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Working papers (and published articles) “Comparing responsibilization strategies at technical universities in Europe”

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Our European University Network

BoostEuroTeQ

Strengthening institutional transformations for responsible engineering education in Europe

How can technical universities help to create a workforce that **meets the challenges of complex global problems that cut across technology and society**? How can we support the **professional development of future engineers**? How can we **effectively upscale co-creation teaching practices**?

These are some of the questions we aim to address in **BoostEuroTeQ** – a scientific research project funded by EU Horizon 2020. As a complementary project of the Erasmus+ funded EuroTeQ Engineering University our goal is to encourage institutional change towards **responsible research and innovation**. The **multidisciplinary project** brings together engineering education, philosophy, ethics, and science and technology studies.

Over the course of three years (2021-2024)
we will work on two main dimensions

Enabling individuals

Supporting the lifelong learning journey of European professionals by conceptualising new professional profiles

- Analyse the developmental needs of the engineers of the future
- Develop a strategy for the upskilling of professional engineers at universities
- Create tailor-made training programmes in close collaboration with institutional and industry partners
- Conceptualise training for Learning Professionals with the aim to qualify them as specialists in the scientific upskilling of engineers

Societal transformation

Augmenting the transformative potential of universities in society by investigating co-creation practices and developing context-sensitive strategies for their reflexive institutionalization

- Create a EuroTeQ Co-Creation Manifesto on institutional strategies that will enhance the evolution of responsibility practices at technical universities
- Support the development of learning networks to increase co-creation practices in each community
- Conduct stakeholder engagement events on responsibilisation instruments at EuroTeQ partner universities
- Investigate the benefits and challenges as well as identify potential indicators for successful co-creation teaching at universities
- Develop a roadmap for the upscaling of co-creation teaching practices

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1. PREAMBLE

“BoostEuroTeQ: strengthening institutional transformations for responsible engineering education in Europe” explores innovations in engineering education brought into the Erasmus+ funded “EuroTeQ: European University” alliance. Its main objective is to contribute and strengthen EuroTeQ actions by carrying out rigorous empirical work in the areas of lifelong learning and responsible co-creative engagement between technical universities and society.

The EuroTeQ Engineering University builds on the belief that societal developments of recent years call for strong university alliances to make the knowledge square of education, research, innovation and service to society a reality and its impact a benefit to Europe and beyond. As six leading Universities of Science and Technology, spread across Europe, situated in innovation eco-systems and with great collaboration experience, the partners in this consortium have the ambition to introduce a paradigm shift in the engineering education of the future, striving for responsible value co-creation in technology. “EuroTeQ Engineering University” has a twofold meaning: To provide excellent education to our future engineers and to engineer the University of the Future, thus becoming a role model for the European Higher Education Area and beyond.

As highly renowned European Universities of Science and Technology, we share the conviction that for effectively shaping value creation processes in technology, we need an approach that involves all of society as an active partner, including all relevant stakeholders in the process (developers, producers, and users) alongside civil society and policy-makers. Yet, each of us lives in different societal structures and traditions. Therefore, value creation processes are shaped and perceived differently across different countries, requiring a situated approach to understanding and using the science-society interface. We share the conviction that Europe with its European values in general bears successful societies, but we are interested in understanding the differences, unique features and best practices across the continent. The relative comparability of our Partner Universities is an advantage when analyzing and assessing the learnings of each activity within the EuroTeQ Engineering University. It will also help to understand the benefits of international and transcultural collaboration for each of the involved societies. By collaborating with this set of Partner Universities, we expect findings that will be transferable to other university networks across Europe and beyond, and that will ultimately promote a deeper understanding between the different national societies and societal layers alike.

BoostEuroTeQ strengthens the EuroTeQ alliance by carrying our research and interventions on two main pillars. On the first pillar, it develops the concept and profile of learning professionals – the mediators between technical universities and professional engineers, on the side of universities (WP2) – and a strategy to upskill professional engineers (WP3). On the second pillar, the project develops a **strategy for reflexive institutionalization of co-creative and responsible teaching and research practice**. It does so by investigating the responsibilization strategies of technical universities (WP4), the co-creative communities they help develop (WP5), and by building on those, designing a strategy to boost co-creation in teaching (WP6). WPs 1, 7 and 8 contribute to achieve these research goals and enhance their impact by conducting rigorous project management and communication and dissemination activities, while also strengthening the links with the EuroTeQ alliance. **This deliverable compiles the research papers – published, submitted and under review, and in advanced drafting process – that we have put together during the project.**

2. EXECUTIVE SUMMARY

Work packages 4-6 focus on the development of a **strategy for reflexive institutionalization of responsible and co-creative teaching and research practice at the EuroTeQ universities**. The three work packages follow a shared research strategy divided in three phases. On the first phase, we carry out empirical research to get a grasp of the current status of responsibility practices and their links to co-creation efforts. On the second phase, we carry out interventions oriented to strengthen these activities but also to build stronger ties to the main Erasmus+ EuroTeQ alliance and its different components and work packages. On the third phase, we carry out a policy analysis and connect it to our efforts to design policies that should lead towards the reflexive institutionalization of responsible co-creation in teaching and research across the six EuroTeQ universities. These include, for example, a “Co-creation manifesto” and a “Co-creation teaching roadmap”.

The purpose of this deliverable is to bring together a range of research articles and working papers that we have produced during the project. These derive mostly from the empirical research conducted in the context of WP4 and 5, yet WP6 contributed to the collection of data and drafting. The papers build on the analytical conducted for Milestones 4.1 (Project guideline) and 4.2 (Database on responsibility practices and experiences at EuroTeQ Universities), and Deliverables 4.1 and 5.1 (SWOT analyses of Responsibilization strategies and instruments, respectively). Moreover, the papers gain from the philosophical expertise provided by TU/e partners.

Description of work

During the first phase of the project (ca. September 2021 – Dec 2022), researchers and university staff involved in WP4-6 collected data on multiple case studies across the EuroTeQ universities related to their responsibilization trajectories. For pragmatic purposes, responsibilization was understood as processes of 1) addressing sustainable transitions, 2) incorporating social sciences and humanities (SSH) in technical universities, 3) fostering multi and interdisciplinary research, particularly across SSH and STEM disciplines, and 4) engaging with society. These are also themes that relate to, and facilitate co-creation between universities and society. The remaining of the project funded period was dedicated to data analysis, drafting research papers, and carrying out interventions such as stakeholder engagement events and co-creation and Challenge-Based Learning workshops.

All the meetings had components dedicated to planning and discussing research papers on different topics related to the responsibilization of universities, each approaching a different angle. The empirical data collected is rich and diverse, which allowed fruitful exchange required for scientific paper development.

This deliverable presents the most advanced pieces of academic writing produced during the funded period of the project. Two published and open access papers explore how the University Alliances supported by the European University Initiative can support the responsibilization of the universities. The article in *Tertiary Education and Management* combines philosophical analysis and a comparative study of the EuroTeQ Collider. It pays detailed attention to how the Collider has allowed the sharing of know how, the development of strategies and moral reflection across the EuroTeQ universities. It builds on our earlier paper for the *Frontiers in Education* conference.

Cuevas-Garcia's single authored manuscript, currently under review, examines the different transformations taking place in one of the EuroTeQ universities. The argument is that not all

understandings of sustainability put forward by different initiatives mean the same. Yet, some have more chances to thrive than others. This observation should help universities assess what multiple understandings of sustainability the are bringing into being and which ones predominate. This article has been shared with a Sustainability Office of one of the EuroTeQ universities to encourage them to develop further key performance indicators of its sustainability strategy.

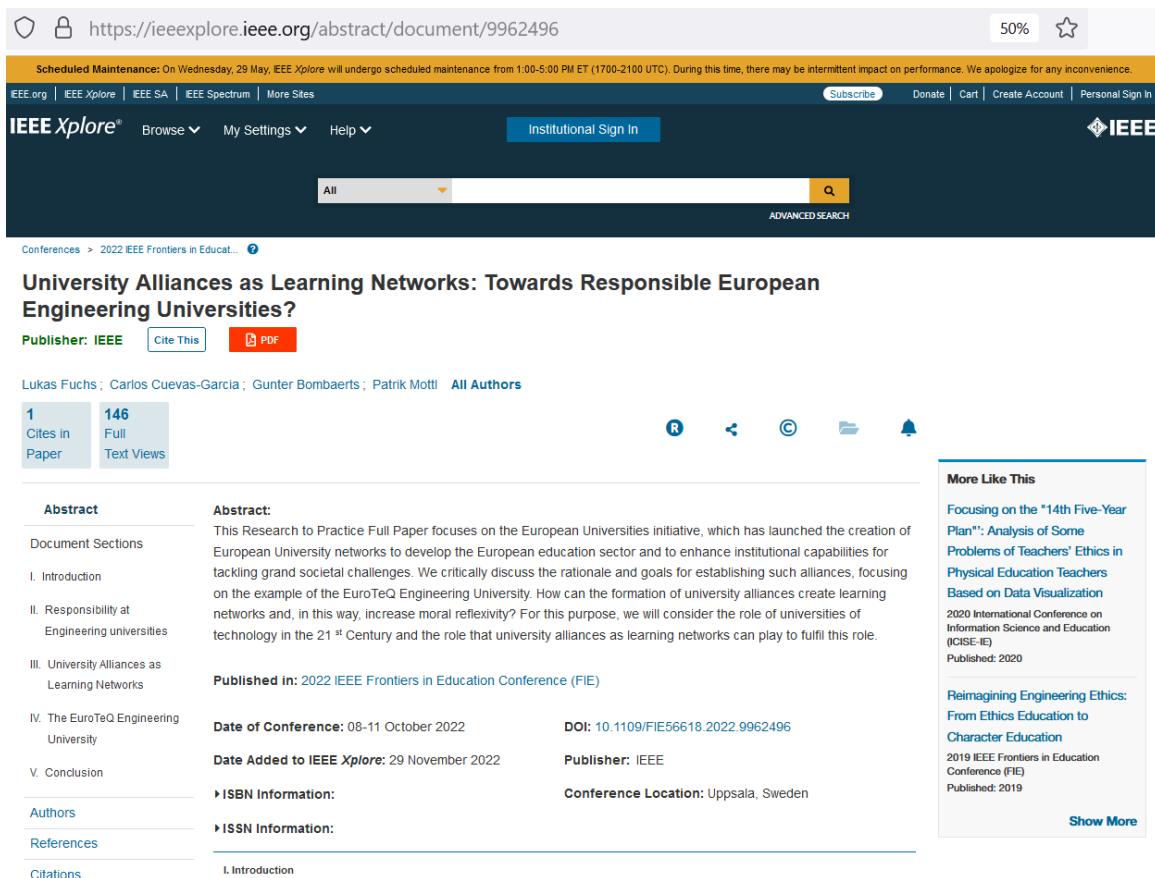
Finally, a manuscript still under development builds on these previous publications to examine more thoroughly the sustainability strategies of several EuroTeQ universities. We omit information about the co-authors to avoid compromising the double-blind peer-review process. We decided to spend more efforts on the sustainability dimension because that is the more pressing socio-environmental challenge. Moreover, as we have found, sustainability is the most comparable of the dimensions examined in our initial SWOT analysis. The remaining ones – integration of social sciences and humanities, interdisciplinarity, and engagement with society – are also part of less developed comparative papers, which hopefully will be finished and published,, most likely, after the project ends.

3. PUBLISHED: UNIVERSITY ALLIANCES AS LEARNING NETWORKS: TOWARDS RESPONSIBLE EUROPEAN ENGINEERING UNIVERSITIES?

This article by Lukas Fuchs, Carlos Cuevas-Garcia, Gunter Bombaerts and Patrik Mottl was the first peer reviewed article produced by the BoosEuroTeQ WP4-6 team. The whole reference is:

Fuchs, Lukas, Carlos Cuevas-Garcia, Gunter Bombaerts, and Patrik Mottl. 2022. "University Alliances as Learning Networks: Towards Responsible European Engineering Universities?" Pp. 1–6 in 2022 *IEEE Frontiers in Education Conference (FIE)*. Uppsala, Sweden: IEEE.

Available at: <https://ieeexplore.ieee.org/abstract/document/9962496>



The screenshot shows the IEEE Xplore digital library interface. At the top, there is a banner for 'Scheduled Maintenance' on May 29, 2022. The main search bar has 'All' selected. The article title is 'University Alliances as Learning Networks: Towards Responsible European Engineering Universities?' by Lukas Fuchs, Carlos Cuevas-Garcia, Gunter Bombaerts, and Patrik Mottl. It is published in the '2022 IEEE Frontiers in Education Conference (FIE)'. The 'Abstract' section is visible, along with 'Published in', 'Date of Conference', 'Date Added to IEEE Xplore', 'DOI', 'Publisher', 'Conference Location', 'ISBN Information', and 'ISSN Information'. On the right, there is a 'More Like This' sidebar with related articles and a 'Show More' button.

The full paper starts in the next page. We include an author's version, not the journal's edited copy.

Abstract

The European Universities initiative has launched the creation of European University networks to develop the European education sector and to enhance institutional capabilities for tackling grand societal challenges. This paper critically discusses the rationale and goals for establishing such alliances, focusing on the example of the EuroTeQ Engineering University. How can the formation of university alliances create learning networks and, in this way, increase organisational reflexivity? For this purpose, we will consider the role of universities of technology in the 21st Century and the role that university alliances as learning networks can play to fulfil this role.

Keywords — university alliances, universities of technology, responsibility, reflexivity

Introduction

The European Universities initiative has launched the creation of European University alliances to develop the European education sector and to enhance institutional capabilities for tackling grand societal challenges, such as climate change (Gunn 2020). One of these — the EuroTeQ Engineering University — emerges from six leading European universities of technology. These are: Technical University of Denmark (DTU), Eindhoven University of Technology (TU/e), École Polytechnique (I'X), Technical University of Munich (TUM), Czech Technical University (CTU) and Tallinn University of Technology (TalTech). These universities aim to establish a shared European campus, increase cooperation in the areas of research and innovation and set standards for educating the engineers of the future.

The academic literature has discussed “university alliances” mostly in the form of interest groups for member universities (such as, for example, the European University Alliance (EUA)). For example, Vukasovic & Stensaker (2018) analyse university alliances acting as political representatives and Sebeok (2020) discussed their role in shaping university technology transfer policy. While the European university alliances are also expected to do some of this interest group work, their focus lies in the collaboration to improve their own activities in education, research and innovation. Another novelty of these new alliances is that they are restricted to universities in EU member states. Other university alliances may be global and may comprise a much greater number of member universities. The creation of such university alliances, with roughly half a dozen members, aimed at setting educational standards, has few precedents.

This paper therefore aims to be a first exploration of how to best understand the benefits and opportunities such alliances create for their members. We critically discuss the rationale and goals for establishing such a European Engineering University. What advantage can universities gain from being part of such an alliance? How can the formation of university alliances create learning networks and help universities be reflective about their own role in society? Addressing these questions also requires us to consider the societal responsibility that universities of technology and their ecosystems can exercise, especially in educating future engineers (Miller 2019).

Today many universities of technology are entangled with an “ecosystem” of companies and other societal stakeholders (Jongbloed et al. 2008). How can the formation of university alliances strengthen the connection between universities and their ecosystems, for instance in the field of student entrepreneurship? We distinguish three ways in which alliances provide platforms for universities to learn and mutually reflect on their activities.

First, universities can share know-how about course design and curricula change to co-creative education (*know-how*). Second, university alliances may have significant influence on the internal discussion and developments of universities about their future strategic plans. Resource pooling and economies of scale might enable universities to tackle projects they would individually be unable to do (*strategy*). On a third level, university alliances might help universities reflect on their role and responsibility in their local environment and in their society (*reflexivity*) and hold each other accountable to these commitments. We follow Stilgoe et al. (2013: 1571), who defined this kind of institutional reflexivity as “holding a mirror up to one’s own activities, commitments and assumptions, being aware of the limits of knowledge and being mindful that a particular framing of an issue may not be universally held”.

The next section will sketch the new demands and responsibility at European universities and Engineering universities in particular. Later, we look at alliances and how they provide learning networks for know-how, strategy and moral reflexivity. Finally, the paper will explore an example, namely the EuroTeQ alliance and how it aims to increase learning and reflexivity among its partner universities.

Responsibility at Engineering universities

In addressing the responsibility of engineering universities, we enter a broader debate about the role of universities in society in the 21st Century. In order to understand the ways in which alliance formation may aid universities in fulfilling their role, we must first consider the expansion of functions and requirements that universities have come to be measured against. In this context, Collini (2012) has written of universities as ‘multiverses’ given the great variety of societal purposes they are meant to fulfil.

This trend is particularly strong at universities of technology. In addition to the traditional roles of education and research, these universities are increasingly expected to engage in innovation, which includes technology transfer, creating spin-off companies, and providing technical advice to policy makers and the broader community. Engineering universities are expected to develop technological solutions to societal problems and to cooperate with other actors who will be able to disseminate these solutions to society. All this takes place against the background of substantial changes in tertiary education. Miller (2019) suggests this is a threefold process of “massification”, universities provide education to broad segments of society; “corporatization”, transforming universities into market-driven organisations (Slaughter and Leslie 1997; Resnik 2007); and, a process of “bureaucratization”, with the adoption of top-down management practices and performance indicators. Miller (2019) points out that the purpose of the university in our society — especially with a view to sorting out tensions between its functions — is still unresolved. Such a conception, argues Miller (2019: 1680-1) “would doubtless embrace the pursuit of knowledge for its own sake as well as the realization of wider social and economic goals”.

One way to approximate the question of universities’ responsibility is to ask: *Who do they have responsibility towards?* In answering this question, we can first point out that in some sense, all universities have a public mandate. Their funding (at least for research-led universities in Europe) is to a large extent provided by public funds. Thus, universities are — perhaps more than private businesses — to be held accountable by the public. To which extent do universities serve public interests, as opposed to their own interests? Second, universities are situated in a local city, or community, and for their education, research and innovation purpose they must somehow interact with this environment. Universities play a role in these local ecosystems and the question of responsibility also applies here. Finally, students often spend some of their most formative years in universities. What responsibility do universities have to their own students?

The narrative of grand challenges for society and engineers serves as the focus point for the recent changes in thinking about responsibility at engineering universities (Rip 2018). These challenges are now closely linked to an understanding of the future role of the (responsible) engineer. The main impact of linking the education of responsible engineers to challenges has been to identify a broad set of skills that are required. The Dutch technical universities make an interesting example because they were among the first to adopt the sustainable development goals and to rethink their education programmes accordingly. For example, the strategy for 2030 of the Eindhoven University of Technology states that: “Engineers of the future need a broad, open and cooperative mindset to meet the UN sustainable development goals, contribute to the technological revolution and create impact for society in a responsible and sustainable way. This implies reflection, analysis and participation in academic and public debates about technology and its impact” (TU/e Strategy 2030).

Linking education with societal challenges led to the identification of a broader set of skills needed for future engineers. This has often been done by giving students more choice and to let them tailor their programme according to their interests and ambitions. In a vision statement about the “Engineer of the Future”, Anthonie Meijers wrote that “[m]uch innovation takes place at the interface between disciplines and students must learn to seek and embrace the creative tension arising from multidisciplinary contacts” (Meijers 2013: 28). Besides interdisciplinarity, lifelong learning is another element on the agenda of engineering universities. While the significance of university degrees used to indicate the end of a learning process, this shifted to a model where the degree indicates that graduates are able to continue learning throughout their lifetime. As a result, learning how to learn became more central.

“Co-creation” is an umbrella notion of innovation practices in which diverse actors gather in an innovation process to achieve mutual benefits (Ramaswamy 2011). Co-creation can take different forms and take place in different situations. As co-creation is embedded, improving the innovation process is not an abstract endeavor, but requires interactions and collaborations with innovation practitioners to touch on the specific situated aspects of co-creation. Universities are increasingly expected to engage in co-creative processes to contribute their particular expertise and resources to societal efforts. Understanding universities role in co-creation is a key step to defining their responsibilities towards societal actors, like the public sector and industry.

In discussions about engineering ethics, the concept of responsibility has played a core role (Herkert 2005). Here it has been understood as the “exercise of judgment and care to achieve or maintain a desirable state of affairs” (Whitbeck 2011: 159; see Martin et al. 2021: 59).

Philosophers discussing the concept of ‘responsibility’ often distinguish between two different notions. First, “backward-looking” responsibility (blameworthiness) denotes the idea that some agents can be blamed for harms that came about or goods that did not come about. Second, “forward-looking” responsibility is the idea that some agents have a responsibility to act, whether or not it is possible to (individually) blame them for their (in)action. Ascribing the “backward-looking” type of responsibility to universities is very difficult. First, universities operate in a wider university ‘system’ — along with other universities, policy, and other educational and research institutes. It is virtually impossible to point at individual university players and blame them for undesirable results in the education of engineers or the production of research and innovation necessary for overcoming grand challenges.

However, the forward-looking sense of responsibility is very relevant in the context of grand challenges. Focusing on the forward-looking sense of responsibility lets us ask which institutions and protocols can help universities exercise this kind of responsibility. How can universities launch a process that makes it more likely that they will transform and act in a way that corresponds to the societal expectations placed on them? In other words, how can university alliances aid partners in tackling these new challenges and provide a platform for moral reflection? The next section turns to these questions.

University Alliances as Learning Networks

Despite increasing analytical interest in university alliances and networks at the turn of the century (Beerkens 2002; Theater 2004; Fisher et al. 2001), recent studies observe that transnational networks are rarely mentioned or studied (Fumasoli and Rossi 2021). There are quite a few case studies on specific regions or countries, such as Scotland or Canada (Fischer et al. 2001; Kitawa 2010). Moreover, in the few occasions when they are, the advantages that universities receive from being a member of such an alliance has not been linked to explicit discussion of the broader role of universities in society and their role in grand societal challenges.

To illustrate this absence of considerations of university responsibility, the recent paper by Fumasoli and Rossi (2021) is instructive. These authors examine the role of higher education institutions in 991 strategic partnerships and network alliances supported by the ERASMUS programme between 2014 and 2018. In their study, they create different categories of topics and of importance given to them within the networks. They differentiate between core, transversal, specialist, and marginal topics. The marginal topics include:

“cooperation between educational institutions and business; access for the disadvantaged; energy and resources; gender equality and equal opportunities; migrant issues; social and environmental responsibility of educational institutions; early school leaving and combining failure in education... civic engagement and responsible citizenship; cultural heritage; human rights; ethics, religion and philosophy; post-disaster rehabilitation; rural development and urbanization; transport and mobility; Roma and other minorities” (Fumasoli and Rossi 2021: 207).

The fact that these authors include extremely important university activities, such as “cooperation between educational institutions and business” in the category of “marginal topics” illustrates the diminished role that such topics of responsibility have received in the literature on alliance formation.

Recent studies on the European Universities Initiative suggest it promises to assign a more prominent role to topics of sustainability, focusing on societal challenges, and searching for strategies for civic participation (Arnaldo Valses and Gomez Comendador 2021). Arnaldo and Gomez observe that the alliances formed by the initiative could test different ways of inter-institutional cooperation and best practices sharing, ideally aiming to form a “network of networks”. However, they observe that a weakness of the initiative is the “hyper-concentration” of universities from Germany, France, Italy and Spain (p.7). It is still too early to have results of how the alliances supported by the European Universities Initiative share resources to become more responsible towards their ecosystems. Given that the European Universities Initiative has only been launched in 2020, it is too early to analyse their empirical success. In the rest of this section we will put forward a conceptual scheme for how to study the success of university alliances as learning networks.

The guiding idea here is that university alliances are learning networks in which universities help themselves and others to exercise different types of responsibility. Gunn and Mintrom (2013) argue that “[t]he best possible outcome of any global university alliance is creation of opportunities for mutual advance, mutual learning, and positive organisational transformations. [...] we refer to these positive outcomes as the creation of ‘collaborative advantage’”. In the following we will distinguish three types of advantages that universities may derive from alliances.

Know-how. The first level on which universities can learn from each other is basic know-how on how to improve education. Here, universities can learn from those who were early-adopters and thus already have experience with experimenting with new educational formats. Technical universities adapt their curricula to specific pedagogical approaches to address societal challenges, such as project based

(Kolmos et al., 2016) or challenge based (Doulougeri et al., 2021; Bombaerts et al. 2022; Martin & Bombaerts 2022) learning. In the attempt to answer the global challenges of the 21st century, technical universities incorporate complex, sociotechnical innovation challenges (Hadgraft & Kolmos, 2020) including human sciences (Bekkers & Bombaerts, 2017) or ethics (Bombaerts & Spahn, 2021) in their courses. Pedagogical sciences focus on a wealth of topics to improve this education, such as how to motivate students (Bombaerts & Vaessen, 2022), how to increase competences (Bombaerts et al., 2021) and how to upscale this education (Bombaerts, 2020). Universities can exchange syllabi, reading lists, challenges and problems to work on and, more generally, advice on how to implement education that tries to encompass such societal considerations.

Strategy. Next to this restricted focus to the know-how of education, universities can exchange ideas and collaborate to pursue a common university strategy. On this level, which concerns the university as a whole as opposed to individual courses or modules, universities may share ideas about how best to collaborate with other societal actors, such as political actors, NGOs or industry. Here, the universities may exchange experience in setting up, maintaining and cultivating a university “ecosystem”, other societal actors who are (spatially) close to universities and who closely interact with it for the delivery of their services to society. University alliances may also be a way for formulating and implementing strategies for linking these ecosystems with each other. The resulting sharing of resources and knowledge may give a decisive advantage to these individual ecosystems (Gunn and Mintrom 2013).

Moral Reflexivity. On a third level, universities are required to rethink their own role and responsibility in society given the need to adapt to grand societal challenges. The last section sketched some of the issues of responsibilities for universities of technology. However, deliberating these issues, including them in the day-to-day practices of education, research and innovation requires a platform where universities can mutually reflect on their practices. University alliances may also be a good way to “hold themselves accountable” to implement considerations of responsibility. By adopting a similar framework, comparing and benchmarking their activities, universities can make themselves accountable to the other members of the alliance. Such a platform to reflect on one’s own activities and values necessarily requires a culture of open conversation and transparency to function well. Such a platform must be beyond merely showcasing success stories at universities. They must also allow in-depth discussions of failures and obstacles encountered in implementing considerations of responsibility.

The EuroTeQ Engineering University

As was shown in the previous sections, the focus on responsibility is very recent and the empirical evidence of its enactment at technical universities and their alliances is still missing. In this section, we will sketch the ongoing research into the formation of the EuroTeQ Engineering University. As the EuroTeQ alliance states:

“we share the conviction that for effectively shaping value creation processes in technology, we need an approach that involves all of society as an active partner, including all relevant stakeholders in the process (developers, producers, and utilisers) alongside civil society and policy-makers. Yet, each of us lives in different societal structures and traditions. Therefore, value creation processes are shaped and perceived differently across different countries, requiring a situated approach to understanding and utilizing the science-society interface. We share the conviction that Europe with its European values in general bears successful societies, but we are interested in understanding the differences, unique features and best practices across the continent” (EuroTeQ 2022).

As this vision document shows, the universities themselves view the alliance formation as the creation of a learning network where the university partners become responsible by learning from each other. The three levels of engagement described in the previous section may be studied as part of this process. How can the attainment of these learning goals be operationalized with the example of EuroTeQ?

Know-how. In the case of EuroTeQ, the exchange of engineering learning formats is likely to be the main objective on a practical level. Some universities within the alliance have experimented significantly with novel educational formats. The “EuroTeQ Collider” is one project within the EuroTeQ alliance formation and is an especially valuable project to study the dissemination of this kind of knowledge. The same instructions were given to all partner universities in the alliance. “During the EuroTeQ Collider project weeks, interdisciplinary and international teams composed of students, vocational trainees, young professionals and lifelong learners collaborate on challenges developed with the support of industry partners, start-ups, teachers and students at each institution” (EuroTeQ 2022). Universities are free how to implement the course and significant divergences are thus to be expected in the way that universities carry it out. For example, there has been less experience so far with including external stakeholders in the education process at L’X or CTU. Here co-creation activities and closer cooperation with industrial partners were not traditionally part of the curriculum and were mostly optional for students. The existence of the university alliance and possibility of discussion and comparison with the other more experienced partners in this area facilitates the implementation of this format into the student’s curricula. In addition, the availability of courses, study programmes and academic units that aim at bringing ethics, responsibility, and social aspects of science and technology in these universities are ways in which the sharing of know-how may be studied.

Strategy. The partner universities within the EuroTeQ alliances have launched *maker spaces* in recent years, such as “Mektor” in TalTech; “Innovation Space” at TU/e; “UnternehmerTUM” at TUM; and “SkyLab” at DTU. Some of these serve as hubs of co-creative education and play a crucial role in re-orienting the university strategically, especially with a view to their ecosystem and external stakeholders. Inviting these maker spaces to engage with each other may likely be the most fruitful way to understand the creation and sharing of university strategy in the context of alliance formation. Next to the maker spaces in general, we will also analyse other co-creation institutes and instruments that support co-creative education to increase the moral reflexivity. Examples include the Intelligent Lighting Institute (ILI) at TU/e and Venture Labs in TUM.

Moral Reflexivity. Studying how universities define their societal role and hold each other accountable may be the most difficult aspect of studying alliances as learning networks. The creation of a common narrative is a central element in this. Partner universities, as well as similar European university alliances, have different discourses. These different conceptual narratives may each point to slightly different directions as to what should be done at universities. On the one hand, the idea of “responsibility” at universities suggests that there are obligations to society that universities must be sensitive towards. On the other, for some universities (and alliances) there is a strong link with entrepreneurship (a responsibility to make students entrepreneurial). The partner universities enter the alliance with different expectations and with a different conceptual framework. One crucial aspect of studying moral reflexivity will be to consider whether these narratives converge over time and how they interact with one another.

A crucial aspect of this is the regional aspect that comes along with such a European project. By combining universities from different geographical regions from Europe, universities with very contrasting/different histories, societal embeddedness and resources are made to engage and learn from each other. In this context it is critical to study different universities’ needs, as well as some of the legacies and barriers that may prohibit them from more actively engaging or from changing as a result of alliance formation. One consequence of such an imbalance may be observed in student behavior as

they look for resources or teaching in other universities unavailable at their own, with possible asymmetric flows as a consequence. For example, after the first year of making courses open to students from other alliance universities, we see greater numbers from the Eastern European universities (CTU and Taltech) to TUM than the other way around.

Considering these historical and geographical aspects raises an important issue for the propensity of universities to engage in moral reflexivity. One important risk is the pursuit of an imperial style of sharing resources. This links to more traditional challenges in collaboration and those present in the European context. The alliance has old Western-European members and new East-European members. There are differences in world ranking that are seen as a strength by some participants, but as a challenge by others. And there are administrative burdens of semesters starting at different moments and having different lengths that do not form fundamental challenges, but nevertheless are very intensive to overcome. Alliances in general and specifically those addressing moral reflexivity may be fragile. Yet they may also be a golden opportunity for universities to reflect on themselves, transform and actively engage with questions of societal responsibility.

Conclusion

Forming university alliances may be a decisive step for engineering universities to transform themselves into responsible education facilities, geared for the challenges of the 21st century. The necessary changes in the curricula go beyond tinkering and require forming learning networks, engaging with external stakeholders and reflecting on the broader role of engineering universities in society. We described three ways in which alliances — such as the European university alliances — may facilitate this process: sharing know-how, aligning strategies and moral reflexivity. Against this background, we sketched how these benefits may materialize in the context of the EuroTeQ alliance.

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4. PUBLISHED OPEN ACCESS: THE SOCIETAL ROLE OF UNIVERSITIES AND THEIR ALLIANCES: THE CASE OF THE EUROTEQ ENGINEERING UNIVERSITY

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The societal role of universities and their alliances: the case of the EuroTeQ Engineering University

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We analyse the creation of European university alliances as an effort to build learning networks between universities in light of newly perceived needs in Europe. The rationales for such alliance formation include cultural integration, grand societal challenges and reforms in the European innovation ecosystem. We consider how alliance formation may be instrumental in achieving closer cooperation and understand alliances as learning networks where universities can share know-how, define strategies and pursue moral reflection. How such learning may take place is illustrated with a case study of the "EuroTeQ Collider", a joint educational programme by one of the European university alliances. The case illustrates how uneven experience with novel educational formats and stakeholder engagement creates opportunities for exchange and how formulating a common language for joint activities can make universities align their strategies and deliberation.

Keywords European university alliances · Engineering universities · Role of universities in society

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Introduction

The European universities initiative (EUI) has launched 41 university alliances under the Erasmus+ Programme. These universities have committed to intensifying collaboration in a variety of fields, with a focus on building joint online campuses where students can take courses from another university and get credit for them. The characteristics of the alliances

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vary significantly: some consist of established research universities, some mostly of newcomers, some of technical universities, some of generalists, some with a focus on the arts or business (Gunn, 2020). Yet the underlying idea is similar: to increase collaboration between previously more-or-less unconnected universities.

For instance, the “EuroTeQ Engineering University” consists of six well-established universities of technology, namely Czech Technical University (CTU), École Polytechnique (L’X), Technical University of Denmark (DTU), Technical University of Munich (TUM), Tallinn University of Technology (TalTech) and Eindhoven University of Technology (TU/e). The stated goal of this alliance is to open courses to students of the other alliance members, collaborate in research and entrepreneurship activities and set standards for educating engineers of the future (EuroTeQ, 2022), including lifelong learning. Besides EuroTeQ, there are other technology-focused alliances, including the “European Engineering Learning Innovation and Science Alliance” (EELISA) or the “European Universities of Technology Alliance” (ENHANCE).

Higher education collaborations — such as strategic alliances, joint ventures, university collaborations, partnerships or mergers — provide an opportunity to solve challenging issues by conferring resources, knowledge, and skills, leveraging structure and support (Eddy, 2010; Pinheiro et al., 2016; Valmeekanathan et al., 2021) of involved partners to achieve common objectives. These collaborations in higher education take place in many forms, such as between or among institutions as a whole, as departmental collaborations across institutions, or as university programs that join forces with businesses, communities or NGOs (Eddy, 2010). Collaborations that go beyond mere window dressing and that enhance academic performance, achieve economic efficiencies and better align the network and performance of institutions to public needs seem to be able to strategically stimulate institutional initiative, support effective planning and implementation, secure stakeholder buy-in, concentrate resources, and achieve policy alignment (Thune, 2011; Williams, 2017). Long-term financing gives higher education organizations flexibility to set their own agenda and focus on their strategic aims (Larsen, 2020).

However, the creation of European alliances, with roughly five to eight members, aimed at setting educational standards and intensifying collaboration in various fields, is a relatively novel phenomenon and has few precedents. Recent literature has started to examine the main themes addressed by these alliances (Fumasoli & Rossi, 2021; Brooks & Rensimer, 2023), their alignment with the economic competitiveness of Europe (Flury et al., 2021), and their alignment with good practices according to the Civic Universities’ standards (Arnaldo Valdes & Gomez Comendador, 2022). In addition, there are important questions about the motives and incentives of universities for joining such alliances. Besides the EU policy objectives of these alliances (and the lip service all must give to join), it is likely that a strong pull for many universities to join has been the fear of being left out and the uncertainty of how this new programme will interact with existing EU higher education programmes.

In this article, we acknowledge the likely role of such incentives but focus on the question what role EUI alliances can play in making universities address the new demands they are expected to address. While there is currently insufficient theoretical and empirical research on the rationale and success of such collaboration (Vukasovic & Stensaker, 2018), there is especially a shortage of empirical knowledge of how university alliances work and how alliance formation interacts with the impact of universities on society. The question of

the role and societal responsibility of universities has come to the fore in recent years (Collini, 2012; Geschwind et al., 2019). The launch of the EUI represents the latest step in the evolution of universities in Europe and therefore requires careful consideration of what their societal responsibilities are and how they are meant to fulfil them. Why should half a dozen of universities pool their resources (such as their courses), learn from each other and in this way engage in joint action?

We will survey the emerging political and societal demands on universities and analyse the potential that university alliances have for meeting these demands. We argue that alliances of this kind are promising for bringing about joint action because they enable learning and reflection between universities. In other words, university alliances are learning networks (Gunn & Mintrom, 2013; Fuchs et al., 2022). Universities can share know-how, can work together on a common strategy, pool resources and engage in a mutual dialogue about the role of their universities in society and their societal responsibility, thus participating in a kind of moral reflexivity. We believe the framework of learning networks and inter-university collaboration aids our understanding of the role that alliance formation can play in helping universities re-orient in the face of new demands, especially concerning societal orientation.

We discuss a case study from an inter-university course collaboration as part of the EuroTeQ alliance. Through ethnographic observation, we followed the implementation of a co-creative learning format across the six member universities (“EuroTeQ Collider”). We describe how learning took place during the planning and implementation phase and discuss the propensity and limits of this collaborative exercise in creating joint action between universities. We acknowledge that establishing general statements about EUI alliances will require further empirical case studies beyond our interpretive qualitative case study.

We focus on the creation of alliances between technical universities (Geschwind & Broström, 2022) and our case study arises from one of them. The role of technical universities in society has come into sharp focus in recent years (see articles in Taebi et al., 2019). Besides the traditional functions of research and education, universities of technology are expected to generate new technologies that can be translated into solutions that encompass technical as well as social aspects.

The next section surveys the emerging demands on the role of universities in society that motivate the creation of EUI alliances. In Sect. 3 we describe such alliances in terms of learning networks in order to address these new demands. In Sect. 4 we illustrate the idea of a learning network by means of the EuroTeQ Collider case study. Section 5 concludes.

The changing role of universities in society

Today, universities engage in a wide range of activities. Already in 1963, Clark Kerr introduced the term *multiversity* to recognise the great variety of activities and societal functions universities are expected to fulfil in addition to research and education (Kerr, 1963). As part of the so-called “third mission” (Papadimitriou, 2020; Compagnucci & Spigagelli, 2020), universities contribute to regional development (Pinheiro et al., 2012), engage in lifelong learning activities, host public lectures, advise local government or other stakeholders and catalyse academic entrepreneurship (Siegel & Wright, 2015) and a wide range of other co-

creation activities (Ramaswamy, 2011; Berghaeuser & Hoelscher, 2020; Lipp et al., 2022; Trencher et al., 2014).

This expansion of university activities is accompanied by changing views about the role of the university in society. Instrumentalist views about the role of universities (Fuchs et al., 2023) see the value of universities mainly in their contribution to societal or economic goals. After World War II, universities were tasked to focus on basic research and technology in the hope that these will later serve public purposes like national defense or welfare (Bush, 1945). The concept of the “entrepreneurial university” highlighted that universities also play a role in disseminating research in the form of patents and innovations, thus directly contributing to economic development (Etzkowitz, 2003). Today, there is recognition that universities need to address societal goals more directly and assume broader societal responsibilities (Arnaldo Valdes & Gomez Comendador, 2022; Trencher et al., 2014; Martin, 2012). Geschwind and colleagues (2019, 4) observe that universities “are expected to contribute to the development and resilience of societies”, “to provide students with high-quality, relevant education” and to have “an impact on the cultural, social, political, technological and economic development”.

Against this broader shift in the role of universities in society, we identify three societal demands on universities that provide the most direct rationale for the creation of university alliances, namely the need for European integration, addressing grand challenges and reforming the European innovation ecosystems as key reasons for joint action between universities.

First, EU tertiary education projects such as the EU-sponsored Erasmus programme have been guided by the idea of creating European integration by encouraging student exchange between member states (Flury et al., 2021; Brooks, 2021; Corbett, 2005). As demonstrated in the Erasmus student exchange programme, tertiary education is the primary level on which such integration takes place. The facilitation of mobility for higher education students has already been successful in bringing about a new generation of citizens with a European outlook. However, the continued challenge of European integration and collaboration between EU member states means that this goal remains the basic rationale for alliance formation.

Second, the narrative of grand societal challenges (such as climate change) has been central to EU research funding policy. Instead of science for science’s sake, there is now strong recognition that science must be employed to tackle societal problems (Nowotny et al., 2001; Gibbons et al., 1994). The narrative of grand challenges for society and engineers serves as the focus point for the recent changes in thinking about responsibility at engineering universities (Rip, 2018). In the case of universities of technology, the narrative of grand challenges has also contributed to the need to rethink education more broadly (Välikangas, 2022; Trencher et al., 2014), thus requiring joint agency with other universities facing the need to reform their curriculum. The need to reform engineering given the orientation towards grand challenges is often discussed as the need to define the “engineer of the future”. Such a notion challenges three aspects of traditional engineering education. It forces universities to identify a broader set of skills, beyond merely technical expertise. Engineers must be able to relate their technical expertise, implement it in a social reality, communicate and be able to reflect. Furthermore, it places increased emphasis on lifelong learning activities. Universities offer courses for alumni and other graduates and offer certificates that do not result in degrees. Finally, the core implication of the grand challenges

narrative is to require more interdisciplinary work (Cuevas-Garcia, 2021). This can also be observed in engineering education. Meijers and den Brok (2013, 28) wrote that “[m]uch innovation takes place at the interface between disciplines and students must learn to seek and embrace the creative tension arising from multidisciplinary contacts”.

Third, the realisation that the EU lags behind the US in terms of commercialisation of (university) research led to an increased focus on academic entrepreneurship and valorisation of research findings (Salajan, 2018). The need for greater collaboration between universities must also be understood in reference to this need for changes in the entrepreneurship culture in Europe. New products and services, and along with them new economic players, of the telecommunications revolutions came from the United States (Google, Facebook, Amazon) and increasingly from China (Alibaba, Tencent). Part of the response to this perceived need was the establishment of the “European Institute of Innovation and Technology” (EIT) in 2008 to ensure that the next big innovations also originate from Europe (“the next Google should come from Europe”). Another step was the promotion of the idea of an “entrepreneurial university” (Pinheiro & Stensaker, 2014). Joining up powers between universities in the form of alliance formation may be yet another way to address this gap.

To understand the role of university alliances, we must recognise that overarching cultural, societal and economic concerns require that we take a different perspective on what universities are meant to achieve (integration, addressing grand challenges, innovation ecosystem). For society and policymakers, science and education are not merely carried out for their own sake but should also address the broader concerns of the societies in which they are conducted (Trencher et al., 2014). Additionally, universities have the autonomy to determine their own educational curriculum (within national frameworks and within professional codes) and to define research and entrepreneurship priorities. This becomes clearer if compared to the scope of secondary schools to determine their educational curricula. Given that these curricula are set to a large extent by ministries of education and exam boards, there would be little sense for secondary schools to engage in a similar type of alliance formation as universities. For universities, however, this makes sense simply because of their greater autonomy. The next section will now turn to how university alliances may aid in addressing these needs.

University alliances as learning networks

What are the grounds for thinking that university alliances will help universities address these new demands on universities? The need to supply an answer to this question becomes pertinent when we consider that there are also powerful theoretical arguments supporting the decentralisation of research, teaching and entrepreneurship activities.

The first argument draws on a tradition in the philosophy of science that is skeptical of interferences in the organisation and coordination of science. Researchers’ (or at least individual universities’) knowledge, the argument maintains, places them in the best position to make decisions about research priorities and methods. The most famous picture of this view is given by Michael Polanyi (Polanyi, 1951), who compares the organisation of science to solving a puzzle. Central supervision seems inferior to letting researchers follow their inclinations and hunches. Similarly, it might be argued that forming alliances is an attempt to supervise a creative process that is best left unsupervised. Instead, one may argue, we

should welcome the diversity and research competition between different university traditions for experimenting with different approaches to advance science and technology for devising solutions to grand societal challenges.

Besides this epistemic argument about the decentralisation of research, there is a second well-known economic argument for competition in tertiary education, namely to allow students to make choices among a wide variety of higher education options. Thanks to the creation of a European Higher Education Area since the 1990s, students increasingly choose on the basis of university rankings, university characteristics and monetary prospects (tuition fees, expected salaries); as opposed to mere geographical vicinity. University alliances create common educational campuses and thus (to a certain extent) homogenise their approaches. Should we not instead welcome the existing diversity and wealth of options for education that has emerged for students in recent decades?

For entrepreneurship, too, there may be reasons to be skeptical that increased collaboration between universities will aid in the reform of the European innovation ecosystem. Competition between universities as centres of entrepreneurship may be encouraged for market-based reasons similar to those of students. A greater variety of approaches may allow for greater experimentation and better address the different needs across campuses, regions and nation states. Besides, the desire to file and guard patents with new university-generated technology may fuel secrecy between universities and may make collaborations difficult. Industry collaborations may be jealously guarded from other research teams and universities.

A final argument concerns less the basic rationale, but the concrete design of the EUI alliances. The EUI encourages alliances between universities located in different countries, ideally with a good spread, including universities from “old” and “new” EU member states. On the face of it, it is not obvious how aligning universities with different histories, languages and national higher education and research frameworks could be the best way to generate joint action between universities. Would not aligning universities within a country be a more straightforward way of increasing collaboration?

One reply to these worries concerns the structural set-up of the EUI. Gunn (2020) has shown in his narrative of the history of efforts towards creating a more integrated European higher education sector, there have been various attempts towards harmonisation. In the past, the main idea was to establish new European flagship institutions (such as the “European University Institute” in Florence, established in 1972) that would serve as a role model for other institutions in Europe. By contrast, the present effort towards alliance formation encourages the dispersed joining up of (*bottom-up*) efforts, with a resulting multitude of approaches. In other words, thanks to the multitude of networks, there is little danger that the diversity and experimentation among universities within Europe is diminished.

Thinking of universities as members of alliances, we may ask in which sense universities in such European alliances are complementary in a way that promises to mobilise their collaboration without undermining their diversity. In other words, what do some universities have that others lack and whose pooling may aid in addressing a societal need? Kitagawa (2010), for example, describes how Scottish universities pool together research resources to make their areas of excellence more visible. Besides, in the little scholarly attention that university alliances have, they have been analysed in terms of learning networks (Gunn & Mintrom, 2013).

Organisational learning is commonly defined as a change in the organization's knowledge that occurs as a function of experience (Argote, 2013; Fiol & Lyles, 1985). In higher education, the theory of organizational learning as the process of generating, maintaining, and transmitting knowledge has been applied to organizational processes such as achieving and sustaining change (Boyce, 2003) or to characteristics of the organization such as inequality in educational outcomes for historically disadvantaged groups (Bensimon, 2005). In the context of university alliances, we identify three levels on which learning networks may generate organisational learning, which we call *know-how*, *strategy* and *moral reflexivity*. In the following paragraphs, we draw heavily on our recent work on learning networks (Fuchs et al., 2022).

Know-how. Universities can acquire basic know-how on how to improve their activities, for instance education. This type of learning consists in the form of knowledge and practice. By sharing best practices and practical know-how academics can improve their own activities. For example, universities can learn from early adopters with experience with new educational formats. Universities and academics can share know-how by exchanging course syllabi, reading lists, project ideas and best practices for collaborating with external stakeholders. More generally, they may share experiences on orientating education towards societal considerations. In the next section we discuss the example of the EuroTeQ Collider programme which illustrates the sharing of basic know-how with the example of challenge-based learning programmes.

Strategy. Besides know-how, university managers and boards can discuss ideas and collaborate to pursue a common university strategy. This type of learning consists of relating to each other, understanding the strategic decisions that other universities make and potentially working towards collectivizing for joint action in these strategies. This type of learning may affect the university much more holistically. It is not just individual academics who share know-how, but university management may share ideas about how best to collaborate with other societal actors, such as political actors, NGOs or industry. For instance, the universities may exchange experiences in setting up, maintaining and cultivating a university "ecosystem", with other societal actors who are (spatially) close to universities and who closely interact with them for the delivery of their services to society. The formation of a university alliance may help formulate and implement strategies for linking ecosystems with each other. The resulting sharing of resources and knowledge may give a decisive advantage to these individual ecosystems (Gunn & Mintrom, 2013).

Moral Reflexivity. As we already argued before, universities are required to accommodate to a great number of demands for change. This means that universities must also actively reflect on what their societal role is and how their past practices may not have fulfilled this normative role. Deliberating such a sensitive topic and accordingly modifying education, research and innovation practices requires a platform where universities can mutually reflect on their practices. University alliances may also be a good way to "hold themselves accountable" to implement considerations of responsibility. By adopting a similar framework, comparing and benchmarking their activities, universities can make themselves accountable to the other members of the alliance. Such a platform to reflect on one's own activities and values necessarily requires a culture of open conversation and transparency to function well. Such a platform must go beyond merely showcasing success stories at universities. They must also allow in-depth discussions of failures and obstacles encountered in implementing considerations of responsibility.

Engaging in a discourse of “responsibility” is far from self-evident for organizations in general and universities in particular. Sharing know-how and strategy may be risky in a competitive European higher education market (Aghion et al., 2010; Sánchez-Chaparro et al., 2021). University alliance partners will always consider the return on investment and be careful when sharing core organizational aspects such as knowledge and strategy. This is even stronger for moral reflexivity. Moral reflexivity is already delicate for communication at the single university level (Entradas, 2022; Simancas Gonzalez & Garcia Lopez, 2019), as it forces universities to be open about values and strategy and flexible enough not to counteract their other goals. In the case of social and healthcare service networks, Visse and colleagues (2012) show that instrumentalist ways of thinking about responsibilities may be counterproductive. They argue that members of the organisation constantly must find out who they are in relation to others, what their core shared values are and what the resulting responsibilities are. Toivainen and Kira (2017) mention three types of struggles to realise moral reflexivity: differences in practices, challenges that follow from multivoicedness, and the experienced gap between the networking ideals and the reality of cooperation. At the same time, they refer to positive aspects of collaborations or alliances, going back to the first two core organizational aspects of knowledge and strategy. The alliance members can use “emotional resources (e.g., a stronger sense of meaningfulness at work), cognitive resources (e.g., understanding the customer needs from alternative perspectives), and social resources (e.g., being able to rely on other professionals’ competence)” (ibid., 479).

The basic idea of learning networks is that universities share insights with each other and create the conditions for collaboration without giving up on the diversity of approaches. Broadly speaking, know-how concerns straightforward practical knowledge that universities may share with each other. Strategy pertains to the mental frameworks that university boards and academics use when making decisions. Moral reflexivity is about changing the values and views on responsibility held by participants. Universities help themselves and others to accommodate the new challenges we identified above regarding education, research and entrepreneurship. By focusing on the idea of learning networks, we can see more clearly how the diversity of universities within alliances may be conducive to addressing European integration, grand societal challenges and reforms in the European innovation ecosystem.

This section argued that university alliances are best understood as learning networks to make sense of how they can address new societal demands on universities while preserving their decentralized efforts and diversity. The next section will turn to illustrate this concept by means of the EuroTeQ Collider.

Case study: the EuroTeQ collider

The effort of the EuroTeQ Engineering University to set up a co-creative learning format across the alliance provides an interesting example to illustrate the notion of a learning network and how university alliances may aid universities in adjusting to new demands. One of the main goals of the EuroTeQ Engineering University was to implement a semi-standardized format of challenge-based learning to bring together students across degree programs and universities, companies, the NGOs sector and academic staff to address grand

societal challenges.¹ While challenge-based learning can take many different shapes, the EuroTeQ alliance envisioned a “Green Challenge” in all partner universities; a competition originally developed at the Technical University of Denmark (DTU). This initiative was called “EuroTeQ Collider”.

The initiative consisted of the following steps: first, a committee formed by strategic partners and staff from all the universities decides on a general theme. A “call for ideas” resulted in three topic domains: cities, energy and consumption. Second, a call for specific challenges on the selected general topic is launched, in which external public and private organizations, academic units and student teams can submit challenges for students to develop possible solutions. Third, multidisciplinary groups of students are recruited across the challenges to work on their solution for a certain period of time (from one to eight weeks). Fourth, a challenge-based learning activity is implemented in each university, where student teams are selected for the next step. Fifth, the winning teams of each university are brought together to refine their pitch presentations and participate in a final competition (the “EuroTeQathon”). Sixth, the winners of this final competition travel to Brussels to present their ideas to the European Commission.

In the first edition of the EuroTeQ Collider in the spring semester of 2022, staff from L’X were in charge of inter-university coordination. The selected theme was “Leave no waste behind” and focused on the categories of “cities”, “energy”, and “consumption”. Although the initial plan was that all universities would share the same duration, due to calendar disparities and the assumed workload of staff and students the competitions were assigned different timeframes in each partner university. Three universities gave 8 weeks to the teams to work on their solution, one university gave 3 weeks, and two universities gave only one week. The local pitching events were all held in May, and the EuroTeQathon took place 10–12 June.

Our observations of this project draw on a wider study of the trajectory of the EuroTeQ alliance conducted in the Horizon 2020-funded project *BoostEuroTeQ: strengthening institutional transformations for responsible engineering education in Europe*. The project brings together researchers from the social sciences and humanities from the six EuroTeQ universities to explore how these universities redefine the profile of the engineering university and the European engineer of the future. The research accompanies the alliance formation process and provides recommendations on how to better integrate responsible research and innovation across the network.

In the case of the EuroTeQ Collider, we conducted ethnographic observations and semi-structured interviews with organisers and participants in the six EuroTeQ universities, the final cross-university event (the EuroTeQathon) and mentoring sessions. In each university, we interviewed at least one course organiser, one teaching staff, and two students. Furthermore, we established several informal conversations with participating students, jury members, and challenge givers. The research design consists of a comparative case study approach informed by multi-sited ethnography and constructionist grounded theory (Charmaz, 2006; Marcus, 1995).

¹ Challenge-based learning is a learning format that has received much academic attention recently (Bombaerts et al., 2021; Martin & Bombaerts, 2022; Fuchs & Bombaerts, 2022). In the attempt to answer the global challenges of the 21st century, technical universities incorporate complex, sociotechnical innovation challenges in their courses.

Our interviews and observations showed that launching this format in the different partner universities posed great challenges to some. One of the EuroTeQ partner universities struggled to get students to sign up for the course because the format was new and unfamiliar in that institutional context. Those students who had signed up dropped out because they did not receive credits for their overall degree programmes at that university. One of the other universities — one of the more experienced in implementing challenge-based learning — also struggled to run a local competition and, instead, only one team from another course was sent to participate in the EuroTeQathon. By contrast, in other universities, especially those with significant experience organizing such learning formats, the implementation was smooth and registration numbers were higher. In two universities, students could choose between 15 challenges, and the resulting teams consisted of four to six members.

Another striking result of our comparative work is the difference in experience in working with external stakeholders in co-creative teaching. Some universities had relatively little experience including external stakeholders and challenges, with students being relatively unacquainted with teamwork and challenge-based learning approaches. A primary motivation for implementing a teaching format across universities was that the strengths of some of the universities in this field may be translated into learning opportunities for others as part of the EuroTeQ project. The Collider therefore represents an interesting case to illustrate different ways how collaboration may help overcome some of these problems and results in the creation of learning networks, including the exchange of *know-how*, the formulation of *strategy* and engagement in *moral reflexivity*.

Considering know-how, the most important factor was that the Collider enabled the sharing of knowledge on challenge-based learning across partner universities. The six organisers of local Collider courses held regular (roughly every six weeks) online meetings throughout the planning and implementation phase. In these meetings, they discussed the thematic orientation of the project, the learning format, the local obstacles towards implementation, as well as the organisation of local events and the EuroTeQathon. In the interviews with these local organisers, they reported that these coordination meetings were highly constructive and useful for sharing experiences with this learning format. Especially those organisers working at universities with little experience in co-creative teaching and stakeholder collaboration reported that these meetings gave them crucial insights into how to set up and implement such a course. Those universities with more experience, too, could reflect and improve their existing practices. The rapid transmission of co-creative educational formats and discussions about societal responsibility from some universities to others is the most important opportunity resulting from the EuroTeQ Collider.

In terms of strategy, we observed that the universities benefited from discussing how to approach stakeholders in their local ecosystems and what to expect from those interactions. Technical universities are often entangled with an “ecosystem” of companies and other societal stakeholders (Jongbloed et al., 2008; Geschwind & Broström, 2022; Youtie & Shapira, 2008). This raises the question how such universities can collaborate with their respective ecosystem and what type of leadership may be expected from them. The opportunity in terms of defining a strategy is to collaborate with societal stakeholders and student initiatives and in this way increase the ecosystem interaction of universities. Universities co-develop strategies between themselves and actors in their local ecosystems to reinvent their roles and their responsibilities towards students and towards the local economy and community. Since many uncertainties exist, it is beneficial to discuss steps together with local

ecosystem partners. Some EuroTeQ universities have established multiple formats to interact and collaborate with local industrial designers and manufacturers. For example, TUM has close contacts with Siemens, Infineon and SAP; TU/e has strong ties with Philips. These universities can decide how to exploit these contacts better for mutual university-industry benefit, but they can also learn together how not to be limited by those relationships but learn to engage with other stakeholders. A primary motivation for implementing the Collider was to strengthen bonds with local organizations while at the same time establishing new ones. For instance, the winners of the EuroTeQathon were teams who closely aligned with local companies: TUM-Siemens, TU/e-Philips, TalTech-R8 Technologies. Some universities seem to be focused on collaborations with industry, with few connections to other parts of society. Knowledge on how to include other challenge holders in the education may be shared by those universities with collaborations with municipalities and civil society.

In terms of defining a strategy for stakeholder engagement, the most substantial exchange during the Collider project took place when the student teams of one university visited another. This happened in two different ways. First, at the end of the course period, there were local events three universities of the alliance visited another one (for example, the students, teachers and organisers of L'X visited TU/e). Challenge stakeholders were present in all three of these resulting events. Several students reported that meeting with the student teams from another university, along with challenge holders, teaching staff and organisers made them fully appreciate the collaborative nature of the educational format.

The event with the most visibility on campus was the final “EuroTeQaThon” in which the best student teams from each university competed with each other in front of a jury. One question that has come up and that has been discussed among those involved in the Collider is to which extent are students autonomous in defining their problem and how closely they must stick to the instructions by the challenge owner, even if the students disagree with the challenge-owner’s framing. Another question concerning the question to which extent the work of student teams is mutually beneficial is the question whether students own the intellectual property derived from their projects. This raised questions about the relationship between the university and its ecosystem.

The diversity of approaches between universities as exemplified by contrasting visions in the local visits and the EuroTeQaThon point to an important danger for the formation of university alliances. Sometimes formats, such as co-creative teaching, are transferred from one university to another without attention to their unique institutional context. Existing formats may be only successful due to the existence of a tradition, experience and a network and it may be impossible to simply ‘transplant’ a successful format to another university. In addition, while some universities may have organizational units dedicated to establishing contacts with stakeholders from their local ecosystems to secure real external challenges, others lack such a unit, with the workload falling onto teaching assistants. Universities have different resources to create interdisciplinary student teams if they only offer engineering programmes. Consequently, some teams develop only a shallow understanding of the social and political aspects of their solutions.

But the question who the universities should aim to interact more closely with (e.g. what type of organizations, companies, NGOs, etc.) raises questions about their moral reflexivity. How can universities find the right balance between establishing contacts with prestigious and technically-fluent organizations on the one hand, and more modest, younger, and vulnerable organizations on the other hand? It is likely that privileged companies know how

to respond best to the invitation of the university, they will be better prepared to submit challenges that will be more appealing to students. By contrast, small organizations or those working on less visible, yet necessary services will struggle more to convince students to work on their challenge. Together, the EuroTeQ universities can discuss these inequalities and how to address them.

Our observations are that exchange in terms of moral reflexivity took place mostly during the writing period of the EuroTeQ proposal (of which the Collider was a major part), as well as the planning conversations where the theme “Leave no waste behind” was selected. Selecting such a theme shows that the universities could agree on a common language to understand societal challenges and to orient university education towards addressing them. One danger for technical universities is the idea that addressing grand societal challenges depends merely on novel high-tech solutions, rather than, for example, major social participation, fairer distribution of wealth, concern for the most vulnerable, low-tech solutions, as well as repair and reuse of existing technologies.

Conclusion

The success or failure of the EUI will likely vary between the respective alliances and will depend on the individual context. It is too early to speculate about the likely outcomes of this initiative three years after its launch. The limited empirical basis is insufficient for speculation about a process that will take at least half a decade, with consequences that may only be measurable and understandable later on. Nevertheless, we approached the topic with some optimism and analysed the role that this initiative may play.

We aimed to make three contributions: First, we analysed the changing societal demands on universities (of technology) and traced the distinctly European rationales for placing high importance on joint action among universities, namely the need for further cultural integration in the European Union, the targeting of grand societal challenges, as well as the need to foster entrepreneurship. Second, alliances are likely to contribute to a process of joining up agency between universities because they allow them to share knowledge and align on strategy and values (learning networks). Heterogenous universities with different historical, social and political contexts may learn more from each other than universities from the same country. Third, we illustrated some of these ideas about learning networks by means of our case study from the EuroTeQ university alliance.

There are several limitations to our argument. Most importantly, the conceptualization of university alliances as learning networks and our description of the EuroTeQ Collider as leading to joint strategizing and moral reflection is in some sense idealistic. Given that participating in the EUI is accompanied by substantial financial resources (as well as career opportunities for individuals), there will likely be agents who adopt the language associated with this programme and participate in it mostly due to that motive. A different framework to understand university alliances (one that we cannot explore here) would trace whether the incentives created by programmes like the EUI are productive in the sense that they incentivize behaviour intended by policy programmes.

Universities are unique organisations within society; their role is to be at the frontier of new thinking and societal development. Supporting partnerships among them, moving

closer to joint action, will hopefully strengthen their confidence in addressing societal needs and take leadership in moving their ecosystems and other societal actors with them.

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Declarations

Competing Interests On behalf of all authors, the corresponding author states that there is no conflict of interest.

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5. SUBMITTED AND UNDER REVIEW: RE-SHAPING THE XXXX UNIVERSITY TOWARDS SUSTAINABLE ENGINEERING EDUCATION

This is the 800 word abstract submitted by Carlos Cuevas-Garcia to a call for papers for a special issue in an engineering education journal – *strongly altered and anonymized to avoid conflicts with the peer review process*. This abstract was submitted in January 2023 and invited to be developed into a full 10,000 word manuscript. The full manuscript was submitted in January 2024.

Abstract

In the last two decades, the XXXX University has adopted a number of reforming concepts to guide its ongoing transformation. Currently, XXXX University brands itself as sustainable, responsible, and a place for “XXXX engineering”. Significant actions include the creation of the XXXXX Center, a Sustainability XXXX, and the launch of a Sustainability Strategy. For responsibility, the establishment of the Center for XXXX and its upscaled re-launch as the Department of XXXXXXXXXXXXXXXXXXXX are key milestones. Although these reforming concepts are highly compatible – some more than others –, they are neither automatically nor carefully connected in the university’s institutional statements and strategic actions. Rather, more discrete and specific initiatives designed at the bottom or middle require ad-hoc, local efforts to articulate them coherently. Yet, these initiatives have different chances to thrive, transcend and become durable, or disappear.

The proposed manuscript integrates literature on transformations for sustainability in engineering education (Kolmos, Hadgraft, and Holgaard 2016; Mathebula 2018; Wals 2009) and approaches informed by structuration and institutional theory (XXXXXX, XXXX; Stones 2005) to examine efforts at one university to offer courses focused on socio-technical understandings of contemporary problems, sustainability in particular, and their trajectories. It puts forward two concepts to enrich current understandings of transformations for sustainability in engineering education. The first is “XXXXXXX”, to underscore that university transformations might be driven by multiple rather than single reforming concepts (as above). The second is “XXXXXX” (originally developed by XXXXX), to highlight that courses or other initiatives that bring together content on sustainability and critical social sciences and humanities (Lotz-Sisitka et al. 2015) have mismatching possibilities to create durable and stable structures.

The materials and methods used in the manuscript include, for mapping out the top-down process of systemic transformation, research interviews, document analysis, and ethnographic observation of institutional events conducted for the XXXXX funded project “XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX”. For the courses examined, reflexive notes and accounts collected during three experimental, bottom-up, interdisciplinary, and sustainability-oriented courses in which the author was involved. First, a “traditional” course on XXXXXXXXXXXXXXXXX co-organized by two postdoctoral researchers. Second, the project-based course “XXXXXXXXXXXXXXXXXXXXXX”. Third, the first Challenge-Based Learning course (Kohn Rådberg et al. 2020) offered at the university, which contributed to establish a community of practice between a number of universities, and relations with stakeholders across Europe. It was supported by a XXXXX-funded project.

The courses implemented different pedagogical approaches to make students think critically about sustainability and society. The XXXXXXXXXX course consisted of a reading-intensive and discussion-driven seminar; in XXXXXXXX student teams travelled to different European cities to explore sustainable projects and examine what could be implemented in XXXXX; and XXXXX was a hybrid theory-practice course in which student teams examined and hypothetically re-designed co-creative projects/case studies on XXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX. The students were able to collaborate with the real stakeholders to different degrees.

The cross-examination of these courses makes it possible to identify the conditions that enabled some courses to thrive and continue, or to be paused. Since the organizers of the XXXX course were put in charge of (co)convening other courses, for instance XXXXX, this illustrates existing competition between courses on sustainability within the same university.

Drawing on the concepts of XXXXX and XXXXX, the study makes the following contributions to the literature. First, transformations for sustainability designed at the top of the university do not get to the bottom automatically but depend on situated negotiation for integration, planning, additional funding, and strong individual motivation. This differs from Kolmos et al.'s observation that systemic change for sustainability may start as add-on, then as integration and then re-building. Rather, re-building or transformative strategies *then* require multiple attempts of integration and add-on courses. Second, since not all courses integrate sustainability to social considerations with input from social and human sciences, as Mathebula (2018) and Lotz-Sisitka et al. (2015) describe, sustainable transformations in engineering education can differ substantially.

In order to argue how engineering education could contribute to making “more profound sustainability transformations” (Rosén et al. 2022), the discussion will focus on how these experiences could enrich the initiatives of the XXXX alliance, supported by the European Universities Initiative, and other EU supported alliances more broadly.

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6. IN PROGRESS: COMPARING SUSTAINABILITY INITIATIVES IN FOUR EUROPEAN TECHNICAL UNIVERSITIES

This working paper draws on the data produced for the SWOT analysis conducted as Deliverable 4.1 and further data collected after its submission in December 2022. The full paper will be made public on the project website and/or integrated into the present deliverable once it is published (estimated time last third of 2024).

Besides building on updated and more detailed information, the paper in progress implements a different methodology. While the SWOT analysis merges information within four distinct categories, the comparative analysis searches for important differences across the universities examined.

To inform the reader about analytical findings already shared, we reproduce below insights included in the SWOT analysis Deliverable (4.1). For further reference, Deliverable 4.1 also includes SWOT analyses of the incorporation of social sciences and humanities at the EuroTeQ universities, initiatives to foster multi- and interdisciplinary research, particularly across SSH and STEM disciplines; and finally engagements between the EuroTeQ universities and society.

ADDRESSING SUSTAINABLE TRANSITIONS AT EUROTEQ UNIVERSITIES			
Internal / Current	Strengths	Weaknesses	
	All EuroTeQ partners have recently launched strategies. Specialist research centers on sustainability topics. World leaders in diverse renewable technologies.	Strategies are in early stages, under-staffed and under-funded. Many strategies and statements, little implementation. Mostly tech-driven solutions.	
External / Potential	Opportunities	Threats	
	Students are very committed to sustainability. They lead many initiatives. Collaborations in other national university networks. Universities can learn from each other	University actions could be constrained by strategic partners from unsustainable sectors. Technology-driven solutions overshadow other possible responses. Overemphasis on marketable “green” solutions.	

Strengths

The most relevant strength is that most universities have launched ambitious sustainability strategies almost simultaneously within the last two years. TUM celebrated in October its first ever Sustainability Day, where the sustainability strategy was presented, but also there were activities, discussion panels, presentations and research showcases in all faculties and campuses. Similarly, DTU has held a Green Week and a Green Challenge since 2010.

Some university strategies count with diversified lines of action to implement these strategies. These include for example, particular objectives on research, governance, education, and operations (TUe), and innovation and entrepreneurship, and communications added on top (TUM). At TUe the line in governance is fundamental for the implementation of sustainability in a more reflexive way by connecting it to questions regarding what forms of partnerships with industry should and shouldn't be developed. It also encompasses the ethical issues that sustainable implementations may involve. Others (CTU) are divided in spatial efficiency and flexibility, social responsibility, synergy and cooperation, environmentally friendliness and sustainability, future-oriented planning, and image of an attractive and innovative institution. Moreover, TUe addresses the dimension on sustainable research through the notion of "transformative research", currently promoted in Dutch universities. This means research that is oriented to re-imagine research systems in order to transform them. Transformative research involves multi, inter and transdisciplinarity, collaboration with stakeholders, action research and valorization.

Yet, besides the similar and almost simultaneous temporalities in which the EuroTeQ universities have launched their sustainability strategies, there are substantial differences in how these were developed and how they are internally perceived. In some universities, the strategy is meant to be the result of a well-coordinated participatory effort, while in others there seem to be big contrasts between bottom-up initiatives and unofficial meetings, and top-down strategies. In some universities, the top-down strategies often lack the institutional know-how to persuade different research groups to get involved. As a result, some universities have many actions which are disconnected from each other and that have only recently gone through centralized coordination efforts. The diversity of experiences and modes of creating strategies is a strength because it offers a broad range of possibilities that can be adopted and from which all universities can learn.

In most of the EuroTeQ universities there are specialist research centers and even whole campuses focused specifically on sustainability. To name only a few, CTU has the University Center for Energy Efficient Buildings, the Centre of Vehicles for Sustainable Mobility, and the Centre for Advanced Photovoltaics. TUM has the Campus Straubing for Biotechnology and Sustainability, the Center of Energy Efficient and Sustainable Design and Building, and the MCube project and cluster, which aims at co-creating and testing sustainable mobility concepts for the Munich metropolitan region, and will be active for the next 8 years. TUe, in turn, has Brainport Smart District, which combines cutting-edge smart technologies and participatory design aimed at experimenting with smart city concepts in the real living environments. Finally, it is worthwhile to include the Novo Nordisk Center for Biosustainability and some still ongoing projects of the initiative EnergyLab Nordhavn in DTU.

As a strength, some of the EuroTeQ universities are world leaders in particular renewable technologies, for example DTU in wind energy. Other universities are very strong in other renewable energy technologies and mobility.

Although not connected in all cases to strategies at the university level, student-led initiatives and organizations are a strength that most EuroTeQ universities count with, and which represent opportunities worthwhile considering.

Weaknesses

One of the most concerning weaknesses is that there are many strategies and statements for sustainability, but these by far outnumber actual implementations. Moreover, all strategies are still

young, little known, and lacking resources. For instance, most universities have little budgets and a small number of people actively working full time on developing and implementing the sustainability strategies.

Although strategies exist, these were created not necessarily out of genuine interest but intending to increase the universities' positions in national and international rankings.

Some of the EuroTeQ universities have made efforts to identify, catalogue and sometimes quantify the amount of courses that explicitly involve content on sustainability. At TUe, there is a database collected by the Go Green Office that links extant courses to specific Sustainable Development Goals. These databases reveal that currently it is still a small percentage of courses which relate to sustainability. But the shortage is relatively common across universities, even in technology universities in countries as progressive as the Netherlands. At least in TUe, the hope is that Challenge Based Learning could contribute to address this shortage.

Since technical universities are often conceived as places that train engineers to develop novel technologies, one of the weaknesses is that solutions to sustainability problems seem to be technology oriented, and other approaches such as de-growth, responsible stagnation (de Saille & Medvecky, 2016), and related governmental and social solutions seem to play secondary role at the most.

Opportunities

Even though university-wide strategies are in the early stages, one opportunity is that some of the EuroTeQ universities participate in local and national initiatives. For example, CTU is part of a network of 20 Czech universities seeking best ways to adopt and contribute to the Sustainable Development Goals. Participating in these networks offers opportunities to understand better the national context of sustainable transitions and a chance to act in a context-sensitive way. These opportunities represent ways in which the EuroTeQ universities can receive support and advice, but also the possibility for EuroTeQ universities to become a leading force to inspire and provide direction to other higher education organizations.

One of the most valuable opportunities is to take advantage of the new generations of sustainability-enthusiastic and proactive students. The students of EuroTeQ universitis are a very committed group of stakeholders who are very interested in sustainable transitions. At TUe, DTU, and TUM there are many student-led initiatives on sustainability. There are different forms of student initiatives that deserve attention. There are those that exist internationally and across universities, for example Enactus, 180 Degrees and the Eco-teams of Formula Student, and those that originally started at the EuroTeQ universities. One example is the TUM-based Plant a Seed, which intends to transform campus spaces into urban gardening pits, encouraging students to get involved, learn and share knowledge and experience.

A key opportunity is for all EuroTeQ universities to discuss their current efforts and limitations, and explore together what is the role that these universities should play in sustainable transitions. These should include highlighting distinct cases that are technologically and research-wise strong, but also strong with regards to their engagement to teaching and their involvement of diverse sectors of society. Examples are wind energy in Denmark, mobility justice in Germany, automated infrastructure inspection in CTU, and smart cities in Tallinn and Eindhoven.

Threats

Among the threats, the EuroTeQ universities do not make explicit mention of the active roles that other sectors of society can play in their sustainability strategies. This is a concerning threat because it reproduces the assumed boundaries between university and society and between experts and lay people. If the universities want to be role models in the promotion of sustainable change, they should be more explicit about what these role models are, whom they involve, who they benefit, and who loses.

Another threat is that the universities have different understandings about what sustainability strategies are for and at what level they should operate. Some universities have a holistic view and actions, but others understand sustainability mostly as something that campuses should physically do, for example aiming to create “climate neutral campus”, rather than a shift in perspective on research and teaching. While the contrasting ways of understanding and implementing sustainability strategies could offer opportunities for mutual learning, it also can create misunderstandings, lack of cross-university engagement, and loss of interest.

Although it is an advantage to have overlapping partners in the EuroTeQ and the EuroTech alliances, having lines of action on sustainability that exclude the EuroTeQ partners that are not EuroTech partners is a threat, since it can jeopardize the sense of collaboration and cooperation that the alliances intend to represent.

In some of the universities, the research groups demarcate clearly between the technologies that they aim to use to contribute to sustainable development and those that get the most attention and which guide where the funding is going. The tension between autonomy and originality of single universities on the one hand, and collective missions should be handled carefully so that it does not become a threat.

The most serious threat is that most of the EuroTeQ universities and their actions on sustainability are often hindered by their strategic partners: strong industrial actors that represent the incumbency of widely established sociotechnical systems. Technical universities face the major challenge of learning to deal with the fact that they have helped to establish and maintain systems that are now seen as a threat to environmental and human welfare. It is important that the universities learn to engage reflexively with the non-innocent roles they have historically performed.

Finally, one external threat is represented by current economic crises and the war in Ukraine. These might undermine the importance and urgency of sustainable transitions.

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