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A Crazy Little Thing Called Sustainability

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ABSTRACT

Achieving the 17 Sustainable Development Goals (SDGs) set by the United Nations (UN) in 2015 requires global collaboration between different stakeholders. Industry, and in particular engineers who shape industrial developments, have a special role to play as they are confronted with the responsibility to holistically reflect sustainability in industrial processes. This means that, in addition to the technical specifications, engineers must also question the effects of their own actions on an ecological, economic and social level in order to ensure sustainable action and contribute to the achievement of the SDGs. However, this requires competencies that enable engineers to apply all three pillars of sustainability to their own field of activity and to understand the global impact of industrial processes. In this context, it is relevant to understand how industry already reflects sustainability and to identify competences needed for sustainable development.

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This article therefore first presents an explorative qualitative study that provides information on the extent to which sustainability is addressed by engineers in central management positions in German industry (focus on manufacturing sector). Results show a need for teaching concepts in which future engineers increasingly deal with sustainability concepts and the global impact of their own actions. The survey indicates that the social pillar of sustainability, in particular, is often left out of the equation and, consequently, is rarely considered in industrial sustainability efforts. Based on these findings, an interactive teaching concept is presented that uses the design thinking approach to sensitize future engineers to all three pillars of sustainability.

1 INTRODUCTION

Climate change and its far-reaching consequences on the global population require a stronger focus on sustainability when it comes to educating future generations. The need for intergenerational reflection on one's own actions is demonstrated not least by the United Nations Brundtland Commission, which defined one of the most cited definitions of sustainability: “[…] meeting the needs of the present without compromising the ability of future generations to meet their own needs.” (United Nations, 1987, p.15, [1]). This definition results in a (social) responsibility of today's generation, which extends to the private spheres of life as well as to the professional scope. In order to reflect on sustainability in a holistic way, the three pillars of sustainability - economy, ecology, society - represent a guiding concept helping to understand the complexity of sustainability questions (e.g., [2], [3]). Despite the different scientific discourses on the order of the three pillars [4], a strong or weak understanding of sustainability [5] or a required focus on the ecological pillar [6], scientists and practitioners agree that a reflection of all three pillars is necessary to act in a holistic manner.

As sustainable action is significantly influenced by the technologies available and used, especially engineers and the technology industries in which they operate are decisive factors having an impact on how sustainable the global society can be [7]. For example, with their strategic direction if development processes focus also on energy-saving technologies and if designed products are inclusive and thus can be used and afforded by a broad target group, technology industries have an impact on sustainable actions. This is also supported by the association of German engineers (VDI), as the largest technical and scientific association in Germany, stating that natural science and technology are essential factors in shaping the present and the future, which results in a special responsibility of engineers [8]. In addition, engineering-based management in particular has an influence on entrepreneurial orientation and the consideration of sustainability in product development [9].

To enable future generations of engineers to reflect sustainability in an holistic way and to make sustainability a part of management, teaching approaches are needed that ensure a detailed examination of the concept of sustainability and the transfer of the three pillars of sustainability to one's own field of action. In order to be able to develop teaching concepts that are linked to entrepreneurial reality, it is first necessary to gain an insight into the extent to which sustainability is already reflected and practiced in the management of engineering industries. This makes it possible to identify needs that must be addressed in engineering education in order to create a holistic understanding of sustainability.

Therefore, in a first step a study is presented that examines the perception of sustainability in the context of engineering enterprises. The study was conducted under the heading of digital transformation and the investigation of corporate strategies, change approaches and organizational processes. The underlying theory was that a targeted survey of the respective understanding of sustainability tends to reveal socially desirable perspectives. It was therefore decided to analyze

sustainability in the context of digital transformation, since digitization projects are already understood and broadly discussed in the context of sustainability [10, 11]. This allows conclusions to be drawn about the extent to which sustainability is already reflected in the management of the respective industry and what contribution teaching concepts must make in order to tie in with this actual state.

2 METHODOLOGY

In this chapter, the target group of the study is outlined and the procedure within the framework of the study is explained.

2.1 Sample & Data Collection

To ensure an inclusion of different engineering fields, study participants were recruited from the Industrial Advisory Board (IAB) of the Cluster of Excellence Internet of Production (IoP) at RWTH Aachen University [12]. The members of the Industrial Advisory Board are distinguished by their many years of experience in the German industry and their focus on engineering or information technology topics. In addition, the members come from a wide variety of sectors (e.g. textile industry, automotive industry, energy industry) and thus represent a broad engineering experience. The participants can be assigned to middle to upper management, so that it is possible to classify the sustainability activities for the respective area.

38 participants of the Industrial Advisory Board were contacted in total. 15 additional contacts were made via the Institut für Textiltechnik (ITA) of RWTH Aachen University, to ensure the inclusion of managers of textile industry. The special characteristic of the textile industry lies in the many years of dealing with sustainability, especially in the textile production context [e.g. 13]. This results in a total of 53 people invited to the qualitative survey. 31 interviews were conducted, which results in a response rate of 58.5 %. Regarding gender distribution, 30 participants identified themselves as male, and one as female. Participants were members of the upper management level, which ensures an overview over company strategies, strategical directions and thematic priorities in the respective organization.

Regarding the interview language, 28 interviews were conducted in German and three in English. 30 interviews took place via an online conference tool, one interview was conducted in presence at the organizations headquarter. All interviews were recorded and transcribed using the computer-assisted qualitative data and text analysis software MAXQDA. The average duration of the interviews was 50 minutes.

2.2 Data Analysis

In order to investigate to what extent sustainability is addressed and reflected by the interview partners from German industry, a qualitative approach was chosen to enable a deeper analysis of perceptions and application approaches. Against the background of the approach and the intention of not specifically asking for concrete sustainability approaches in order to avoid biases, an analysis instrument is needed which, through structured process steps, allows an in-depth analysis of the described sustainability perception in one's own field of activity. The analysis method chosen was the qualitative content analysis according to Mayring (2015) [14]. The content analysis is

a structured analysis method and offers at the same time freedom '[…] to adapt the concrete object, the material and constructed to address the specific question.' (Mayring 2015, p.51, [14]). By analyzing content in a structured way, it is also possible to summarize qualitative data statistically.

3 RESULTS

Building on the study described in chapter two, the study results are summarized and discussed below.

3.1 Findings and Discussion

Five out of the 31 interviewees (16.1 %) addressed sustainability without being specifically asked about it. In doing so, all five interview partners reflected sustainability in the context of the company's field of activity and thus associated with the individual professional focus. Consequently, the field of activity of material production (Interview No. 12), classical mechanical engineering (No. 14, 24, 25), and the energy industry (No. 22) are represented. Sustainability was associated with the topics production processes (No. 12, 24), the Co2 footprint and the energy transition (No. 12, 14, 22, 25) as well as the general need for energy efficiency (No. 12, 24, 25, 22), which were explicitly mentioned. The topics mentioned indicate that the focus of consideration is on the ecological pillar and also on the economic pillar. Only two of the interview partners addressed the social dimension of sustainability and reflected people as consumers who are interested in sustainable products, as employees in the context of individual reflection on the necessity of business trips (No. 12) and as future generations employees and their role in climate change (e.g., *'[…] a person who goes on the road with Fridays for Future and tells me 'How can you work for this store*?*'* – No. 22, * In this context, *store* means a disrespectful designation of the respective organization).

Transferring the results to United Nations (UN) sustainable development goals (SDGs), this picture is confirmed. Most of the topics addressed are in the context of goal 7 – Affordable and Clean Energy and goal 9 – Industry, Innovation and Infrastructure. A deeper analysis of the associations with sustainability shows that sustainability seems be viewed rather superficially (e.g., '*But productivity will be needed, for example, to meet future sustainability requirements, which are becoming increasingly important*' – No. 24).

In summary, the results indicate that in the context of engineering business, the ecological and economic pillars of sustainability are mainly addressed. It is striking that the ecological issues are topics that are more strongly addressed in the political discourse and thus lead to new framework conditions and economic effects for the companies. In the absence of corresponding public discourse on the social perspective, it is therefore not surprising that the social pillar appears as a marginal topic. However, this is accompanied by the assumption that there is still no awareness of the triad of sustainability pillars and thus no awareness of the need for interrelations between ecology, economy and social issues.

3.2 Limitations

In view of the framework conditions of the survey and the methodology, there are limitations against which the results must be reflected. The survey was conducted during peak phase of COVID-19 pandemie. The resulting industrial situation had a significant influence on the interviewees. At this point in time, geopolitical developments that occurred in 2022 did not yet have an influence on the response behavior in the context of sustainability. In addition, the investigation of sustainability perspectives was a side analysis basing on the investigation of digital transformation. This means that interviewees weren't ask directly for reflecting sustainability, for preventing socially desired response behaviour. Esser (1991) argues that within the framework of rational choice theory, respondent behavior can be regarded as a special case of a general theory of situation-oriented action [15]. It is argued that respondents' answering behavior is not determined in advance by fixed orientations and attitudes, but emerges within the situation of the interview in mutual influence with the interviewer by comparing different, alternative possible answering options [16]. Consequently, the chosen approach can be defined as explorative.

Despite the limitations resulting from the framework conditions there are also constrains resulting from the qualitative method. Due to the high (time) effort of qualitative studies and especially expert interviews, the number of the conducted interviews cannot be defined as representative in a statistical sense. This results in a limited overview over the reflection of sustainability in engineering branches.

However, the presented results should be seen as a starting point for further investigating the prevailing perspective on sustainability in engineering branches and, furthermore, identifiying areas of activities for the respective companies in the sustainability context.

4 TRANSFER INTO HIGHER EDUCATION

Study results indicate a need to integrate the topic of sustainability into engineering study programms and to tie sustainability to the practical context. This means that teaching concepts must ensure that all three pillars of sustainability are addressed, critically discussed and applied to the engineering field. In the following, a teaching concept is presented that provides an interdisciplinary and transdisciplinary conceptual framework and is based on the three pillars of sustainability. The so-called sustainability challenge was developed to provide an interdisciplinary and transdisciplinary perspective on all three pillars of sustainability in engineering. In order to achieve this, importance is initially attached to heterogeneous teams (with regard to cultural background, specialist background and gender) to achive the integration of different perspectives and to create an interdisciplinary working environment, as is also prevalent in industry. In doing so, the course concept is based on the key processes, learning environments and competencies identified by the UNESCO expert review of processes and learning for Education for Sustainable Development (ESD) [17].

4.1 Course concept

The course consists of both on-campus and online elements. The course begins with an online kick-off event during which the students get to know each other, receive a theoretical introduction to sustainability concepts [e.g., 4, 5, 6] and learn about the topic of the sustainability challenge (see fig. 1). The sustainability challenge is characterized by being thematically broad in order to enable a transfer to different contexts and to different people and cultures. For example, an engineering perspective on floods can be reflected against the background of all three pillars. After the online kick-off, three block courses follow, focusing on the triad of the three pillars of sustainability. The resulting block format allows a low level of collision with term-accompanying events which aims to make it possible for students not only from different faculties but also from different universities to participate in the challenge.

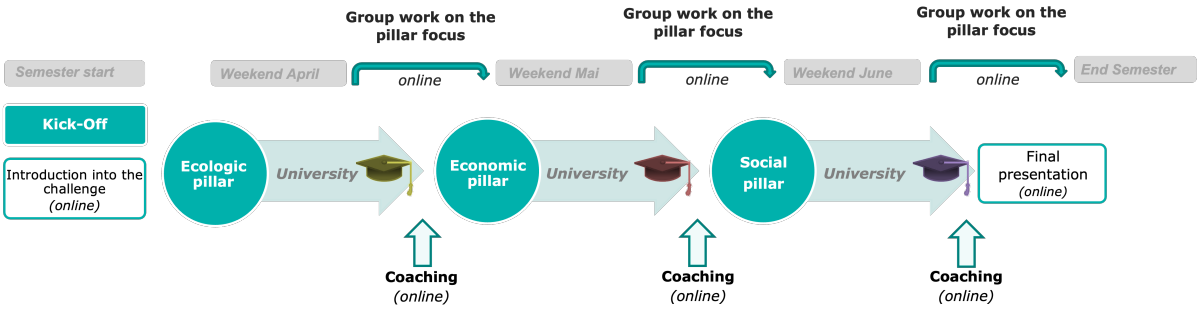

Fig. 1. Course Concept – Sustainability Challenge

The diverse student teams are accompanied in their work on the respective pillar with the help of methods that provide a transdisciplinary perspective on scientific topics. For example, design thinking can be used as a methodological approach when addressing the social pillar of sustainability. Design thinking is a five-step process that focuses on identifying the needs of potential users. In order to be able to develop solutions and products that meet these needs, the first step is to take a comprehensive look at the user's perspectives. The social pillar of sustainability also requires an in-depth analysis of user perspectives in order to develop solutions that are, for example, socially equitable, reflect diverse needs, are generally accessible, have a high acceptance and address the realities of life of the identified target group. In doing so, an inter- and transdisciplinary approach is ensured as both disciplinary and institutional boundaries are crossed with the help of population surveys, and the disciplinary mix of groups which strives to integrate different disciplinary ways of thinking. [for more information see 18]

Between the blocks, the students work out the solution to the challenge against the background of the respective pillar focus. The focus on single pillars is deliberately chosen, as the students are supposed to deal in depth with the framework of the respective pillar. It is well known that a separation of the pillars is not possible in reality and that there is an interdependency between the three pillars of

sustainability. Students are therefore encouraged to consider this aspect in their final presentation. To support them in this step, online coaching sessions are held between the block courses to clarify prevailing questions and to support the students in their teamwork. Especially in the case of heterogeneous teams, there is a need for active guidance and support through coordinating measures. Due to the diverse perspectives, there is a higher potential for conflicts, more discussions take place and negotiation processes take more time [19].

After the students have dealt with the three pillars, the final presentation of the results follows. The results represent a summary of the knowledge gained and solution approaches developed in the three course blocks.

It must be taken into account that corresponding format is accompanied by a limitation of the number of participants. Consequently, the presented concept is designed for a maximum group size of 30 people. However, it is possible to scale the challenge concept with more collaborative partners so that a larger number of students can participate.

5 SUMMARY AND ACKNOWLEDGMENTS

In conclusion, a concept is presented ensuring the reflection of all three pillars of sustainability. The concept was motivated by a qualitative study conducted in industry, which indicates the need to teach future engineers all three pillars of sustainability using practice-oriented cases. The study has shown that it is necessary to relate sustainability to engineering topics in order to enable engineering students to transfer sustainability concepts into their future field of activity.

The concept can be transferred to different contexts. For example, three faculties of a university can cooperate or the three pillars can be viewed more internationally through the cooperation of several universities. In this context, it should be taken into account that cross-organizational cooperations require close interdisciplinary collaboration and a coordination of the applied (transdisciplinary) teaching approaches (e.g., design thinking) that enable active engagement with society.

The presented concept represents a first step to ensure that sustainability is taken into account in a more sustainable way in the engineering business context. Only if we succeed in making sustainability an inherent part of engineering education we can ensure that ecology, economy and social perspectives are taken into account in the technology of the future and that technological development can contribute to achiving the 17 sustainable development goals.

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