firstly, TU/e could promote a culture of collaboration throughout the organisation, where encouraging open dialogue, knowledge sharing, and interdisciplinary cooperation is crucial. To facilitate this culture, creating dedicated physical platforms that encourage collaboration and the exchange of ideas about sustainability is recommended; where these platforms could serve as meeting spots for actor groups from different levels of the organisation, where expertise is shared and where there is room to work on sustainability-related topics. By stimulating this, TU/e can increase their leverage of collective knowledge. Secondly, TU/e could actively collaborate with external actors, such as governments, NGOs, companies, and knowledge organisations of different sizes. Collaborating with these external actors provides valuable resources, expertise, and support to the internal and external ST. Thirdly, TU/e could transform its campus into a collaborative space that promotes collaborations with actor groups and external actors. This collaborative space could encourage interdisciplinary collaborations between academia, industry, government, and society. Fourthly, TU/e could influence the external ST by utilising its buying and supplying power through demanding sustainability requirements.

6.3 Framework Evaluation

First, a conceptual framework was developed from the USCA definition, after which the conceptual framework was converted to an assessment framework to assess to what extent TU/e is acting as a USCA. It is important to critically reflect on the assumptions of the conceptual framework, specifically focusing on the hierarchy between individuals, actor groups, and categories. It was argued that without individuals possessing SCA skills and characteristics, the actor groups could not create collaborations to steer towards sustainability within the categories. This assumption seemed to be true, because the results showed that high scores on the *skills and characteristics criterion* did not necessarily mean a higher score on the *collaborations* and *sustainability direction criteria*. However, there might be a possibility where high scores on the *sustainability direction criterion* help improve the *collaborations* and *skills and characteristics criteria*. For example, when a university has incorporated sustainability into all its goals and activities in the four categories, established collaborations would inherently be based on sustainability. This would also mean that if a new actor group is introduced, it would create sustainability collaborations because of the category it falls into and the other actor groups pushing this group toward sustainability. When this happens, it is assumed that the actor group will adjust or move out of the organisation. Next, it is also likely that individuals will develop more SCA skills and characteristics within an organisation that promotes sustainability in all its goals, actions, and

collaborations. It is assumed that these SCA skills and characteristics could be developed through learning.

Developing a comprehensive assessment framework to assess to what extent TU/e is acting as a USCA has been a key contribution to this research. The assessment framework provided a structured approach to assess TU/e's potential as a USCA, starting with indicating the categories: Higher-level management, Education, Research, and Operations. It defined for the categories the *sustainability direction criterion*, for the actor groups the *collaborations criterion*, and for the individual level, the *SCA skills and characteristics criterion*.

One notable strength of the framework is its ability to assess TU/e's progress in driving the internal ST and splitting TU/e into three levels of analysis: individual, actor groups, and categories. However, several aspects of the framework warrant further evaluation and potential refinement. Next, the *sustainability directions, collaborations,* and *SCA skills and characteristics criteria* should be critically examined. While the framework provided a starting point to assess TU/e, applicability beyond TU/e should be considered. Additional research and validation with diverse organisations could provide insights into the framework's adaptability and effectiveness in different contexts. Furthermore, the assessment framework only allowed for assessing the extent to which a university acted as a USCA and showed areas for improvement. However, the limitation was that it did not identify the solutions to the areas of improvement. Lastly, the iterative data collection and analysis process provided valuable insights into the strengths and limitations of the assessment framework. As the analysis progressed, adjustments and refinements were made better to capture the complexities of TU/e's sustainability efforts. This iterative approach demonstrated the framework's adaptability and potential for future revisions and improvements.

6.4 Contribution to Literature

The contributions to literature are both in innovation sciences literature as well as in organisational change literature. First, the USCA definition was created, after which a conceptual framework is created from this USCA definition. This conceptual framework was used to assess to what extent a university is acting as a USCA. The framework typified universities into four key activity categories: Higher-level management, Education, Research, and Operations, and provided three criteria to assess to what extent a university is acting as a USCA. The four categories can be judged on the *sustainability direction criterion*, which evaluates whether the direction of the categories is heading towards sustainability. Moreover, it assesses the extent to which sustainability is embraced and incorporated into the activities and goals of each category and to what extent the category tries to influence the internal and external ST. Next, within these categories, universities have actor groups. The *collaborations criterion* focuses on the actor groups and to what extent they collaborate with other actor groups and external actors to contribute to the goal of sustainability. Furthermore, within these actor groups, there are individuals, and the *skills and characteristics criterion* examines whether these individuals possess SCA skills and characteristics. These three criteria are hierarchical because the direction towards sustainability of the categories cannot be achieved without collaborations between the actor groups, and the collaborations cannot be established without individuals possessing the skills and characteristics of a sustainability change agent.

This thesis enhances understanding of how universities can effectively drive sustainability change by providing this structured approach to assess the extent to which a university acts as a USCA. In addition, focusing within this framework on collaborations' role in becoming a USCA contributes to the literature on effective collaboration strategies for sustainability change. Furthermore, by focusing on the individual SCA skills and characteristics, this research stresses the importance of research on the individual level. It acknowledges the importance individuals can have in stimulating sustainability change in organisations. Next, by bridging transitions studies literature and innovation management literature, a unique perspective on the fact that to promote as university an external ST, the university should first undergo an internal ST to become a leader in the external ST. Moreover, this interdisciplinary approach allowed a deeper understanding of how universities can leverage their collaborating partners, resources, and expertise to catalyse external ST.

6.5 Limitations and Avenues for Future Research

This section first addresses the limitations of this research, after which it provides future research directions. Firstly, the potential selection bias from purposive sampling. This bias was compounded by the requirement for actors to exhibit an interest in sustainability. Consequently, the sampling process may have skewed towards individuals with favourable opinions on STs, thereby limiting the generalisability of the study's findings. Secondly, the semi-structured interview analysis was susceptible to researchers' biases and subjectivity, where the researchers' interpretations may have differed from the participants' reactions, potentially resulting in misinterpretation of the results. Thirdly, this research primarily focused on collaborations, constraining the analysis from exploring alternative approaches to establishing or enhancing TU/e's transition to a USCA. Fourthly, the three-point scale was broadly defined. Although it helped to keep the assessment framework flexible to the specific context, it also created subjectivity. Fifthly, the three-point scale helped with the simplicity of analysing universities. In contrast, additional points on the scale could improve the precision per indicator, which could help with a deeper analytical depth. Sixthly, the assessment framework did not allow for the development of the solutions, but only indicated where there is room for improvement.

Considering the limitations, the findings of this research may not be readily applicable to other universities, as the study was specifically tailored to TU/es specific context. Nonetheless, the assessment framework could be valuable for assessing to what extent a university acts as a USCA. Therefore, future research could focus on testing the framework to other universities. Moreover, future research could explore whether the framework applies to non-university organisations. This is expected to be possible given the flexibility of the criteria, but the categories must be adjusted because the key activities are unique for universities. Last, extending the framework towards the on-campus ecosystem could also be an exciting research avenue.

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8 Appendix

Appendix A Interview Guide

Introduction

First of all, thank you very much for participating in the interview. I am happy you could free up this time at such short notice. As you know, this research aims to understand how the TU/e ecosystem could become a sustainability change agent by leveraging open innovation processes and engaging with different actors inside and outside the TU/e ecosystem.

The term sustainability change agent (SCA) stands in this research for an individual, group, or institution that is part of an ecosystem, that actively promotes sustainable practices and behavior inside and outside their specific actor role or system. Furthermore, the term TU/e is seen as the TU/e ecosystem in this research, which includes all the actors present at the TU/e. The last term to explain is the sustainability transition, which means the transition the TU/e makes from its current status till the end where the TU/e has become a USCA.

To research this, the interview consists of five parts with around three questions per part. Part one will focus on the definition of USCA. This is followed by the second part, where the role that (Name actor group) plays in this transition will be looked at. The third part will examine collaborations, followed by questions about how information and resources are found and shared. Finally, the last part will look at the future of the TU/e ecosystem.

Before we start, can the conversation be recorded? Of course, I will delete this recording after the transcription. The recording will help me focus on the questions and the answers instead of focusing only on noting down the answers.

It is also important to mention that you are always free to end the conversation or take a break. Furthermore, you may always ask questions whenever you have them. Now, before we start, do you have any questions beforehand?

All right, great; then I will start the recording, and then we will start the interview.

Opening question

'*Could you tell me who you are and about your role in (**Name actor group**)?*'

'*How long are you fulfilling this role at (**Name actor group**)?*'

Key questions
Sub-question 1: 'What is a SCA?'

1 The USCAdefinition
1: How would *(Name actor group)* define a sustainability transition?
2: How would *(Name actor group)* define a SCA?

Sub-question 2: 'Who are the actors inside and outside the TU/e ecosystem that influence the ST at the TU/e?'

2 The role that (Name actor group) plays in this transition.

3: What is the role of *(Name actor group)* in the ST of the TU/e?

4: To what extent is *(Name actor group)* influenced by the ST of the TU/e?

5 To what extent does *(Name actor group)* try to influence the ST at the TU/e?

Sub-question 3: 'To what extent could open innovation processes help accelerate the sustainability transition at the TU/e?'

3 Collaboration

6: Who are the actors inside and outside the TU/e ecosystem that *(Name actor group)* collaborates with regarding the ST within the TU/e ecosystem?

7: In what way does *(Name actor group)* collaborate with these actors?

8: How close is the relation with these actors?

4 Information and resource finding and sharing

9: What could be ways for *(Name actor group)* to find information and resources that help to accelerate the ST at the TU/e?

10: What could be ways for *(Name actor group)* to share information and resources that would help to accelerate the ST at the TU/e?

5 Imagine the future
Now imagine that the TU/e ecosystem has reached the status of a SCA.

11: What changed in the ecosystem compared to the current status of the TU/e ecosystem?

12: How would *(Name actor group)* need to adapt in the future to fit the SCA?

13: Which actors would be influenced outside the ecosystem?

14: How would the ecosystem promote sustainability outside its boundaries?

15: With whom could the TU/e ecosystem collaborate to promote sustainability outside its boundaries?

Closing
These were all the questions.

'Is there anything you want to mention or discuss that I did not ask?'

'Was everything clear for you?'

'Do you have any questions left for me?'

If there are no further questions, I would like to thank you once again for the interview. I found it an enjoyable interview where your answers will contribute very much to the research. If there are any further questions later you can always call or email me.

Appendix B Themes and Criteria
Table 14: Themes and Criteria

Criteria	Beringer, 2007	Blanco-Portela et al., 2018	Dobson & Tomkinson, 2012	Filho et al., 2020	Hesselbarth & Schaltegger, 2014	Kapítulčínová et al., 2018	Lozano et al., 2013	Lozano & Lozano, 2014	Lozano et al., 2015	Moore, 2005	Peer & Stoeglehner, 2013	Ralph & Stubbs, 2014	Rodriguez et al., 2009	Stephens et al., 2008	Wanner et al., 2018	Mintrom & Rogers, 2022	Wittmayer et al., 2017	Brown et al., 2013	Castan et al., 2019	Fayez et al., 2018	Novalia et al., 2020	Raven et al., 2012	Van Poek et al., 2017	Saravanen, 2015	Tichy 1975	Ginsberg & Abrahamson, 1991	Caldwell 2003
Normative orientation																											
Sustainability	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Sustainable development	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X		X	X	X	X	X	X			
SDG		X		X												X			X								
Navigation of change																											
Collaboration	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X					
Exchange	X	X	X	X	X	X	X				X				X	X			X			X	X	X			
Partnerships						X	X								X	X	X			X		X					
Co-creation											X				X			X		X							
Co-design															X												
Co-production															X	X		X		X							
Transdisciplinary	X			X	X	X			X		X		X		X	X											
Internal actors: Campus communities		X	X	X			X		X		X				X	X											
External actors: Universities		X	X	X		X	X	X	X		X				X		X			X	X						
External actors Government	X		X	X			X	X	X						X	X	X	X	X	X	X		X				
External actors: Society	X		X	X		X	X		X		X	X			X	X	X	X	X	X	X	X					
External actors: Companies		X	X	X			X		X						X	X	X	X	X								
External actors: NGO		X	X												X		X				X						
Distributed leadership																X	X										
(multi-)Actor network		X				X	X				X					X	X	X	X			X					
Normative orientation																											
Transformative	X				X	X	X		X	X					X					X	X		X				
Radical change/shift/transformation			X	X			X		X						X	X	X		X	X			X		X	X	X
Fundamental (systemic) change																X	X	X	X			X					

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Critical mass						X																						
System innovation																X		X		X								
Sustainability transition													X	X	X	X	X			X		X					
Disruptive															X			X	X		X						
Long-term	X		X		X	X	X	X			X	X	X	X	X	X	X	X		X	X	X					X
Confrontation	X				X					X		X			X					X		X	X	X			
Pathways		X			X					X		X	X	X	X	X	X	X		X							
Dynamics (e.g. multi-level/multi-phase)	X			X		X		X	X				X	X	X	X	X	X	X	X	X	X				X	X
Lock-in			X													X											
Phase 1: pre-development																X											
Phase 2: Take-off																X											
Phase 3: Acceleration																X											
Phase 4: Stabilisation																X											
Socio-technical system/transition															X	X	X	X	X	X							
Creating niches/ niche development													X	X	X	X				X							
Disrupting /destabalise/shift regime													X	X		X			X	X							
Landscape pressure																X				X							
MLP														X		X	X	X		X							
Niche													X	X	X	X	X			X	X						
Regime													X	X		X	X			X	X						
Landscape														X		X	X	X		X							
Internal university conditions												X		X														
University classified as CA						X				X																		
Involve high administration	X	X		X		X				X		X	X	X														
Partnership/ public relations	X	X		X		X		X	X	X	X	X	X	X														
Education and communication	X	X		X		X		X	X	X	X	X	X															
Financial support and planning		X		X																								
Policy concern				X																								
Curriculum and training	X	X	X	X	X	X	X	X	X	X	X	X	X	X														

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26
Behavioural change				X										X												
Operations	X	X				X			X	X		X		X												
SCA Skills and charateristics																										
Clarify problem and articulate shared vision		X		X					X	X	X	X		X	X	X	X	X	X		X	X	X			X
Engage others to identify workable solutions											X					X										
Engage others to implement pathways							X									X	X		X		X	X			X	X
Secure support from influential stakeholders																X						X				
Establish effective monitoring tools	X	X				X				X		X				X										
Establish effective learning systems																X										
Foster long-term relationships of trust and mutual support				X							X	X				X	X	X		X						
Heterogeneity of actors are involved																X						X				
Interaction between organization levels																X										
Interaction between administrative levels																X										
Self-organization instead of hierarchical steering					X											X										
Work with normative aspects					X												X		X	X	X	X				X
Seek to transcend current thinking														X	X			X								
Multifacet approach to understand change																		X								
Multifacet approach to shape change																		X								
Value alternative researchers role																		X								
Encourage second-order experimentation																		X								
Be reflexive															X			X								
SCA characteristics																										
Individual				X	X					X		X		X	X	X		X	X	X	X	X	X	X	X	X
Group of actors				X					X							X				X		X				X
Inside an organization or system																	X		X	X	X	X	X	X	X	X
From outside an organization or system																					X	X	X	X	X	X

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Formaly invited to organization or system																						**X**	**X**	**X**	**X**	**X**
Not formaly invited to org. or system																						**X**	**X**	**X**		
Reacts to outside pressure							**X**											X				**X**	**X**	**X**		
Task oriented																						X				X
Process oriented																						X				X
Agency (e.g. to overcome path dependence)						X											X	X		X						
Leader			X	X					X	X									X			X	X		X	X
Participate in deliberative processes										X																
Promote ST and S practices			X			X	X										X									
Create awareness (e.g. share vision)	X		X	X			X	X		X		X		X				X	X	X	X	X				
Frontrunner or champion	X	X					X							X			X	X	X		X					X
Possess positional power																	X									
Provide people with a platform for influence																	X									
Leader in creating collaborations																	X									
SCA skills																										
Critical thinking		X		X			X		X	X				X												
(Complex) problem-solving			X	X	X		X	X		X				X	X				X			X		X	X	X
Creativity		X	X	X	X		X		X	X	X			X	X			X		X	X	X				
Communication		X		X	X	X		X	X					X								X		X		X
Innovative										X				X	X			X				X				
Self-reflexive				X			X																			
Social capital															X											
Systems-thinking				X	X		X	X			X			X												
Novel leadership skills																	X									
Context specific																	X	X					X			
Transformative capabilities/ capacities																	X		X		X			X		
Visionary leadership																						X				
Initiate change																										X
Managing change																						X			X	X
Implement change																									X	X

Types of sources	Sources
Policy documents	TU/e, 2018b; TU/e, 2021a; GoGreenOffice, 2022;
Research documents	Shindler et al., 2022
Electronic documents	DIFFER, n.d.; GoGreenOffice, n.d.-a; GoGreenOffice, n.d.-b; GoGreenOffice, n.d.-c; Studenten voor Morgen, 2018; Team Energy, n.d.-a; Team Energy, n.d.-b; TU/e, 2018a; TU/e, 2020; TU/e, 2021b; TU/e, 2022; TU/e, n.d.; TU/e, n.d.-a; TU/e, n.d.-b; TU/e, n.d.-c; TU/e, n.d.-d; TU/e, n.d.-e; TU/e, n.d.-f; TU/e, n.d.-g; TU/e, n.d.-h; TU/e, n.d.-i; TU/e, n.d.-j; TU/e, n.d.-k; TU/e, n.d.-l; TU/e, n.d.-m; TU/e, n.d.-n; TU/e, n.d.-o; TU/e, n.d.-p; TU/e, n.d.-q; TU/e, n.d.-r; University Rebellion, n.d.

Interviewee	Position	Departmental affiliation or role	Date of interview
Interviewee 1	Head of public relations	Student team	17/04/2023
Interviewee 2	Head external affairs	Study association	18/04/2023
Interviewee 3	Employee	Procurement and contract management	19/04/2023
Interviewee 4	Employee	Strategic industry and alliances	20/04/2023
Interviewee 5	Member	University Rebellion	20/04/2023
Interviewee 6	Employee	Eindhoven Institute for Renewable Energy Systems	21/04/2023
Interviewee 7	External affairs and community manager	GGO	21/04/2023
Interviewee 8	External affairs	FSE	24/04/2023
Interviewee 9	Employee	Sustainability core team	25/04/2023
Interviewee 10	Employee	Eindhoven Artificial Intelligence Systems Institute	26/04/2023
Interviewee 11	Employee	Innovation Space	26/04/2023
Interviewee 12	Employee	Advisory board/Real estate/ Facility management	02/05/2023
Interviewee 13	Employee	Department Mathematics and computer science	08/05/2023

Declaration concerning the TU/e Code of Scientific Conduct for the Master's thesis

I have read the TU/e Code of Scientific Conduct[i].

I hereby declare that my Master's thesis has been carried out in accordance with the rules of the TU/e Code of Scientific Conduct

Date

05-06-2023……………..…………...…

Name

Lucas Ramaekers…………………………..…………..

ID-number

1734881………………….…………..

Signature

Lucas Ramaekers
………………………………………………..…………..

Submit the signed declaration to the student administration of your department.

[i] *See:* *https://www.tue.nl/en/our-university/about-the-university/organization/integrity/scientific-integrity/*
The Netherlands Code of Conduct for Scientific Integrity, endorsed by 6 umbrella organizations, including the VSNU, can be found here also. More information about scientific integrity is published on the websites of TU/e and VSNU

February 21, 2020