
Editorial

Stefan Huesig*

Chemnitz University of Technology,
Innovation Research and Management of Technology,
Thueringer Weg 7, 09126 Chemnitz, Germany
Email: stefan.huesig@wirtschaft.tu-chemnitz.de
*Corresponding author

Klaus-Peter Schulz

ICN Business School ARTEM,
86 Rue Sergent Blandan, 54000 Nancy, France
Email: klaus-peter.schulz@icn-artem.com

1 Introduction

Since some decades, we face a fundamental imbalance between social and economic activities as well as earth systems. This has spawned various challenges in the fabric of human civilisation in multiple subsystems of society such as transitions in energy, monetary and transport systems, deglobalisation and digitalisation, as well as environmental degradation and social, financial and economic instability (Hüsig, 2020). Creativity, innovation and sustainable development are today considered to be adequate responses to those challenges and vital indicators of societal and professional life (Shrivastava, 2014). Traditionally, however, their advances have been considered separately. Though, there is an inherent demand to integrate creativity, innovation and sustainable development to bring about solutions that are able to cope with the complexity of the above challenges (Schulz et al., 2021): Organisations and social systems need creative approaches for identifying innovative solutions for implementing the UN's sustainable development goals. Furthermore, we live in an age of disruption (Hüsig, 2020; Christensen et al., 2018; Kumaraswamy et al., 2018): dramatic events and new opportunities, although signalled through preliminary indicators, require radical action and immediate reorientation. Financial crises, ongoing wars and destruction, refugee streams, environmental disasters or pandemics are very recent examples.

To navigate through an uncertain era of ferment in societies and many industries, and to innovate radically, it is of paramount importance to dissolve disciplinary and functional boundaries, connect formerly unconnected knowledge and application fields, foster systemic thinking, overcome thought barriers, and break existing paradigms (Hüsig, 2020). New combinations frequently emerge when crossing disciplinary and cultural borders, which enable further learning at various levels of society, and offer improvements in sustainable local development.

The challenges and growing uncertainty also produce resistance, anxiety and turmoil in and between societies. Potentially disruptive innovations and business models, and new institutional technologies such as decentralised blockchain-based sharing and crowd-controlled economic platforms emerge, but it seems that there is a lack of a common orientation and visionary leadership connecting all these trends towards sustainable development (Hüsig, 2020). Disruption in this context should be considered two-fold. On the one hand, there is the process whereby a smaller company (entrant) with fewer resources and an innovation that provides a new set of features, performance attributes, and/or price characteristics compared to those of existing products is able to successfully challenge established incumbent businesses (Christensen et al., 2015; Huesig, 2012). On the other hand, there are events that require a complete rethinking of existing practices. The COVID-19 pandemic can be seen as an example.

There is a growing consensus within academia, politics and business that current challenges can only be solved through connecting creativity, sustainable development, innovation and through multidisciplinary perspectives (Shrivastava, 2014; Schulz and Mnisri, 2020). Nevertheless, this discussion remains often only on a highly aggregated level. Concrete pathways on how to deal with the comprehensiveness of challenges, and to search for potential solutions are often missing (Schulz and Mnisri, 2020). The identification of problems and the development and implementation of specific solutions, particularly if applying disruptive innovation in new fields, require a detailed and thorough analysis and development to grasp the comprehensiveness and interdependence of the challenge. For instance, innovation may fail because of the lack of infrastructure, or creative ideas of sustainable development may only lead to a shift of problems to other areas or regions. In other words, the discourse of interrelating creativity, innovation and sustainable development needs to be brought to an operational level (Schulz and Mnisri, 2020).

The following articles provide a collection of studies from different disciplinary views, and various topics related to creativity, sustainable development and innovation. They consider products, product service systems or lifecycles, processes and methods. What they have in common is the detailed consideration and theoretic reflection of specific cases. This special issue was designed as a conclusion of the 3rd ARTEM International Organizational Creativity and Sustainability Conference (ARTEM OCC 2020), which had to be cancelled due to the disruptive event of Covid19. ARTEM stands for ARts TEchnology & Management and therefore represents the idea of a multidisciplinary approach. The special issue consists of nine articles from different disciplinary perspectives, several which were supposed to be presented at the conference, others were writing in response to the special issue call.

We consider the contributions as case collection and theory development related to the overall topic: connecting creativity, innovation and sustainable development in the age of disruptions. Hence, the contributions of this special issue are introduced in the following. Afterwards, we reflect the articles and discuss the learning from the contributions and the described cases. We will particularly discuss the questions: How are the topics of creativity, innovation and sustainable development addressed in the research cases? What are concrete challenges when connecting creativity innovation and sustainability in a disruptive environment?

2 Basic concepts as prerequisites for this special issue

Creativity we frame here as a collective capability since new ideas are mainly developed through interaction between people or are influenced through exchange and encounters (Parjanen, 2012; Schulz and Geithner, 2014). In creativity research, it is often seen as a spontaneous and intuitive action in combination with a planned composition and design of processes and product frames (Amabile and Fisher, 2009). Hence, it comprises both intuition and composition. With regard to organisations that are able to act creative, the aspect of ‘composition’ may refer to bringing about framework conditions that foster a creative action (Amabile and Fisher, 2009; Schulz et al., 2017). Hence, apart from the collective capabilities, creative activity depends on the framework conditions provided and facilitated. Creative ideas emerge out of collective activity which may be more or less supported through adequate artefacts, nowadays often playful modelling with haptic tools (Schulz et al., 2015; Sanders and Stappers, 2014). The idea generation, however, does not necessarily lead to an innovation since aspects of appropriateness, feasibility or usability finally decide whether a creative idea may lead to an innovation.

Innovation is broadly speaking an iterative, interactive, context-specific, multiactivity, uncertain, path-dependent process and the result of a new (at least from a certain perspective) combination of ends and means (Hüsig, 2014). Following this perspective on innovation, someone must perceive a difference concerning the qualitative newness of an object compared to a prior status in a given context. This new combination must be implemented and introduced into a specific context which is the point of reference of the prior status. With regard to the multi-dimensional and complex nature of the innovation phenomenon, the process dimension is central to innovation that finally leads to the novel outcome (Hüsig, 2014). In this view, the innovation process is understood as all activities involved in the creation, introduction, market acceptance and diffusion of innovation (Rogers, 2010). The outcomes of the innovation refer not only to physical ‘products’ but also to solutions in terms of process design, service, business models or software.

Researchers typically classify the innovation phenomena into categories which are often referred to as frameworks or typologies as part of the theory-building process (Hüsig, 2014). Disruptive, reverse or frugal innovations are categories of innovation that can embody various degrees of relatedness towards dimensions of sustainability (Lange et al., 2021; Albert and Hüsig, 2019; Albert, 2019). Especially frugal, low end or low cost-high tech innovation which is characterised through substantial cost reduction, concentration on core functionalities, and optimised performance level seem to have a positive connection between and/or potentials for sustainability in general and is seen as a way to meet the needs of the so called ‘bottom of the pyramid’ (Lange et al., 2021; Albert, 2019; Schanz et al., 2011). However, the roots and role of disruptive innovation in this context is less understood and the conceptual boundaries between innovation concepts such as frugal and disruptive innovation are often blurred (Albert and Hüsig, 2019).

Sustainable development definitions expanded in recent decades from a mere ecological and environmental protecting concept to a more comprehensive one, which considers ‘development’ from an economic, ecological and social perspective (Lozano, 2008, 2015; Albert et al., 2017). The development of the sustainable development goals (SDG) go one step further as the subjects and objects of development are more clearly

defined (Pradhan et al., 2017; Dressler and Bucher, 2018; Schulz et al., 2021). They comprehend sustainable development also strongly as a human development issue and therefore include education as a central point. The inclusive view of the 17 SDGs demonstrates the multifacetedness of the topic and therefore the demand of an inter- and transdisciplinary consideration (Pradhan et al., 2017; Dressler and Bucher, 2018; Schulz et al., 2021). Often solutions are contradictory and improvements in one field may cause deterioration in other fields (Menton et al., 2020; Albert et al., 2017). This can for instance be the case if changes are made in one section of a supply chain which only relocate the problem to another area. Often existing practice and perspectives and therefore incremental improvements are insufficient to solve such issues. In such case, creative idea development and disruptive innovation is needed to bring about sustainable development.

3 Contributions to this special issue: the research cases

The first article of a life cycle assessment in textile recycling shows the complexity of the textile life cycle from a supply chain and engineering perspective: ‘Development of a recycling process for textiles made from PET, and proof of its environmental preference with life cycle assessment (LCA)’ by Lynn Luedemann, Andreas Felber and Marcus Golder. The article sets into relation synthetic fibres to polyethylenterephthalat (PET) bottles which are made from the same material. It turns out that the recycling potential of fabrics is much higher than from PET bottles, although recycling practice focuses on PET bottles. The study shows the multiple influential factors such as the awareness of recycling potential, the funding policy of recycling or technological opportunities. In the article a technical recycling solution and a process chain is developed. The authors prove the ecological and economical effects of the textile recycling in comparison to refuse incineration through applying a life cycle assessment. The article shows first the importance to analyse a complete product chain compared to alternative product chains in order to appreciate the general saving potential. Second the article provides a technological solution and third with the LCA an analytical model is introduced which delivers facts of the different steps in the process chain. Therefore, comparative analysis of alternative solutions can be carried out. The article shows the demands and importance to provide a solid technological solution at first and then dig into the details to get robust data on the benefits and efforts to be able to assess whether a process is sustainable and to what extent. The article also demonstrates that it is often the lack of reliable data that prevents efficient sustainability strategies. Decisions should be made through a comprehensive consideration based on a robust and reliable analysis. In this case, the reduction of the environmental impact by 60% in relation to the huge use of synthetic fibres opens up the dimension of economical and environmental benefits.

The second article researches frugal innovation as sustainable development driver. In their article ‘Fostering the Sustainable Development Goals with technologies underpinned by frugal innovation’ the authors Alexander Ebolor, Nivedita Agarwal and Alexander Brem discuss the relation between sustainable development and frugal innovation – innovation which are easy in design and simple to use. The motivation to develop such innovation are limited resources in developing, acquiring and maintaining products (Hossain, 2018; Zeschky et al. 2011). The authors raise the discussion that frugal does not necessarily mean sustainable, particularly with regard to the

17 sustainable development goals. Furthermore, they show that several of the SDGs can only be reached through improvements in infrastructure. They therefore consider infrastructural innovation in 10 cases where they assess their contribution to the SDGs and their frugal character. Infrastructure the authors see in a comprehensive way and relate not only to physical, material means but also to human capital and institutional infrastructure. In the study it shows that reaching the SDGs at one end – as the improvement of infrastructure – may have a negative impact on the other end – as this may require high resources for implementation and maintenance. Hence, sustainable development with regard to reaching the SDGs is a complex endeavour where demands, resources and impact have to be well balanced. For instance, technologies that meet criteria of frugal innovation in its use may require considerable development efforts. The authors' study show that frugal innovation may meet selected criteria of sustainable development but it is very difficult to be sustainable in a comprehensive way according to the diversity of the SDGs.

In the third article 'Team creativity: the interplay of shared mental models and the ideation process' by Diana Heinbucher and Julien Bucher the role of shared mental models in ideation processes is researched. Assuming that creativity is a collective capability, the question arises what reveals the creative potential of groups. In ideation processes collectively shared understandings have to be developed that groups are able to work together on a common topic and bring about new ideas. These collectively shared understandings enable a multidisciplinary view on the object of inquiry (Schulz, 2008). The authors therefore research the influence of shared mental models on ideation processes with a multi-method approach. This case study provides a detailed view what influence shared mental models have on participants' behaviour, their strategies, coordination, responsibilities and knowledge. Although the study showed the difficulties of identifying the degree of collectively shared models, the authors found out that the more intensive mental models are shared among participants, the better they can work effectively on complex problems. Therefore, collectively shared understandings can be seen as a prerequisite for the development of sustainability-oriented innovation.

Analysing the potential of innovation to become disruptive is discussed in the article 'Application and validation of a disruptive potential methodology for digital two-sided platforms – the case of marketplace lending in Germany' by Sabine Pur, Stefan Huesig and Christoph Schmidhammer. The authors classify innovation according to their potential of being disruptive. They analyse different types and origins of disruptive innovation, from a platform perspective – whether actors on the platform are on the supply (investment/lender) or demand (borrower) side – and a 'producers' perspective – whether the innovator is an existing enterprise or a new entrant. Further, it has to be considered that disruption may affect any type of physical or intangible product as well as digital service platforms (Kaltenecker et al., 2013; Hüsigg et al., 2016). The fact that it is difficult to appreciate the potential success and diffusion of an innovation in advance makes a prognosis vague whether an innovation will become disruptive or not. The authors refer to a number of influential factors, particularly considering firms' potentials to bringing about innovation. With their case study about market lending the authors provide comparative data to analyse ex post the disruptive potential of this service and business model innovation. Based on this knowledge they develop an ex ante approach to predict the disruptive potential of innovation. The results are promising and therefore further testing is needed whether the approach can be adopted to other fields. Particularly

with the multiple influential factors of sustainability-oriented innovation – as for instance described above with the recycling innovation or similar platforms in the sharing economy as also discussed in this special issue – a reliable appreciation of the potentially significant impact (game changer) of an innovation in terms of sustainable development would be an important contribution to the debate on how to reach the SDGs.

The revelation of creative potential of groups within ideation processes is discussed in ‘The impact of playful interventions for idea generation processes: a case study of an automotive producer’ by Jonas Worede Tarekegne and Klaus-Peter Schulz. The authors argue that methods of intervention have to be implemented that foster two aspects of an ideation process. First, the development of collectively shared mindsets – as described in the afore article – and the revelation of creative potential. The problem lies not only in the idea development but also in illustrating and visualising problems within groups. Particularly with regard to the SDGs and sustainability-oriented innovation, the above examples show that problems are highly complex and effects of solutions are intertwined and sometimes even contradictory. Furthermore, if moving towards disruptive innovation, solutions often lack of imagination. Hence, the more complex problems are and the more diverse and multidisciplinary collaborating groups are, the higher demand is on visualisation and illustration. This is at first a methodical question. Growing acceptance find methods that integrate hands-on modelling processes with simple to use toolkits and playful interventions (Statler et al., 2009). The authors therefore compare three different intervention types (hands-on modelling, drama and play, gaming) and compare it with a traditional innovation workshop. The case is from an automotive producer where participants are not used to playful modelling processes. It shows that one single approach does not necessarily lead to a higher number of ideas but a methodical combination of playfulness with hands on modelling leads to a higher quality of ideas and generates an impact on the daily work processes of participants in terms of openness and creativity in a rather conservative work environment.

Forms and effects of different forms of the sharing economy in Germany are structured and assessed in the article ‘Sharing offline and for idealistic purposes in Germany’ by Anja Herrmann-Fankhaenel and Erne Schell. The authors distinguish between online, offline and hybrid forms of shared business models. Further, they investigate in which forms idealistic or commercial sharing dominates. Particularly idealistic orientation of sharing organisations is the object of research. The study is based on a survey of 505 cases. One contribution of this study can be seen in providing insights into the heterogeneous system of sharing businesses beyond the generic assumptions of a homogeneous economy. For instance, activities may be initiated online but carried out offline. Considering users’ activities within sharing business, they often have a hybrid role as consumer and producer. This research opens up the field of the sharing economy beyond a traditional understanding of a purely digital activity. It also shows the social aspect of interaction and actors’ roles – particularly when regarding idealistic, non-profit sharing. With regard to sustainability the thorough investigations of forms and activities of a sharing economy provide insights how these businesses operate with diverse, often creative forms, and where these forms of businesses may contribute to sustainable development or not.

In their contribution ‘A quantitative analysis of the fostering factors of responsible innovation with a special focus on imagination and women in tech’, Julia Breßler and Lisa Hegemann research how responsible innovation (RI) can be facilitated. Responsible innovation can be considered as synonymous to sustainable innovation. The authors

identified that innovation processes are often dominated by homogeneous groups which have a negative impact on a comprehensive view integrating ethical, legal and social aspects into innovation. Hence, they argue that particularly women in technology provide an enhanced quality of RI. The authors characterise RI as a reflexive, responsive and anticipative process which requires inclusion and resources. The quality of imagination of its stakeholders finally decides about the quality of the RI. Therefore, the authors have investigated the drivers for RI in a survey with over 200 organisations from different industries and fields. They come to the conclusion that women in technology are imagination drivers and therefore have a positive influence on RI, as well as any other aspects of the inclusion of diversity. This article therefore contributes to the question what framework conditions facilitate innovation and sustainable development.

Current development towards digitalisation raise the question how digital technologies may be used in innovation processes. With their contribution 'Organising for AI-powered innovation through design: the case of Hitachi Vantara' by Denis Dennehy, Bill Schmarzo and Mouwafac Sidaoui, the authors argue that a design thinking approach (Razzouk and Shute, 2012; Micheli et al., 2019) can combine a participatory approach to innovating with digital technologies. Particularly with regard to data analysis and modelling of alternative solutions artificial intelligence (AI) can contribute to the innovation process. Question, however, arises how intuitive and creative idea development can be combined with the analytical processes of AI. The authors see their contribution in demonstrating how the human centred and participatory approach of design thinking can be a framework of an AI driven innovation process. AI provides new opportunities to participatory approaches since co-presence can be partially replaced through tele-presence and additional data and information can be integrated in the creative process. This is particularly due with regard to the complexity of sustainability-oriented innovation where a multidisciplinary co-creation process requires thorough information about the consequences of solutions. The authors explore their approach with a case study of a university corporate collaboration. A detailed analysis of the design thinking process and the use of AI provides insights on how an ideation process can capitalise from digital technologies. It shows that the above-mentioned point of shared understanding and language is particularly a challenge when data scientists meet design thinkers. With regard to the above-mentioned playful modelling approaches it is a question how these collective methods of idea generation may be combined with AI.

Several of the sustainable development goals are exclusively dedicated to innovation. The article 'How can makerspace contribute to training for complex technological innovation? – the case of aviation-based training for surgery robotics' by Adam Seymour and Klaus-Peter Schulz deals with an innovation which has the potential to become disruptive – surgery robotics. The disruptive potential is difficult to predict, however, for the surgeon completely new behaviour, use of instruments, communication and surgery organisation are demanded. The article introduces and assesses a training concept which orientates on aviation simulator trainings to develop individual and team skills to deal with the demands of robotic surgery. The learning principles can be seen as innovative themselves as they represent a cooperative development of the participants through practicing and reflecting. The learning environment and process can be described as maker space, similar to an ideation process. The learners are in close interaction with the system and develop further through its use. In addition, the instructors and facilitators

reflect on the learning process and therefore identify outcomes and demands to develop the education process further. The participants also get a direct feedback of their action through the simulation results and the post reflection. Hence, they are able to grasp the complexity of the situation and the consequences of their action. An aspect which also has to be considered in other sustainable development- oriented contexts.

4 Research methodology

The studies represent a broad variety of methodologies. They go along specific cases and processes, describe supply chains or refer to surveys. Hence, in depth insights along supply chains, organisations or processes are provided as well as overviews of specific fields or sectors. The theme of this call is therefore discussed from various angles, which finally provide a comprehensive and diverse view onto the concepts of sustainable development, innovation, disruption and creativity. Table 1 represents the individual research approaches.

The research approaches represent analysis, comparative research, exploration, assessment as well as concept or method development. The majority refers to cases. Even the quantitative studies are based on case data. All studies have in common that they provide in depth views on specific effects or applications. Hence, it can be assumed that case study is the method of choice to bring about new insights, methods, solutions related to the field of sustainability and innovation (e.g., Yin, 2013). The empirical methods are of traditional nature, applying observation, interviews, questionnaires, group discussions but also non-traditional such as collective reflection using representational modelling (Schulz, et al. 2017).

In our meta analysis of the nine studies we consider the research questions:

- 1 How are creativity, sustainable development and innovation addressed and connected?
- 2 What are effects of creativity, sustainable development and innovation with regard to the response to disruption?

We carried a thematic (Guest et al., 2011) and a qualitative content analysis (Mayring, 2014), searching for the above-mentioned concepts in the studies (explicit research) and for related keywords and phrases representing the concepts (implicit research). Among searched keywords and phrases were (non-exhaustive):

- Creativity and innovation: idea development, ideation, new thinking, design thinking, bringing about novelty, new approach, change, development, technological solution, solution, problem solving, radical, incremental, improvement.
- Sustainable development: environmental change, emission, energy efficiency, SDG, life cycle, social change, equality, equal opportunities, education, long term effect, resource, resource efficiency.
- Disruption: radical change, novelty, radical innovation, changed framework conditions, intervention.

Table 1 Research methodology

<i>Study</i>	<i>Research topic</i>	<i>Methodology</i>	<i>Contribution</i>
LCA of fibre recycling	Development of a process and assessment method of textile recycling	Case based action research: testing and analysis	Life cycle assessment of textile recycling chain from a technological and economic perspective. Showing potentials and implementation difficulties
SDGs and frugal innovation	Assessing frugal innovation in different sectors in terms of their contribution to achieve the SDGs	Comparative case study research based on published data	Assessing frugal innovation based on a comprehensive definition of the concept of frugality. Showing that frugality needs to be integrate multiple aspects of innovation
Shared mental models and ideation	Exploring the influence of shared mental models of participants on ideation process	Case study with quasi experiment about preconditions for ideation	Showing that the development of shared mental models has a positive effect on ideation processes in terms of idea development
Disruptive potential assessment	Analysing the potential of innovation to become disruptive in banking industry	Case study based on secondary data from digital banking	Demonstrating what are framework conditions within firms that make disruptive innovation more likely.
Playful intervention in idea generation	Comparing traditional with playful and modelling approaches in ideation	Case study from automotive, quasi experimental approach	Comparing different methodical approaches to ideation and assessing play and modelling in terms of idea development quantity and quality
Sharing offline in Germany	Exploring different forms of a sharing economy	Survey based on different cases	Exploring characteristics and effects of different forms of online, offline and hybrid sharing economy.
Responsible innovation and women in technology (WIT)	Identifying drivers for responsible innovation particularly regarding WIT	Survey with various organisations	Demonstrating women in technology as enhancing quality in responsible innovation processes through imagination
Design thinking and digital technologies	Exploring how design thinking fosters AI-powered innovation	Single case study applying observation and interviews	Matching AI powered innovation with a design thinking approach, balancing technological and social science aspects
Maker space and technological innovation	Analysing Education and its effects for a potentially disruptive innovation	Case study of a surgery robotic training institute	Showing that education and training can lead to learners' development and technology improvement

The following discussion shows that the conclusions gained from the studies are elucidating and provide a differentiated assessment of the topics due to the in-depth research. The diverse methodical approaches provide, as the above listed studies demonstrate, a necessarily holistic view on the coherence of the concepts of creativity, sustainable development and innovation. Particularly with regard to disruption in terms of changing framework conditions and of possible solutions a thorough methodical approach is essential.

5 Outcomes

Both, the thematic and the qualitative content analysis show that all studies implicitly or explicitly address the proposed concepts of creativity, innovation, sustainable development or disruption. There is, however, in all articles a clear emphasis on one, maximum two concepts which are explicitly discussed. Connections to the other concepts are obvious despite not mentioned explicitly. Table 2 provides an overview how the concepts are addressed.

Table 2 Approaches towards the concepts of creativity, innovation, SD and disruption

<i>Study</i>	<i>Creativity</i>	<i>Innovation</i>	<i>Sustainable development</i>	<i>Disruption</i>
(1) Life cycle analysis of fibre recycling	Approach and perspective of life cycle assessment	As technological solution for sustainable development As assessment method	Innovation for recycling Assessment of its contribution to environmental impact	Potential of the innovation Appreciation of its effects (implicitly)
(2) SDGs & Frugal Innovation	Processes and concepts of "frugal" innovation	Frugal innovation Assessment method and factors for frugality of innovation	Contribution of beforehand frugal innovation to SDGs	Frugal innovation as potentially disruptive innovation (implicitly)
(3) Shared mental models and ideation	Collective process, team creativity, driven by shared mental models	Innovation (team) as idea and solution development team	Sustainability as characteristics of innovation	Team creativity as disruption factor (implicitly)
(4) Disruptive Potential Assessment	Creativity as factor to foster disruption (implicitly)	Innovation as novelty with the potential of disruption	Sustainability as innovation criteria (implicitly)	Disruption as assessable impact factor of innovation
(5) Playful Intervention in idea generation	Creativity as collective capability for idea generation	Innovation as creativity related process	Sustainability as characteristics of innovation	Impact of innovation (implicitly)

Table 2 Approaches towards the concepts of creativity, innovation, SD and disruption (continued)

<i>Study</i>	<i>Creativity</i>	<i>Innovation</i>	<i>Sustainable development</i>	<i>Disruption</i>
(6) Sharing offline in Germany	Implicitly referring to a creative business approach	Case example of business model innovation	Business approach related to sustainability	Potentially disruptive business model (implicit)
(7) Responsible innovation and WIT	Creativity as collective capability brought about through diversity	Responsible innovation brought about through diversity and imagination	Responsible innovation as sustainability factor	Responsible innovation as potentially disruptive (implicit)
(8) Design thinking and digital technologies	Design thinking as creativity revealing process	Innovation process powered through artificial intelligence and design thinking	Sustainability as characteristics of innovation (implicitly)	Disruption as potential effect of innovation (implicitly)
(9) Maker Space and technological innovation	Creativity as outcome of a collective learning process	Innovation brought about through collective learning and reflection	Sustainable development through reflexive learning (implicitly)	Disruption through technological innovation (implicitly)

Two articles refer to methodology development [(1) and (4)], one measuring and assessing environmental impact, the other one disruptive potential of innovation. Specific types of innovation are classified in two further articles [(2) and (6)]. Prerequisites for (sustainable) innovation are discussed in the two articles (3) and (7). The three articles (5), (8) and (9) describe and assess frameworks and processes that facilitate the generation of innovation.

Innovation is explicitly mentioned in all articles and the methodologies, methods and thematic approaches refer to innovation as process or outcome. Sustainability is explicitly or implicitly connected, as characteristics or the objective of the innovation referred to in the case study. Creativity is seen as capability of mainly groups or as an attribute of an innovative 'product'. Creativity has in most articles the character of a prerequisite for innovation. Two articles explicitly conceptualise creativity. Disruption finally may be an outcome of (sustainable) innovation. In most cases, this result can be assumed but it is not object of the articles. Only one article conceptualises and mentions the term disruption.

Innovation is therefore described as a main concept and can be seen as the central focus in the discussion. The other concepts are either considered as prerequisites, connected effects or outcomes. Correlations between the concepts were, however, not a subject of discussion in the research cases here.

6 Discussion and conclusions

The analysis of the articles of this special issue raises the following key aspects.

The in-depth empirical research of the cases demonstrate, that frequently made generic assumptions about concepts and processes may lead to incomplete and incorrect conclusions since the comprehensive picture has not been taken into account. This is particularly the case when considering supply chains or infrastructure. Beforehand frugal innovation may not be frugal when considering the process chain of the development and production, context of use and influential factors of an innovation. This is particularly the case when evaluating the innovation according to the comprehensiveness of the 17 sustainable development goals which do not only refer to environmental factors but also to social development and justice. A similar effect can be shown when considering supply chains. Sustainable development needs to be carefully assessed since sustainability means, potentially connected to innovation, at one step of a supply chain may have a negative impact on other stages of the supply chain. Finally, overall assessments have to be carried out. New business models like the sharing economy may appear in different types with diverse intentions and outcomes in relation to sustainable development. This leads to the assumption that considering complex coherencies and to find out causal relations of sustainable innovation and its emergence requires in-depth case research based on sound theoretic conceptualisation. Hence, operationalisation of concepts is key as well as choosing methodical approaches that provide insights that tell a coherent and complete story. Particularly sustainable oriented innovation with the potential of being disruptive (Buhl et al., 2019), require a holistic discourse from various perspectives (Schulz et al., 2021).

Among the aspects that reveal creative potential for bringing about sustainable innovation are group composition, shared mindsets and methodical support. Assuming that creativity is a collective capability, heterogeneous group compositions bring about multiple perspectives for the purpose of inclusive innovation. As discussed from Breßler and Hegemann (in this issue), provide for instance the integration of women in technological development processes different and more inclusive outcomes than exclusively male developer teams. Challenges in heterogeneous teams are, however, the development of shared mindsets. Providing a common understanding among participants needs to be seen as a key aspect in the creative process (Schulz, 2008). Hence, methodical approaches and spaces have to be found to bring about, first, collectively shared understandings and, second, reveal creative potential. Among meanwhile established methodical approaches is the design thinking process, which relates back to what was said before, that diverse groups bring in empathy for diverse users. However, empathy needs to be combined with creative idea development towards responsible and sustainable innovation. Promising methods to combine emotion with rational approaches are gaming or hands-on modelling. It shows that beforehand not the idea quantity increases but its quality. The more complex innovation tasks are, the larger is the difference between such and traditional methods. To cover the rational side of the design thinking process, Dennehy et al. (2022) propose the use of AI, which also opens a new level of collaboration since collective processes can be transferred to distant forms that provide a digital form of a collective maker space.

The referred articles provide highly relevant insights and new findings in their field of study. They also show a thorough and sound theoretic basis of the concepts used. When considering the complete picture, it however also shows that methodologies and topics

are considered from a specific angle. It lacks of connections between the proposed concepts described in Table 2. The point only becomes obvious when regarding this special issue as a whole. While the variety of innovation concepts is often well connected to sustainable development – no serious researcher would nowadays characterise an innovation approach as per se non-sustainable, despite the study is about the lack of sustainability in innovation – this connection remains often implicit. It often lacks a concrete connection to the sustainable development goals as for instance. Even more implicit is the connection between the concepts of innovation, disruption and creativity. The latter is often assumed as being an automatic antecedent of innovation. The disruptive potential of innovation and its effects is often not described or conceptualised. Neither is disruption as a prerequisite for a creative process. Consequently, despite the very valuable insights presented in the articles described above, this special issue we also see as inspiration for further research particularly to connect the concepts to bringing about sustainable innovation. Particularly, connecting the insights of specific types of innovation, its emergence and assessments with methodological and methodical approaches may provide benefits for both.

This study can only draw a spotlight on the topic through the exemplary connection of research topics and approaches. However, all contributions addressed and contributed to the same call, therefore a common ground of interest in the topic can be identified. We see these special issue articles as patterns and proposals based on in depth studies, on how to deal with creativity, innovation, sustainable development and disruption. It also shows paths of connections between these concepts. These connections between the concepts and between thematic and methodical approaches need to be made more explicit in further research.

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