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Taking Eco-Innovation to the Road—A Design-Based Workshop Concept for the Development of Eco-Innovative Business Models

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Abstract: At least since the European Union's Eco-Innovation Action Plan, eco-innovation has received increased attention from scholars, practitioners, and policy-makers alike. Eco-innovation offers many opportunities for businesses in terms of cost reduction, competitive advantage, and sustainability. However, eco-innovative business models differ from conventional business models and have special requirements in terms of stakeholder involvement, value definition, and value creation. Facing technological progress, many businesses need guidance on how to translate the potentials arising from technological innovation into eco-innovative business models. Applying a design-based research approach, this study develops a design-based workshop concept to facilitate the development of eco-innovative business models on a firm level. The workshop concept was iteratively tested in a series of 22 workshops within the European Alpine bioeconomy sector. It transfers the specific requirements and substantive design principles of eco-innovative business models into an operative workshop concept. By building on stakeholder- and value-centred perspectives and ensuring a holistic understanding of sustainability and innovation, the paper derives a number of procedural design principles that could build the basis for further tools and methods of eco-innovative business model development.

Keywords: business model; eco-innovation; sustainability; design-based research; workshop concept

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1. Introduction

With the development of the Eco-Innovation Action Plan, the European Commission has spelt out specific aims for achieving resource efficiency in the EU's economic model [1]. In particular, more value must be gained from resources already in use within society to meet economic, social, and environmental goals. Eco-innovation is the change implemented to achieve these aims and has received increased attention from scholars [2,3], practitioners [4,5], and policy makers alike [1,6]. It offers the potential to overcome ecological pain points through economically viable business solutions [7], thereby creating shared value [8] and stimulating corporate business strategies that target societal needs [9,10]. Hence, eco-innovation represents a highly relevant strategic opportunity for businesses, potentially reducing costs [11] and improving corporate competitiveness [4]. Simultaneously, it helps businesses decrease their environmental impact, foster sustainability, and strengthen the company image in front of their customers [1,5,12]. Demonstrating new options and possibilities to develop and implement eco-innovative business models will open new areas and inspiration for both business practise (e.g., companies, NGOs, governments) and research " ... *on how to translate social and environmental value creation into economic profit and competitive advantage for the firm to build the 'business case for sustainability'*" [13] (pp. 54–55), similarly at [4,14–16].

However, while new technologies and technological progress are a driver of business model innovation [13], many companies need guidance on how to integrate and implement the potentials arising from technological innovation in their businesses [17,18]. Business model innovation often does not occur because companies cannot identify the appropriate business model for new technologies [19] due to inertia in adapting their existing business model [20]. While even conventional business model innovation represents a challenge to many firms, the development of eco-innovative business models comes with additional barriers and difficulties.

Eco-innovative business models have specific requirements compared to conventional business models, which originate in the particular nature of sustainable and/or socially responsible innovation. To configure a business model with a sustainable value proposition, value creation, value delivery, and value capture [18], businesses should open up their conception of doing business [2] by focusing on a broad group of stakeholders and by redefining value from a triple bottom line perspective [13]. To achieve this, a stakeholder-centred perspective, a value-centred perspective, a holistic understanding of sustainability, and a holistic understanding of innovation during the process of business model development are essential (see Section 3). Additionally, as technological advances towards sustainability are increasingly incremental, many companies find it difficult to meet their sustainability targets solely based on technology [4]. Therefore, business model innovation gains increasing strategic importance to align incentives and revenue mechanisms to leverage sustainable solutions [20,21].

Previous research has developed several tools and processes to support organisations in the design of business models enhancing sustainability performance. These tools primarily aim at products or take a broad view on eco-innovation [22–24]. Even more recent is the development of tools that combine both notions and focus on using eco-innovative business model development as a leverage point to support companies in meeting their sustainability ambitions [25–29]. However, most of them address single phases of sustainable business model innovation. For instance, many studies pay particular attention to the ideation stage [23,30,31], but neither of them considers the value creation architecture nor the question of how to make a profit. Nevertheless, as Bocken et al. [23] state, most of the tools and process models are of complex and theoretical nature. Additionally, only a few have been used and tested in the operational process of eco-innovative business model innovation. "*While these tools can provide some support with the conceptual design of business models, they offer only limited guidance through most of the remaining business model innovation process*" [20] (p. 409). One of the major knowledge gaps refers to the fact that the development of eco-innovative business models is considered in an over-simplistic manner because eco-innovation is frequently confined to technological progress. Even though new or modified services and management practices are important parts of eco-innovation, He et al. [4] found that more than half of the studies on eco-innovation is published in the field of engineering or design sciences, but less so with an economics or management perspective. Therefore, future research should deploy an integrated perspective, which examines organisational and managerial aspects in much more depth [4].

Consequently, there is still a gap in the existing literature on how to translate the specific requirements of eco-innovation into an operative procedural development framework that facilitates turning technological solutions into eco-innovative business models and at the same time can be easily used by companies. This paper directly addresses this research gap. Applying a design-based research (DBR) approach [32], the study develops a design-based workshop concept, which transfers substantive design principles of eco-innovative business models into an operative workshop concept guiding the development of eco-innovative business models on the firm-level. Furthermore, the paper derives a number of procedural design principles that could build the basis for further tools and methods of eco-innovative business model development by empirically testing the developed prototypes along a series of 22 workshops. These research objectives lead to the following research questions of the paper:

RQ1: How can substantive design principles of eco-innovative business models be transferred to and integrated into a design-based workshop concept on the operative level of business model innovation?

RQ2: What are procedural design principles of tools and methods for eco-innovative business model innovation?

By answering these research questions, the paper supports companies, decision makers, and stakeholders in enhancing their sustainability and innovation orientation by providing them with a workshop concept that can be helpful in the process of developing and implementing eco-innovative business models. Thereby, it directly addresses the articulated demand for new, tested, and feasible tools and methods to guide eco-innovation in companies [4,33]. The results will hopefully contribute to demonstrate various design options for eco-innovative business models and deliver practical inspiration for companies on how to translate social and environmental value creation into economic profit and competitive advantage for the firm to build the "*business case for sustainability*" [14–16]. The paper positions itself at the intersection of innovation management literature (particularly the strand of business model innovation) and sustainability innovation. By following a DBR approach, the research focus of the paper lies on the design and development of a practical workshop concept, instead of on the identification and analysis of causality [34].

The paper proceeds as follows: After a brief overview of the DBR approach and research context (Section 2), we establish, based on a literature review, a set of substantive design principles (Section 3) to guide the prototype design. After designing and testing the workshop prototypes (Section 4), we present the final workshop concept as well as derive some general procedural design principles that are key for a successful implementation of the intervention (Section 5). The paper closes with a summary highlighting the contribution of the paper, discusses some limitations and raises a number of questions for future research (Section 6).

2. Design-Based Research Approach

To explore the design of workshops aimed at developing eco-innovative business models, a DBR approach was used. While the DBR approach is frequently applied to educational sciences [32,35–37], design aspects are also considered in general management, organizational research, and business informatics [38–42]. DBR aims to "*find innovative practical solutions for unsolved problems*" [32] (p. 17) and develop context-sensitive theory [35,43] and solutions relevant for both the research and the practitioner's community [36].

Generally, DBR is a process conducted in iterative design circles [32], which include a context and problem analysis, the design of a prototype, prototype testing and evaluation as well as final evaluation and theory generation [44]. While the respective process models put forth by various authors differ in terms of the number and descriptions of the phases [32,35,45,46], they share the main phases of designing, developing, and (re)evaluating interventions.

2.1. Research Context

This study is embedded in the context of the EU Interreg AlpBioEco project, co-financed by the European Regional Development Fund through the Interreg Alpine Space Programme. The project aimed to unlock potential for eco-innovation in the Alpine bioeconomy, focusing on the Alpine regions in Austria, France, German, Italy, and Slovenia. From 2018 to 2021, a consortium of thirteen project partners developed eco-innovative business models to foster the sustainability of the value chains of apples, walnuts, and Alpine herbs.

The project was started by researching and analysing the characteristics of the bioeconomy and thus specifying the problem. Next, the project consortium conducted a thorough analysis of three specific bioeconomic value chains in the Alpine Space, placing the raw materials (i.e., apples, walnuts, herbs) at the core. Market and laboratory analyses and a SWOT analysis were performed by the project consortium for each of the respective value chains. The laboratory analyses focused on the waste materials and by-products of the raw

materials, such as apple pomace, walnut bark, or herbal essential oil. As a result, short raw material profiles were created to provide an overview of the raw materials' characteristics and showcase potential technological solutions. After analysing these bioeconomic value chains in the Alpine space and exploring technological possibilities, eco-innovative business models were developed through a series of workshops. The development of eco-innovative business models was facilitated by a workshop concept, as illustrated in this paper, specifically designed for the project. Next, the project consortium pilot tested the selected business model and provided support to businesses for implementation endeavours and, lastly, developed economic and political guidelines for the transregional adaptability of the results.

2.2. Research Design

Inspired by Euler [32], we adapted the DBR process as illustrated in Figure 1 for our study. Guided by the problem definition of the AlpBioEco project, we reviewed and evaluated the extant literature, derived substantive design principles, developed a workshop concept, tested, refined, and evaluated it in an iterative series of 22 business-modelling workshops, and finally defined and evaluated procedural design principles that can be transferred into other research contexts [32,44].

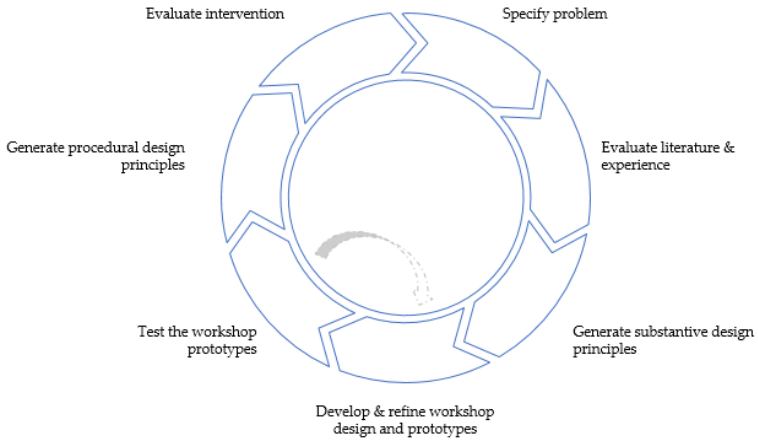

Figure 1. Overview Research Design (own illustration inspired by [32,47]).

Within the context of DBR, design principles aim to bridge the gap between scientific insights and instructional design [32]. They "*provide guidance and direction, but do not give, certainties*" [43] (p. 22), which means that they consider the context of an intervention [46]. Van den Akker [47] differentiates between substantive and procedural design principles to account for both the scope of the underlying topic itself and the development process. While substantive design principles focus on the characteristics of an intervention (in this study the workshops) and provide a design framework, procedural design principles are considered the design methodology and guide how an intervention should be implemented [47,48]. Based on the literature review and practical insights, we first established a set of substantive design principles, which guided the prototype design. Based on our experiences from designing, testing, and refining the prototypes, we derived procedural design principles that are key for a successful implementation of the intervention [32,47].

The overall systematic study of the design-based workshop concept allowed us to further our knowledge about the characteristics of the workshops themselves and the processes of designing them [43]. To gain insights and assure the practical relevance of the developed solution, we collected practitioners' insights at different points in the design process [32]. Additionally, we followed Edelson's [48] call for a research-driven approach and complemented the practical insights, collected by the AlpBioEco project consortium, with a literature review to derive a theory-based framework [32,36].

3. Theoretical Background

3.1. Business Models

The concept of the business model has undergone a change over the last 70 years. In the beginning, the focus was strongly on value creation, the revenue model or computer system modelling without showing any relation to organisational design or business strategy [49,50]. It was not until the end of the 1990s that the term was increasingly used in economic literature and in public discourse [49,50]. Today, it is rather used as a holistic concept to describe or classify enterprises or to represent certain aspects and conceptualisation of a concretely occurring, specific enterprise [50].

Following Osterwalder and Pigneur [42] (p. 14), a business model describes "*the rationale of how an organization creates, delivers, and captures value*". Within the framework of business models, the determination of the market, the value proposition, and value chain and revenue mechanics occur [50,51]. The goal of developing a business model is to combine the business model elements in such a way that they reinforce each other. An advantage of the business model approach is that it is more difficult to imitate, and at the same time it is possible to exploit business opportunities by creating value for all parties involved [52,53].

A wide variety of concepts for business model development can be found in the literature [42,54,55]. In this study, we used the "*magic triangle*" model for business model development by Gassmann, Frankenberger, and Choudra [55]. This model, as illustrated in Figure 2, is based on the following four core elements of a business model: the value proposition (What?), the customer or market segments (Who?), the profit model with their revenue and cost structure (Value? How?) and the value chain/value creation with the coordination of processes, resources, activities, and cooperation (How?).

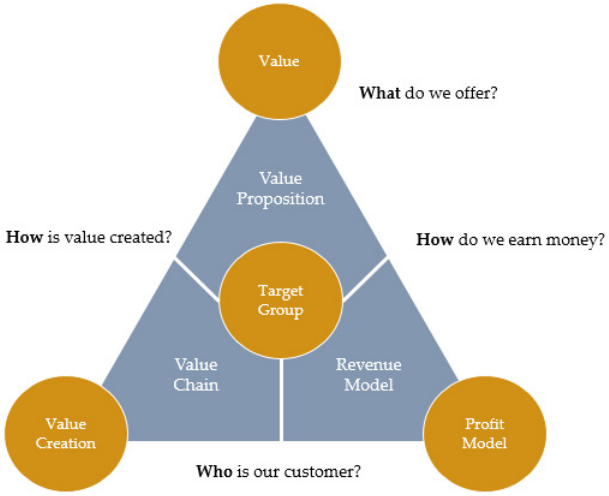

Figure 2. Triangle of Business Model Development (own illustration based on [55]).

According to Gassmann et al. [55], the customer is placed at the core of a business model development. Companies must therefore identify their target groups and understand their needs and wishes [55]. The customer dimension concerns the identification of customer segments, the selection of channels to the customer, and the definition of the relationship with the customer [42,52]. When developing or transforming business models, it is important not to include the customer alone in the analysis, but all the players involved in the company's entire ecosystem [56,57]. The value proposition is the second aspect of business model frameworks. The value proposition defines the benefits of the offerings that create value for the customer [42,55]. According to Schallmo [52], the value dimension includes defining the provided key services and their benefits. The value proposition implies how a company, with its stakeholders, creates value for each actor involved in the network, including customers, suppliers, and partners [57,58]. The third basic component of busi-

ness models comprises the value creation. The value creation dimension includes major resources, activities, and capabilities of a business model [52,55]. Gassmann et al. [55] refer to this component as the value chain. The elements considered here are the key resources and activities of an organisation along the value chain to implement a business model [42]. The network of suppliers and potential partners for optimising business models is also taken into account to reduce risks and acquire necessary resources [42]. In the financial perspective, which forms the fourth basic component of business models, both the cost structure and revenue streams are investigated [52,55]. As the question of how a business model is financially viable is key [55], El Sawy and Pereira [59] emphasise the importance of considering user preferences and willingness to pay.

Altogether, these four elements build the core of each business model. The next subsection elaborates on how their meaning needs to be modified or extended, how their inter-relationship might vary, and how they can be aligned to each other to take eco-innovation to the road.

3.2. Eco-Innovative Business Models

Within the last years, sustainability concerns have received increased attention and have emerged as a new and continuously growing subfield in the business model literature [3,4,18]. Policy makers such as the European Union support this direction and voiced the need for more eco-innovations and eco-innovative business models through the Eco-Innovation Action Plan [1]. Terms such as eco-innovative business model, green business model, or sustainable business model have been coined and are often used interchangeably [33] to describe business models that go beyond a mere profit orientation [18]. While narrow definitions of eco-innovation focus on the economic and environmental aspects and describe it as "*a new solution for a given company [that] leads to the avoidance or reduction of adverse environmental impacts*" [3] (p. 5), we argue that in practice the three sustainability dimensions (economic, environmental, and social) cannot be isolated. Hence, in this study, we follow the approach of Hellström [60] and consider eco-innovation from a holistic perspective including all three dimensions. Consequently, similar to sustainable business models, eco-innovative business models "*create customer and social value by integrating social, environmental, and business activities*" [16] (p. 112).

Incorporating such a triple bottom line approach [61,62], eco-innovative business models consider environmental, social, and economic aspects in their way of doing business [13,18]. This includes implementing significant technological and nontechnological changes or new solutions [3] to an organisation's value proposition and business practices in order to achieve a higher level of sustainability [6]. Hence, based on the conception of conventional business models, eco-innovative business models comprise sustainable value propositions, sustainable value creation and delivery, and sustainable value capture [18]. Eco-innovative business models offer the potential to overcome ecological and social pain points through economically viable business solutions [7], thereby creating shared value [8]. In an attempt to provide an overview of common sustainable business model configurations, Bocken et al. [13] identified eight sustainable business model archetypes (e.g., '*maximise material and energy efficiency*' and '*creating value from waste*') as well as their underlying mechanisms and show that these archetypes build on technological-, social-, or organizational-oriented innovations.

Despite many similarities such as striving for economic success [33], eco-innovations differ from conventional innovations in several ways [63], just as eco-innovative business models differs from conventional business models. These peculiarities include a proactive stakeholder involvement [64], a redefinition of value and value creation [26], and a focus on environmental and social impact [65]. Furthermore, eco-innovative business models are predominantly used by small- and medium-sized companies [17] and tend to start out in niche markets (e.g., in the bioeconomy sector) for pilot testing [4]. Hence, compared to conventional business models, it might take eco-innovative business models longer to become economically viable [13], which requires long-term orientation [20]. Over time,

however, new 'green markets' can emerge due to regulatory push and market pull dynamics, creating growth opportunities for eco-innovative business models [33]. Therefore, some authors expect a paradigm shift towards eco-innovation [4] and argue that eco-innovative business models will become the new standard, making conventional, one-dimensional business models obsolete [20].

Taken together, these peculiarities pose a challenge for the design of eco-innovative business models. To incorporate a true sustainability focus, a proactive business model innovation strategy [16] is needed in order to anchor the triple bottom line approach at the core of the business model [13]. This requires modifications to the inherent business logic and the business model configuration [20] including a reconsideration of its value proposition, value creation and delivery, and value capture [13,18].

3.3. Generating Substantive Design Principles

Although eco-innovation and sustainable business model innovation is well-researched on a conceptual level, a "*design-implementation gap*" still exists [20]. Especially smaller companies tend to have difficulties in translating eco-innovations into viable business models [17], and managers require guidance along the development and implementation process [20]. To overcome this gap, tools and procedures facilitating the design of eco-innovative business models are needed [25] which recognise the peculiarities of eco-innovation [63]. Inspired by the key challenges of sustainability-oriented innovation identified by Buhl et al. [66], we derive four substantive design principles to guide the design of workshop prototypes for eco-innovative business modelling.

3.3.1. Stakeholder-Centred Perspective

Eco-innovative business models consider economic, social, and environmental dimensions in the design of their value proposition, value creation, and value capturing [64]. The aim is to reduce the environmental impact of business operations, create social value, and at the same time generate shareholder value [18]. While this in theory may sound trivial, it is a complex balancing act in practice, which requires a thorough consideration of a broad range of stakeholder groups with sometimes contradicting demands [3]. Compared to conventional innovations, eco-innovations show a higher dependence on external knowledge sources [12] and therefore require a more open and participatory development process [3,4]. Open collaborations with external stakeholders during the development process lead to higher degrees of environmental considerations [67], are prone to create radical eco-innovations [3] and have a positive effect on the adoption of eco-innovations [68]. Thus, to access external information, resources, and competencies needed for the development and implementation of eco-innovative business models, companies are well-advised to engage in an open dialogue with a diverse set of stakeholders [4]. This includes cooperation with upstream (e.g., OEM, suppliers) and downstream (e.g., customers, end-consumers) partners along the value chain, with knowledge institutions (e.g., universities, research centres) as well as policy makers and intermediaries [3,4]. Furthermore, eco-innovative business model development can also benefit from cross-industry cooperation [13]. Hence, stakeholder orientation and cooperation are at the core of eco-innovation and eco-innovative business modelling [20]. Consequently, workshop prototypes for the development of eco-innovative business models need to apply a participatory approach to involve multiple stakeholder groups, reveal conflicts and collision of interests, and allow for real-time negotiations and solution-finding. We, therefore, derive the following substantive design principle:

SDP #1: Eco-innovative business model development workshops need to incorporate a stakeholder-centred perspective.

3.3.2. Value-Centred Perspective

Several studies explored the drivers for eco-innovation in various contexts (e.g., [5,69–71]) and found that regulatory pressure, technology pushes, and market pulls are the main

factors that trigger eco-innovation [33,67,72]. While all eco-innovations—regardless of the driving forces—are desirable, the demand-side perspective (market pull) is particularly important to successfully translate eco-innovations into eco-innovative business models. Recognising customer demands can reveal market opportunities and give impulses for new eco-innovative ideas [4,12]. Hence, "*market-oriented innovators*" are more likely to engage in eco-innovation activities than "*technology-driven innovators*", "*sporadic innovators*", and "*traditional firms*" [67]. However, because consumer and stakeholder needs are dynamic over time [33], asking them for their current behaviour [66] and listening solely to their current needs can be misleading and often result in incremental innovation only [73]. A future-oriented, long-term perspective is needed for more radical eco-innovation activities [4]. Hence, eco-innovators must anticipate future demands and requirements of customers and other stakeholders [26,74] and analyse relevant user behaviour for adopting eco-innovations [66]. A value-centred perspective can help empathise with customers and other external stakeholders, understand their pain points, and design the eco-innovative business model accordingly. The latter includes the definition of a coherent value proposition that addresses the interests of various stakeholder groups simultaneously [3,74]. To include these considerations in the development of eco-innovative business models, we, therefore, derive the following substantive design principle:

SDP #2: Eco-innovative business model development workshops need to incorporate a value-centred perspective.

3.3.3. Sustainability Scope

Eco-innovations aim to achieve a higher level of sustainability [6] by reducing the negative impact of business operations on the environment and using natural resources more efficiently [72]. Potential areas of application for eco-innovations include new products, new production processes, or new ways of sourcing [60]. Hence, eco-efficiency can be improved through optimizing input-, throughput- and output-streams, or through reducing health, safety, and environmental risks [75]. Similarly, reducing, reusing, and recycling waste and by-products helps increase eco-efficiency [76] and valorise waste and by-products [77]. Because eco-innovative actions mainly aim for a positive, or at least a less negative contribution to the known environmental challenges [63] and planetary boundaries [78], economic and environmental considerations often dominate in eco-innovation initiatives [4]. This can also be observed in the sometimes rather narrow definitions of the term eco-innovation [3]. However, the direct and indirect effects of eco-innovations on society are not to be underestimated. If eco-innovations improve the ecological footprint of business operations—for example through fewer emissions or optimised logistics—the local community and the society at large will also benefit through increased quality of life [79]. While isolating the three sustainability dimensions (economic, environmental, and social) might be an easy theoretical task, this delineation does not prove useful in practice. Broader conceptions of eco-innovation, therefore, recognize the complementary dynamics between the economic, environmental, and social dimensions [33,60] and imply a triple bottom line perspective [61,62], similar to the characteristics of sustainable business models [13,18]. To unfold their full potential, the development of eco-innovative business models should therefore be free of definitional restrictions or too narrow perceptions. Consequently, to cover the economic, environmental, and social dimensions of sustainability, we derive the following substantive design principle:

SDP #3: Eco-innovative business model development workshops need to incorporate a holistic understanding of sustainability.

3.3.4. Innovation Scope

Innovation is often seen as the key to solving environmental and social challenges [80]. In a Schumpeterian understanding, innovation goes beyond a pure (technological) invention; it requires a novel idea which is successfully implemented to gain a competitive advantage [81], whereby the idea has to be at least new to the company [82]. Novelty can

be achieved through a re-combination of resources and production factors, which leads to, for example, new products or new production processes [81]. Hence, innovation can occur on different levels: product innovation, business process innovation, organisational innovation, service innovation, marketing innovation, and business model innovation [82]. While these innovation levels also hold for eco-innovations [60,72], eco-innovators tend to focus mainly on the development of new products or new production processes [17]. By limiting themselves to technological innovations [4], these businesses ignore the potentials of nontechnological innovations that could unfold through the implementation of new services, new organizational processes, new supply chain architectures, new management concepts and new marketing solutions [3]. However, a narrow innovation focus might ignore or exclude high-potential solutions in favour of inferior solutions with less environmental or social impact [66]. Furthermore, a narrow focus limits the development of innovation capabilities, which are—due to their path-dependent nature—needed for further eco-innovations [67]. Hence, the successful development of eco-innovative business models should build on eco-innovations at all levels (i.e., product, process, and organizational level) [17]. Consequently, to embrace all levels and types of innovation and apply a holistic understanding of innovation, we derive the following substantive design principle:

SDP #4: Eco-innovative business model development workshops need to incorporate a holistic understanding of innovation.

These four substantive design principles were the starting point for the design of eco-innovative business-modelling workshops. The next section shows how they were translated into the workshop prototypes.

4. Developing, Testing and Evaluating the Prototype

4.1. Developing the Prototype(s)

The design-based workshop concept, based on the previously derived substantive design principles aims to develop eco-innovative business models for the identified technical solutions by previous laboratory analyses. Figure 3 provides an overview of the overall workshop concept. To pay tribute to *SDP #1 (stakeholder-centred perspective)*, *SDP #2 (value-centred perspective)*, and *SDP #4 (holistic understanding of innovation)*, the workshop concept is separated into two consecutive sequences. This has three advantages. First, a separation allows for a greater variety of stakeholders and provides room and time for conflicts, colliding interests, discussion, and problem-solving. For a diverse set of participants in both workshop sequences, farmers, company representatives, researchers, students, intermediaries, and policy makers were invited to participate in the workshops. Second, separating the workshop concept into two sequences allows the application of different time horizons. While the first sequence starts with a future-oriented perspective, the second sequence takes the status quo as a starting point. Third, a separation into two sequences reflects Schumpeter's [81] definition of innovation as the first sequence focuses on new ideas (novelty criterion) and the second sequence focuses on how to successfully implement the ideas (implementation criterion).

Overall, the first workshop sequence focuses on the ideation of the business model dimensions *value proposition* and *target markets/customer* according to the business model framework by Gassmann et al. [55]. The key dimensions of sustainability (*SDP* #3) are incorporated into the workshop concept by introducing the participants to the overall project aim and by providing impulses on the meaning of sustainability at the very beginning of the workshop, emphasising the economic, environmental, and social dimension. By introducing the concept of innovation and its different levels and types, the need for a holistic understanding of innovation (*SDP #4*) is emphasised from the beginning to encourage diverging ideas. Keeping *SDP #2* (*value-centred perspective*) in mind, the workshop participants are introduced to a set of trends of the EU food system, such as food processing and consumer trends, based on a trend report by Wepner et al. [83]. Next, the moderators allocate the participants to their respective groups, aiming to achieve a high level of diversity in each group (*SDP #1*), to discuss and derive emerging demands and

customer needs from the trends in the food industry. For the identified demands, the groups are tasked to translate future demands into new product and service ideas, based on the initial laboratory analyses and technological solutions as mentioned in Section 2.1, and to identify potential target customer groups.

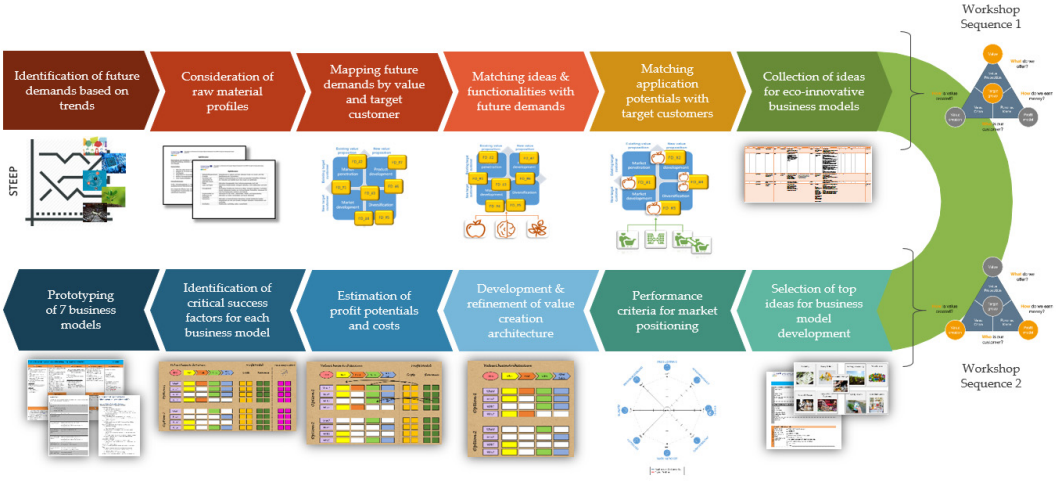

Figure 3. Overview of the Design-Based Workshop Concept (own illustration).

The second workshop sequence is conducted with a broader set of participants at a later point in time and focuses on the realisation of business models, i.e., on the aspects of *value creation* and *value capture* [55]. Again, the workshop participants are introduced to the concept of innovation (*SDP #4*) and encouraged to keep all three dimensions of sustainability (*SDP #3*) in mind throughout the workshop. Building on the results of the first workshop sequence and the overall project aim, participants are asked to evaluate the business model ideas from a future perspective (*SDP #2*) and select the most promising ones in terms of their sustainability potential (*SDP #3*). Each group, made up of a diverse set of participants (*SDP #1*), then specifies its selected business model idea in a step-by-step design sprint with the support of several guiding materials (e.g., BMI Lab cards). The design sprint includes the definition of performance criteria for the positioning on the market compared to competitors and substitutes, the design of the value chain architecture for value creation and delivery, and the identification of potential revenue models for value capture. Lastly, participants are asked to critically reflect on their results and identify critical success factors for the developed business models.

4.2. Testing, Refining, and Evaluating the Prototype(s)

In total, 22 workshops were conducted in Austria, Germany, Slovenia, Italy, and France. Table 1 provides an overview of the conducted workshops. While workshops testing the prototype for Sequence 1 (ideation) focused on a single bioeconomic value chain each (either apples, walnuts, or herbs), workshops applying the prototype of Sequence 2 (implementation) were hosted parallel with two different value chains to allow for synergy and knowledge spill-over effects from a cross-industry setting. In total, the workshop-testing phase was completed with 182 participants from various stakeholder groups:

- Apple, walnut, and herb farmers
- Company representatives (management and employees)
- University staff and R&D organisation representatives
- University students (in their roles as future consumers)
- Intermediaries (e.g., start-up agencies, incubators, business accelerators, industry associations)
- Policy makers

Table 1. Overview of Conducted Workshops.

FIRST WORKSHOP SEQUENCE (HALF-DAY WORKSHOPS)			
#	**Workshop Location**	**Date**	**Value Chain**
1	Innsbruck (Austria)	15 May 2019	Apples
2	Sigmaringen (Germany)	22 May 2019	Walnuts
3	Strahinj (Slovenia)	6 June 2019	Apples
4	Bozen (Italy)	1 July 2019	Herbs
5	Ravensburg (Germany)	1 July 2019	Walnuts
6	Bozen (Italy)	1 July 2019	Apples
SECOND WORKSHOP SEQUENCE (FULL-DAY WORKSHOPS)			
#	**Workshop Location**	**Date**	**Value Chain**
7	Innsbruck (Austria)	10 September 2019	Apples
8	Innsbruck (Austria)	10 September 2019	Herbs
9	Strahinj (Slovenia)	17 September 2019	Apples
10	Strahinj (Slovenia)	17 September 2019	Herbs
11	Waldburg (Germany)	11 October 2019	Apples
12	Waldburg (Germany)	11 October 2019	Walnuts
13	Linz (Austria)	23 October 2019	Apples
14	Linz (Austria)	23 October 2019	Herbs
15	Avignon (France)	24 October 2019	Apples
16	Avignon (France)	24 October 2019	Herbs
17	Sigmaringen (Germany)	8 November 2019	Apples
18	Sigmaringen (Germany)	8 November 2019	Walnuts
19	Nenzing (Austria)	12 November 2019	Apples
20	Nenzing (Austria)	12 November 2019	Herbs
21	Turin (Italy)	15 November 2019	Apples
22	Turin (Italy)	15 November 2019	Herbs

The prototype for Workshop Sequence 1 was tested six times in four countries (i.e., Austria, Germany, Italy, Slovenia) and hosted in the respective national language. Additionally, the prototype for Workshop Sequence 2 was tested sixteen times in five different countries (i.e., Austria, France, Germany, Italy, Slovenia) and hosted in the respective national language as well. For the tests, participant invitations aimed at achieving intra-sequence heterogeneity and allowing inter-sequence continuity. Hence, workshop participants were able to attend two workshops, but not from the same sequence. In the first workshop sequence (ideation), the workshop invitations focused on, but were not exclusive to, younger participants (i.e., future customers) with diverse backgrounds in order to facilitate creative, future-oriented out-of-the-box thinking. In the second workshop sequence (implementation), participants from relevant companies, cooperation partners, industries, and intermediaries were invited in addition to the participants of the first sequence, in order to enrich the innovative ideas with the necessary industry expertise, competences, and networks needed for realization.

The research team critically reflected on the workshop concept and made adjustments to the concept after each iteration. As the research team consisted of members with diverse expertise and backgrounds (e.g., biotechnology, business modelling, industry representation), learnings were drawn from different viewpoints [84]. After changes were implemented, the next workshop was hosted and, again, concluded with retrospective analysis. Data sources used for retrospective analysis and reflection included co-researcher observations, researcher reflection journals, workshop artefacts, and oral feedback rounds with workshop participants [84]. Overall, the main logic of the consecutive workshop sequences and order of the workshop steps, derived from the substantive design principles, remained constant and no fundamental changes were made. However, minor adjustments and changes were made on a procedural level concerning moderation techniques, input and supporting materials, and timing. Tables 2 and 3 provide an overview of procedural changes.

Table 2. Selection of Procedural Changes in the Prototype of Workshop Sequence 1.

Procedural Changes Made	Reasons
Moderation technique: Participants need to be reminded constantly that feasibility should not restrict their creativity in the ideation phase.	Many participants struggled to challenge the status-quo and leave feasibility aside.
Input and supporting materials: Instructions need to be printed and handed out for each step.	Within the workshops, many participants struggled with the newly gained terminology and theoretical concepts. Providing printed materials with key terminology and concepts provided visual support and space for individual notes.
Timing: Allocate extra time for Step 4 to allow the participants to get to know each other before discussing the topic at hand.	Participants voiced their wishes for additional time to get to know each other before diving into the workshop topics.

Table 3. Selection of Procedural Changes in the Prototype of Workshop Sequence 2.

Procedural Changes Made	Reasons
Moderation technique: Steps 7–9 require a constant reminder that the previously selected performance criteria need to be reflected in their elaborations.	The facilitators repeatedly observed that in the course of discussions and research, participants lost sight of their initially defined performance criteria.
Input and supporting materials: Designated research stations were set up with laptops to encourage the groups to conduct quick desk research.	The facilitators observed that participants often forwent significant details, for lack of knowing. When conducting research on their phones, many were distracted by digital interruptions, such as work emails, phone calls, etc.
Timing: Introduce a break before Step 8 to allow for a fresh perspective.	The facilitators observed that participants experienced a low in motivation and stagnation of ideas after Step 7. Thus, a break was introduced to allow for refreshments and informal conversations.

5. Results and Discussion

The study shows two key results. First, Section 5.1 presents the developed and tested workshop concept for the development of eco-innovative business models based on the previously developed substantive design principles. The second main result of this study, a set of general procedural design principles, is proposed in Section 5.2 by discussing the experiences made and lessons learned during the prototyping and testing of the workshop concept.

5.1. Results–Final Workshop Concept

Workshop Sequence 1: The prototype for Workshop Sequence 1 is designed to last a half day and focuses on one value chain (e.g., apple). The workshop venue should contain table islands, covered with paper sheets, that are set up to host 3–4 participants. The execution of the workshop concept requires two moderators, ideally supported by a bio- and food technology expert. All supporting materials are to be printed and distributed in the local language to the participants in the order they are mentioned below. Table 4 outlines the concept for this workshop sequence including information regarding input materials, additional instructional suggestions, and duration of each step. Breaks are excluded in the moderation plan and should be taken as needed.

Table 4. Workshop Sequence 1—Overview of the Final Concept.

Step	Instructions and Activities	Time
/	Preparation: Group formation - Ex-ante assignment of participants to groups based on value chain preference interest/experience/background - Note: Assure interdisciplinary and diverse groups.	/
1	The workshop starts with an interactive introduction of each participant, followed by a short introduction of the overall project and its aims. Next, the moderators set the goals for the workshop and introduce the agenda.	15 min
2	Theoretical input on key terms and concepts: - Innovation, business model, business model innovation, sustainability	15 min
3	Discussion of future trend cards in teams: - Instruction: *Discuss the trend cards in your group and establish a common understanding. What do you associate with these trends in terms of new business models in the food industry and other industries?* - Supporting materials: Laminated trend cards (based on [83]) - Note: If needed, the moderators should name exemplary industries.	30 min
4	Discussion of future customer needs: - Instruction: *What future customer wishes and needs for new products and solutions can be derived from future trends in the food industry and related industries. Each statement should start with "As a customer, I would like to...".* - Note: Feasibility does not matter. Encourage groups to take the future customers' perspective.	30 min
5	Matching ideas and functionalities with future demands: - Presentation of raw material profiles by bio- and food technology expert (*how to read*) - Instructions: *Please take a look at the technical solution/application profiles. Which of the previously identified future customer needs and wishes could be addressed with the technical functions or product ideas?* - Supporting materials: Raw material profiles (based on [85]) - Note: Encourage participants to think in terms of functionalities instead of products.	90 min
6	Categorising identified product and application ideas into market strategy segments: - Instructions: *Please transfer your product/solution ideas and the associated customer need(s) into the prepared product-market matrix. Which of your product and application ideas could also be of interest for customers in other industries/markets facing similar requirements?* - Supporting material: Matrix template - Note: Participants should take the perspective of the apple, walnut, and herb producers.	30 min
7	Matching application potentials with target customers/users - Instructions: *Look at your identified product/application ideas. What could be possible target customers or target markets for each product/application idea from the perspective of the apple/walnut/herbs farmer?* - Note: Participants should be encouraged to take a cross-industry perspective and consider B2C, B2B, and C2C customer groups. No focus on feasibility.	50 min
8	- Pitch and evaluation of team results - Summary of workshop results - Oral feedback/flashlight round - Thanks to all participants! - Outlook/next steps	30 min

Within the context of the AlpBioEco project, the resulting ideas were then adjusted for duplicates prioritised by the bio- and food technology and business model experts in the project consortium in terms of sustainability, novelty, market potential, and technological feasibility. The resulting condensed shortlist of new product and service ideas built the starting point for the second workshop sequence, which combined two value chains to

leverage potential synergies in the business model designs across value chains (e.g., apple and walnut).

Workshop Sequence 2: The prototype for Workshop Sequence 2 is designed to last a full day and covers two value chains (e.g., apples and walnuts). The workshop venue should contain table islands, covered with paper sheets, that are set up to host 3-4 participants each. The workshop concept execution requires two moderators. All supporting materials are to be printed and distributed in the local language to the participants in the order they are mentioned below. Table 5 outlines the concept for this workshop sequence including information regarding input materials, additional instructional suggestions, and duration of each step. Breaks are excluded in the moderation plan and should be taken as needed.

Table 5. Workshop Sequence 2—Overview of the Final Concept.

Step	Instructions and Activities	Time
/	Preparation: Group formation - Ex-ante assignment of participants to groups based on value chain preference interest/experience/background - Note: Assure interdisciplinary groups.	/
1	The workshop starts with an interactive introduction of each participant, followed by a short introduction of the overall project, its aims, and important theoretical concepts. Next, the moderators set the goals for the workshop and introduce the agenda.	30 min
2	Selection of top 5 ideas: - Introduction of idea-clusters by the moderators - Instructions: *Together, please choose 5 top idea leaflets for your respective value chain. Please discuss the ideas in your team to generate a shared understanding and specify the ideas. Which of the following criteria are crucial for choosing the ideas?* - Criteria: market size/market volume, profitability, degree of novelty, competencies available in the region, ecological sustainability, societal sustainability, WOW factor, other - Supporting material: Idea profiles (based on results of Workshop Sequence 1) clustered into main categories (e.g., food and beverages, farming and gardening) - Note: Each idea/profile can be selected only once per workshop (no duplicates). Existing ideas can be modified. All ideas should be viewed from the perspective of today's producers of apples or herbs.	45 min
3	Sprint introduction: - Explaining the sprint steps of value chain architecture - Introduction of guiding questions - Supporting material: A printed overview of sprint steps - Note: Ensure that all participants understand the task and understand how to use the working materials and templates.	15 min
4	Idea specification: - Instructions: *Out of the 5 ideas you selected, for which one would you like to develop a business model?* - Note: All ideas should be viewed from the perspective of today's producer of apples or herbs.	5 min
5	Performance criteria for market positioning: - Instructions: *Which performance criteria can help differentiate the product/solution from the competition? If known: How do the (most) important competitors position themselves in terms of these performance criteria? Use the provided radar chart to illustrate your criteria.* - Performance criteria: Speed, individualisation, price, quality, functionality, sustainability, flexibility, service - Supporting materials: - Research stations with laptops - Radar charts for performance criteria - Glossary for radar charts - Note: Encourage groups to use research stations.	25 min

Table 5. *Cont.*

Step	Instructions and Activities	Time
6	Development of value creation architecture: - Input on value creation architecture with target-group adjusted examples - Instructions: *Which different options for the value creation architecture are feasible to ensure/realise the chosen goals for your idea? Consider various alternatives for the individual steps of value creation. Use the provided BMI Lab cards for inspiration and work aids (e.g., sticky notes).* - Supporting materials - Template for value creation architecture: structured into four phases of value creation (i.e., research and development, production and assembly, marketing and sales, and after-sales services) and sources of value creation (key processes, key resources, and key partners) - BMI Lab cards [86] - Note: Encourage participants to develop different options on how to design the value creation for the selected idea. Additional ideas should be noted on an "Idea Container" flipchart.	60 min
7	- Refinement of value creation architecture - Instructions: *How could the previously determined performance/ differentiation criteria be accomplished through the value creation architecture(s)?* - Supporting materials: - Template for value creation architecture - BMI Lab cards - Research stations with laptops - Note: Encourage participants to conduct research and be as specific as possible.	60 min
8	Estimation of revenue potentials and costs of business model - Instructions: *Where, or during which phases/steps can revenues be generated and how? Where, or during which phases/steps are investments necessary or do costs arise? Which types of revenues/costs? How much?* - Supporting materials: - Template for value creation architecture - BMI Lab cards - Note: Encourage participants to think about profit options (a) in each step of value creation, and (b) in different types of revenue streams.	45 min
9	Identification of critical success factors for each business model - Instructions: *Please review–individually—the value creation architectures and profit models that were developed in your team. What are critical success factors for the value creation architectures? Under which circumstances could the value creation architecture fail?*	15 min
10	Presentation and peer feedback: - Instructions: *Please present your results and open questions in a short pitch to the other teams (max. 3 min). The results of each team will subsequently be discussed with the whole group. Everyone then picks the three value creation architectures that they personally find most convincing/promising by placing your sticky dots.* - Note: Encourage participants to pose critical questions. Multiple points per solution are allowed.	35 min
11	- Summary of workshop results - Oral feedback/flashlight round - Thanks to all participants! - Outlook/next steps	10 min

The final workshop concept was derived at and maintained after half of the workshops were conducted as the following was observed by the researchers: (1) The workshop outputs and artefacts reflected the substantive design principles. (2) The workshop output showed a high level of quality, in terms of feasibility and variety. First of all, feasibility and variety were evaluated based on the adherence of the workshop output to the initially developed substantive design principles, taking the range, amount, and concreteness of ideas into account. Second, the members of the project consortium assessed the workshop

output based on their know-how and expertise. Third, the workshop participants contributed their individual opinions in the oral feedback rounds at the end of each workshop. (3) Participants no longer posed questions for clarification regarding the instructions and supporting materials. (4) A high state of comprehensiveness and efficiency was reached from the perspective of the workshop facilitation. The comprehensiveness of the workshop concept was ascertained by conducting the individual workshops with different facilitators (project consortium partners as well as external ones), in different contexts, in different languages, with and without translators, and with different participants.

Though this study does not aim to analyse the ideated business models themselves, a brief overview of the workshop output is given nonetheless. A total of 440 ideas for new product, service, process, and marketing innovations were ideated in the workshops of Workshop Sequence 1. A set of 26 of these ideas, defined by the project consortium, built the starting point for the conducted workshops of Workshop Sequence 2. In the next phase of the project, seven of these business models were selected for further validation and implementation with bioeconomy companies. These business models centre around gluten-free apple flour, disposable tableware and biodegradable packaging, walnut spreads and flips, herbal pacifiers, Alpine hay seeds, and an overarching digital service platform. Details on the final business models, their pilot testing, and evaluation are linked in the Supplementary Materials of this study.

5.2. Derivation of General Proecedural Design Principles

The study shows that the DBR approach [32,34] served as a suitable and feasible methodological framework for the development of the workshop concept. This is in line with previous studies that considered design elements in the context of general management, business informatics, and organisational research [38,39,42,87]. DBR aims to "*find innovative practical solutions for unsolved problems*" [32] (p. 17) and develop context-sensitive theory in iterative design circles [32,35,43]. Thus, the major goal of DBR is to derive design principles, which serve as general recommendations on how to design the operative process of, in this case, eco-innovative business model development.

The design-based workshop concept presented in this paper is built on two consecutive sequences to support and guide the development of eco-innovative business models. It was iteratively tested and refined by a series of 22 workshops with more than 180 participants from five European countries. Resulting from the development and iterative testing of the concept, a number of conceptual and methodological learnings emerged which are elaborated in terms of procedural design principles in the following sections.

PDP #1: Integrate ideation (what is new, for whom?), implementation (how to make it real?), and exploitation (how to earn money?) perspectives.

This procedural design principle corresponds to *SDP #4*, which postulates a holistic understanding of innovation. 'Holistic' here refers to two aspects. First, it means that innovation according to Schumpeter [81] is not only about novelty. A novelty (invention) only becomes an innovation if it is implemented and increases the competitive advantage of the company. Hence, existing tools and methods which only consider the ideation phase of eco-innovation (e.g., [23,30,31]) do not meet this procedural design principle. Second, the term 'holistic' is linked to the scope of innovation options. While many existing tools and methods are rooted in an engineering perspective, they primarily understand innovation in terms of new products enabled by new technological solutions [22–24]. However, a business model perspective requires a broader understanding of innovation. When it comes to managerial and organisational questions about how to implement a new solution and how to gain competitive advantage, other fields like process innovation, organisational innovation, service innovation, and marketing innovation [82] need to be taken into account.

The designed workshop concept with its consecutive sequences corresponds to this procedural design principle by focusing on the aspect of novelty in the first workshop sequence and focusing on questions of the implementation and competitive advantage in

the second workshop sequence. The required holistic understanding of innovation among the participants and stakeholders is enhanced by providing conceptual input before the respective working phases and using guiding heuristics and visualisations during the tasks (e.g., business model triangle, St. Gallen Business Model Navigator).

PDP #2: Separate the innovation process phases of 'novelty' and 'implementation' in terms of time (temporal separation).

To ensure a best possible value-centred approach (*SDP #2*) as well as a holistic understanding of eco-innovation (*SDP #4*), the proposed workshop concept is characterised by the temporal separation between the working phases of ideation and out-of-the-box thinking (novelty) from the phases of assessment, decision making, and feasibility-checks (implementation). In the workshop concept, this is achieved by dedicating the first workshop sequence to novel demands of existing and future target groups as a basis of novel value propositions for the eco-innovative business model. This is supported by deploying different brainstorming and creativity tools. Thereby, the first ideation-centred workshop sequence resulted in a total of 440 ideas for new product, service, process, and marketing innovations that built the basis for the later business model development. In contrast, the second workshop sequence is primarily dedicated to the question of how to implement such novel value propositions by designing value creation architectures and appropriate revenue models. Thus, the second workshop sequence focuses on managerial and organisational aspects of decision-making and commercial exploitation, which is supported using analytical frameworks for managerial decision-making and value creation design. During this workshop sequence, a total number of 26 eco-innovative business models were successfully developed, of which seven were selected for further implementation with companies in the next project phase.

This procedural design principle is rooted in two strands of the literature. The first one refers to different modes of organisational learning. As proposed by March [88], different organisational learning modes result in different types of novelty. While the exploitation mode of organisational learning is orientated towards reducing variation, maintaining stability, and pursuing efficiency, the exploration mode aims to discover, experiment, and transform. Exploitative learning involves an in-depth application of existing internal knowledge and know-how to achieve overall strategic goals and to improve the efficiency of existing processes and routines in terms of incremental innovation. In contrast, the exploratory learning mode aims to promote the absorption and transformation of new knowledge and ideas while enhancing responses to new or overturned market and user demand, thereby contributing to the implementation of transformational innovations to adapt to environmental dynamics. The exploratory mode of organisational learning thereby aims to achieve higher degrees of novelty.

The second strand of literature is about cognitive modes of problem-solving rooted in creativity research. Guilford [89,90] suggested that creativity is composed of two main ingredients: divergent and convergent thinking. Divergent thinking is the process of coming up with new ideas and possibilities—without judgement, without analysis, without discussion. It is the type of thinking that allows you to free-associate, to 'go big' and to discuss possible new ways to solve difficult challenges that have no single/right/known answer [91]. In contrast, convergent thinking is associated with analysis, judgement, and decision making. It is the process of taking a lot of ideas and sorting them, evaluating them, analysing the pros and cons, and making decisions about how to implement the most suitable idea [91]. Colzato et al. [92] suggested that, given the different characteristics of these two types of meditation, they are likely to induce different cognitive-control states, which again would be likely to affect convergent and divergent thinking in different ways. In particular, divergent thinking would likely require or benefit from a control state that provides a minimum of top-down control and local competition, so that the individual can easily and quickly "jump" from one thought to another in an only weakly guided fashion [93]. Guilford's assumption that convergent and divergent modes of thinking

represent separable components of human creativity has been confirmed by the study of Akbari Chermahini and Hommel in 2012 [94].

Another advantage of this separation is that workshop participants and stakeholders can be purposefully selected according to their preferred "*mode of thinking*" [91] as well as regarding their level of 'representativeness' of different future demands and value-desires. For instance, specific attention was paid in the first workshop sequence to involve stakeholders with different demands and interests as well as members of upcoming generations (e.g., generation Y and millennials), which build the basis for future market segments of eco-innovations.

PDP #3: Assure for stakeholder diversity and plan for additional time to allow for exchange and learning among different stakeholder groups.

This procedural design principle builds on *SDP #1*, which calls for a stakeholder-centred perspective and stakeholder integration in the development process of eco-innovative business models. The results of the conducted workshops show that a higher level of diversity and heterogeneity of the workshop participants turned out as a major success factor for both workshop sequences. During the workshop planning, it has been ensured that every workshop covered all groups of relevant stakeholders by at least one participant. This well-balanced mixture of stakeholders from private industry, society, farming, technological experts, and intermediaries showed richer results in terms of novelty, sustainability, and feasibility of the eco-innovative business models. This is in line with existing the literature on corporate sustainability management that highlights the need for involving different stakeholders and social actors to integrate different aspects of economic, social, and ecological sustainability (e.g., labour rights, gender equality, business principles, general codes of conduct) and to create competitive advantage [95,96].

Additionally, in the second workshop focusing on the implementation of eco-innovative business models, taking a cross-industry perspective turned out to be of enormous value. Cross-industry means that in all workshops of the second sequence, stakeholders of two different value chains or industry perspectives were brought together. As it was highlighted frequently in feedback, participants perceived the cross-industry setting as highly valuable in terms of sharing expertise and exploiting synergies in the design of value-creating architectures and profit models. This is also caused by the fact that different value proposition ideas (e.g., new products, services or processes) from the individual value chains resulted in similar value creation architectures and revenue models at the end. Thus, this procedural design principle is in line with the previous literature about cross-industry innovation [97,98].

To achieve this, a necessary prerequisite in the workshops was to continuously assure a shared understanding of terminologies and concepts across all stakeholder groups by the facilitation team. A careful selection of workshop participants according to their competencies, open-mindedness, and willingness to connect with other stakeholder perspectives was another key to success. Hereby, it is beneficial to rely on local or regional partners (e.g., intermediaries, universities, larger companies) to activate their networks and support in contacting participants. It turned out that higher levels of stakeholder diversity in the workshops required more time resources during the working phases of the workshops to ensure thorough discussion and to allow for multiple learning-loops among the stakeholders compared to single-stakeholder workshops.

PDP #4: Start with future trends and translate them into future market demands to help establish a user- and value-centred perspective.

A major characteristic of eco-innovative business models is that they should consider environmental, social and economic aspects in their way of doing business [13,18]. Although already new technological solutions were given from the previous work package in the research project, the first workshop sequence of the overall workshop concept nevertheless started by exploring and identifying future demands arising from future societal, economical, and ecological trends, instead of putting technology in the centre. This helped

establish a user- and value-centred perspective from the very beginning of the business model development process, which directly links to *SDP #2*. The value-centred perspective was supported by workshop facilitation in terms of tools like future trend cards developed based on existing studies about future trends and megatrends. Only in the second step were the given new technological solutions from the previous work package matched with the identified future demands to discuss which future demand or value proposition could be achieved by which technological option. Interestingly, this value-centred approach involving multiple stakeholder interests resulted in many eco-innovative business models using a collaborative design of value creation, for instance by using horizontal and vertical integration of stakeholders [99].

PDP #5: Plan for iterative learning loops and reflection cycles.

As the research team consisted of members with diverse expertise and backgrounds (e.g., biotechnology, business modelling, farming, intermediaries), learnings were drawn from different viewpoints. After changes were implemented, the next workshop was hosted and, again, concluded with retrospective analysis. Data sources used for multi-sided retrospective analysis and reflection included co-researcher observations, researcher reflection journals, workshop artefacts, and oral feedback rounds with workshop participants [84]. The hereby stimulated "*second-loop learning*" [100,101] turned out as another important design principle. Second-loop learning involves questioning the assumptions about objectives, ways of discovering and inventing new alternatives, objectives, and perceptions, and ways of dealing with unforeseen problems. The goal is to extract tacit knowledge from individuals working with the procedure and convert it to explicit knowledge that can be made available to other stakeholders and organisations. Hence, individual and collective second-loop learning is a prerequisite for critical reflection, deeper understanding, and dealing with failure [102,103]. Particularly, when dealing with eco-innovation, learning loops are important to reflect and, if needed, adjust the fit of the procedural design principles to the underlying substantive design principle of sustainability (*SDP #3*). Hence, this final procedural design principle can be regarded as a 'meta' design principle when dealing with complex, multi-stakeholder, and multi-dimensional topics as eco-innovative business models.

Besides these five explicit procedural design principles, some additional learnings occurred during the prototypic testing of the workshop concept which are summarised below:

- The workshop iterations of the first workshop sequence (ideation) showed a strong initial focus on product and service innovation. Hence, additional facilitation efforts were needed to enlarge the participants' perspective on other fields of innovation like technical, organisational, and marketing innovation. This might be rooted in the fact that many people associate innovation primarily with new products or services that become directly visible in the market. To meet the *SDP #4* of eco-innovative business models, however, this perspective is too narrow as eco-innovation requires holistic, hybrid bundles of products, services, processes, and marketing to provide the demanded value for different stakeholders.
- Many of the developed eco-innovative business models are characterised by a dominant role of ecological and economical sustainability while the dimension of social sustainability played a secondary role. This phenomenon has already been described by Abidin [104]. One reason, which was also mentioned in the feedback loops, could be that social sustainability is cognitively linked to being responsible for employees. While this is in line with the triple bottom line by Elkington [61,62], many participants did not consider this as part of a business model, but rather as a responsibility of the company's human resource management. As the external perspective of social sustainability in terms of addressing societal needs was already defined by the project context (increasing resource efficiency), many participants might have neglected this perspective during the business model development process. Nevertheless, it is recommendable to take this issue into account by making stakeholders more aware of social sustainability elements right from the beginning to pay tribute to *SDP #3*

(holistic understanding of sustainability). A tool that might be helpful here is the value-mapping tool [25,105].

- Finally, for the second workshop sequence about the design of value creation architectures and revenue models, it would have been beneficial to have more participants with expertise in the fields of economic feasibility and pricing strategy. Consequently, the revenue models and cost structure of many eco-innovative business models were built on the basis of estimations and assumptions. Because the business models were further validated and implemented by the subsequent work package in the project, that was not a major concern. However, when applying the proposed development procedure for eco-innovative business models in a company setting, this point should be considered for the second workshop sequence to optimally implement *SDP #4*.

6. Conclusions

Eco-innovative business models come with specific requirements for their development process. These requirements originate in the particular nature of sustainable and/or socially responsible innovation. Despite the considerable number of previous studies focusing on the concept and development of eco-innovation and eco-innovative business modelling, the literature about how to translate the conceptual requirements of eco-innovation into an operative procedure that guides and facilitates companies in turning new technological solutions into eco-innovative business models is still scarce. The paper directly addressed this research gap with its underlying research questions: (1) How can substantive design principles of eco-innovative business models be transferred to and integrated into a design-based workshop concept on the operative level of business model innovation? (2) What are procedural design principles of tools and methods for eco-innovative business model innovation?

These research questions are elaborated by applying a DBR approach to the field of business model development, following the attempts of Österle et al. [87], Osterwalder and Pigneur [42], and van Aken [38,39] to consider design elements too. The first research question is answered by the proposed design-based workshop concept, which transfers substantive design principles of eco-innovative business models derived from the previous literature into an operative workshop concept on the firm level. The workshop concept was developed, iteratively tested, and refined along the research project "Alp-BioEco" funded by the Interreg Alpine Space programme of the European Commission (2018–2021). The testing and validation phase occurred in a series of 22 workshops with more than 180 participants covering all relevant stakeholder groups from five European countries accumulating to a total of 93 workshop hours. By applying the workshop concept, workshop participants explored a total number of 440 ideas for eco-innovative product, service, process, and marketing innovation, which built the basis for the development of 26 eco-innovative business models at the end of the conducted workshop series. Seven of these 26 business models were selected for further validation and implementation with bioeconomy companies in the next phase of the project. When this paper is published, two-thirds of these eco-innovative business ideas are likely to be successfully implemented in the market. Based on the development and iterative testing of the design-based workshop concept, a number of conceptual and methodological learnings emerged which are presented in terms of procedural design principles answering the second research question. Companies and organisations can regard these procedural design principles in terms of general recommendations of how to design workshops for developing eco-innovative business models.

With its results, the paper contributes to the literature on operative innovation management and eco-innovative business model innovation. It advances the understanding of the procedural design of business model development processes for eco-innovation. Thereby, it directly addresses the articulated demand for new, tested, and feasible tools and methods to guide eco-innovation by companies [4,33]. With this study, we contribute to research and practice in four ways. First, we develop a design-based workshop concept for

constructing eco-innovative business models. Second, we iteratively test this workshop design in an international, cross-industry setting within the bioeconomy sector in the Alpine space, a sector frequently neglected in management literature. Third, applying a design-based approach, we derive procedural design principles that can be transferred to participatory business-modelling workshops in other contexts. Fourth, we offer an initial procedural framework to facilitate the translation of technological solutions into applicable eco-innovative business models and hope to nudge the academic community to start a wider debate about the transfer of conceptual requirements of eco-innovation to the level of operative implementation in the market.

Furthermore, the identified procedural design principles support companies, decision-makers, and stakeholders in enhancing their sustainability and innovation orientation by providing them with a design-based workshop concept that can be helpful in the process of developing and implementing eco-innovative business models. The results will hopefully contribute to demonstrate various design options for eco-innovative business models and deliver practical inspiration for companies on how to translate social and environmental value creation into economic profit and competitive advantage for the firm to build the "*business case for sustainability*" [14–16].

As with every study, this paper is not without limitations. First, due to the overall project context in which the development was embedded, the proposed design-based workshop concept is strongly driven by the perspective of profit-oriented companies as the main actor of eco-innovation. Although the developed business models meet all the substantive design principles of eco-innovation, they are all more or less designed for implementation by a company. Therefore, forms of sustainable or eco-innovative business models driven by societal stakeholders (e.g., grassroot movements, civil citizenship) have not been taken into account. This is important to mention because many tools used to facilitate the workshop concept are based on the profit-oriented perspective of the single company. In such a case, the workshop concept needs further extension by adding novel tools addressing society-driven eco-innovation. Second, the workshop concept was developed by the premise of commercialising new technological solutions from bioeconomical research into eco-innovative business models. This is due to the given work package architecture of the overall research project which could not be influenced by the authors. While the proposed workshop concept is not technology-centred but value-centred, it nevertheless had to account for the circumstance that at some point in the business modelling process, identified future demands and value propositions had to be matched with the given technological solutions. This is a quite typical setting in existing companies. Therefore, we believe that the workshop concept works particularly well in such settings. However, in an ideal world, it would have been beneficial from the value-centred perspective of eco-innovation if the exploration of stakeholder demands and new technological options were organised simultaneously and iteratively, following the principle of design-based development processes. Finally, it was not possible in the given project context to apply and test the workshop with stakeholders outside the European bioeconomy sector. For this reason, the developed and tested workshop concept presented in this paper can only be a first attempt to progress the development of subsequent procedures, methods, and tools for taking eco-innovation to the road. Hence, it would be interesting for further research to explore whether the workshop concept is transferrable to other regions, industries, or fields of eco-innovation, and if so, to what extent its procedural design principles, methods, and tools require adjustments and extensions.

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