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A model for the development of sustainable innovations for the early phase of the innovation process

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Abstract

Current industrial development is faced by the global challenge to meet the continuously growing demand for capital and consumer goods in emerging countries while simultaneously ensuring a sustainable industrial growth in the social, environmental and economic dimension. By means of market dynamics of cooperation and competition in global value creation and knowledge networks, innovations geared towards sustainability can be essential drivers for realizing a sustainable development. The targeted development of new sustainable innovations is consequently a key activity in order to move towards sustainable industrial growth. This paper will describe a model for the development of sustainable innovations. The model focuses on idea generation in the early phase of the innovations process, addressing the fuzzy front end of innovation. In this context, specific goals and principles of sustainable development are integrated into a problem-solving approach. This integrated approach is subsequently used as a foundation for the targeted development of sustainable innovations in the frame of a workshop concept.

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1. Introduction

Global development is currently coined by some major trends such as an increasing socio-economic inequality, migration and displacement, urbanization, climate change and environmental degradation, which are leading our

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global community along a sustainably irresponsible development path [1,2]. Moreover, these trends bare the risk of significant incidents on a global and regional level, for instance the occurrence of extreme weather events, fiscal crises, or profound social instability [1,2]. In order to cope with these global trends and to foster a Sustainable Development, the United Nations have passed the so called UN Sustainable Development Goals (SDGs) [3]. These goals were adopted by 193 countries during the 2015 UN General Assembly, and can serve as a basis for generating new technological innovations. By means of market dynamics of cooperation and competition in global value creation and knowledge networks, technological innovations geared towards sustainability can be essential drivers for realizing a sustainable development. The targeted development of new sustainable innovations is consequently a key activity in the push towards sustainable industrial growth. This paper will describe a model for the development of sustainable innovations. The model focuses on idea generation in the early phase of the innovation process, addressing the fuzzy front end of innovation with reference to Sustainability Drivers and Innovation Drivers.

2. State-of-the-Art

2.1. Sustainable Development

The concept of Sustainable Development was first clearly defined in 1987, in the Bruntland Report, as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" [4]. Although now a widely used and accepted term, the concept and practice of sustainable development still maintains a significant degree of ambiguity, which has led to a variety of different interpretations [5]. Since the conception of this idea of Sustainable Development, its interpretations have been largely dominated by three main approaches: status quo, reform and transformation [6]. The status quo approach to sustainable development argues that, while changes in the environment and society are necessary, our current political and economic institutions can achieve the necessary results without any alterations [6]. Supporters of such an approach see growth, and specifically economic growth, as part of the solution for Sustainable Development, as well as business, private ownership, improved management and new technology [6]. The reform approach believes that significant changes in current policy and lifestyle will be necessary in order to achieve Sustainable Development [6]. Supporters of this policy generally argue that technology, increased energy efficiency, market modification and regulation such as the internalization of environmental costs, and increased democracy can solve the problems that Sustainable Development seeks to tackle [6]. The transformation approach is the most radical of the three, arguing that our environmental and societal problems are caused by the fundamental structures of society, such as our political and economic institutions, and that major changes to these structures are necessary to overcome the current challenges [6]. Proponents of this approach generally believe that the solution lies in involving marginalized groups outside of the normal centers of power, such as indigenous, poor, working class and women. They draw a strong link between social equity battles and environmental concerns [6].

Another framework used to differentiate between conflicting interpretations of Sustainable Development is that of weak versus strong sustainability. In this context, the definition of Sustainable Development can be reframed as development that maintains "the capacity to provide non-declining per capita utility for infinity" [4]. These two opposing paradigms, weak and strong sustainability, differ mainly in how they believe this capacity must be maintained [4]. Weak sustainability holds that the total net investment of capital must be greater than zero, without differentiating between different types of capital, and hence relies on the assumption that natural capital is unlimitedly substitutable [7]. As long as there is greater investment in man-made capital than loss of natural capital, Sustainable Development is achieved [7]. In contrast to weak sustainability, strong sustainability holds that natural capital is fundamentally non-substitutable [7]. Under this paradigm, investment in other forms of capital, such as man-made capital, cannot make up for the loss of natural capital [7]. Hence, to maintain a total net investment greater than zero, any degradation of natural capital must not exceed its regenerative capacity [7].

A common thread that links these different interpretations of sustainability is the three focus areas, often referred to as the three pillars of sustainability: the environment, society, and the economy [5,6]. However, specific views on the relative importance of each factor, and the ways in which they interlink, are varied. For example, some may model these factors in a Venn-type diagram, with three separate but connected rings, implying a certain degree of independence and trade-off between the three pillars [6]. An alternative model is that of three concentric circles, the

outermost circle being the environment, within which the middle circle, society, exists, and within society lies the innermost circle, the economy. This model implies that the pillars cannot exist separately, but are interconnected, and dependent upon each other [6].

Given the many different interpretations of Sustainable Development, how can one define the state of the art, or best practice, when looking to develop sustainable inventions? While it is evident that pinpointing one definition or aim of sustainable development is difficult, and possibly not even desirable, insight can be gained from analyzing trends over time, as more is discovered about what this overarching goal of Sustainable Development may necessitate.

At the beginning of its conception, views and actions on sustainable development were largely dominated by a status quo, reform, or weak sustainability paradigm. In 1987, the Bruntland report argued that economic growth would be an important part of Sustainable Development. It also argued for integrating environmental concerns into decision making, increasing resource efficiency, developing environmentally sound technology, full environmental cost accounting and improved risk management systems. This indicates an approach somewhere between status quo and reform. During this time, efforts towards Sustainable Development were generally focused around two main principles – cooperation, which includes information sharing, participation and transparency, as well as efficiency, which includes streamlining, intensification and specialization [8]. These principles can serve to guide companies in improving their environmental management practices, but do not produce significant changes in the environment and society, or our current societal institutions.

Today, however, approaches are shifting more towards the transformation, and strong sustainability, side of the spectrum. This can be seen in the recent UN 2030 sustainable development goals, which emphasize the importance of the interconnected nature of society and the environment, strengthening the roles of less powerful communities and changing our economic patterns [9]. There is increasingly widespread recognition of the importance, and non-substitutability, of ecosystem services such as climate regulation, erosion control and nutrient cycling, which cannot be replaced by man-made capital [11]. Even large institutions such as the World Wildlife Fund and the World Economic Forum recognize the need for significant institutional changes, such as developing a metric for success other than GDP in order to account for environmental conditions and quality of life [8, 9]. Further, there is increasing realization that improving cooperation and efficiency while otherwise maintaining a business-as-usual approach is not a sustainable solution. Rather, a new set of principles, which challenge society's standard methods of production and consumption and promote the transition from a linear, extractive economy to a circular, regenerative economy, are necessary for Sustainable Development [8, 11].

2.2. Sustainable Innovations

The discussion about Sustainable Development also requires a closer look at the question of how to achieve this massive transition towards a new global paradigm. As mentioned, the world and our global society require a shift towards a more responsible treatment of environmental, social, and economic capital. For this reason, new ideas and innovations must be created.

The concept of innovation in our present understanding is symbolically represented as society's "engine of growth" [12], illustrating the strong economic orientation of the concept of innovation. This characteristic has been solidified notably by the treatises of Joseph Schumpeter at the beginning of the last century, who defined innovation as "realisation of new combinations" and that this is "the overwhelming fact in the economic history of the capitalist society" [13]. Since then, the concept of innovation had led to a variety of possible definitions. For instance, Edison et al. identified 41 possible definitions for this term [14].

Nevertheless, the core characteristic of the term of innovation can be seen in the origin of the Latin verb of "innovare", which can be translated as "renew". Thus, innovation can be understood as "renewal". Renewals are mandatory not only to drive the engine of our economy, but rather to keep the engine of our planet running. Therefore, the combination of sustainability and innovation is indispensable to realize new combinations, which can lead to an innovation process tackling the current sustainability challenges. Nidumolu et al. described sustainability as the relevant key driver for innovation in the 21st century [15].

The expressions for combining innovation and sustainability include sustainable innovation, sustainability-driven innovation and eco-innovation. The concept of eco-innovation was firstly defined by James as "new products and processes which provide customer and business value but significantly decrease environmental impact" [16]. Complementary to this, the OECD defined eco-innovation as "the production, assimilation or exploitation of a novelty in products, production processes, services or in management and business methods, which aims, throughout its lifecycle, to prevent or substantially reduce environmental risk, pollution and other negative impacts of resource use (including energy)" [17]. In this context, the implementation of eco-innovations can address technological, organizational, social and institutional levels and involves all three pillars of sustainability [18]. Sustainability-driven innovation is defined according to a report from Arthur D. Littles as “the creation of new market space, products and services or processes driven by social, environmental or sustainability issues." [19]. The term sustainable innovation was defined by Horbach in the context of Sustainable Development as following [20]: “Sustainable innovations not only comprise the environmental dimension but also economic, social and institutional aspects. They improve the realization of the aims of a sustainable development and represent a subset of all innovations." In conclusion, the aforementioned terms are strongly based on the same understanding and are focused on a holistic view of sustainability.

The innovation process itself can be divided into several phases, including sub-processes, from the generation of ideas, to developing the invention, and up to the diffusion process [21]. It can be described by a multitude of different process models [22,23,24]. Cooper describes the innovation process with his commonly used Stage Gate Model covering five stages. This model is determined as a sequential process chain with precise milestones for the innovation process marked by so-called gates [22]. Due to the continuously decreasing timespan of innovation cycles, the model was lately adapted to the current understanding of innovation as a process with a stronger orientation towards the customer. Furthermore, Cooper identifies an initial starting point for any innovation in his process model, which he determines as the discovery and idea generation phase [25]. The established term for this phase is the so-called fuzzy front end of innovation (FFE). This is defined by Koen et al. as “[...] those activities that come before the formal and well-structured New Product and Process Development (NPPD) or Stage Gate process. Even though there is a continuum between the Front End of Innovation (FEI) and the NPPD, the activities in the FEI are often chaotic, unpredictable and unstructured” [26]. The FFE process is the first prerequisite for any innovation and addresses the generation of ideas [27]. Furthermore, the consideration of this phase has a decisive influence on the quality of innovation [28]. In the past, the scientific focus was predominantly on sustainable product design and thus on the NPPD process [29]. Consequently, it is now necessary to look more closely at the question of how sustainability values can be fostered throughout idea generation during the early phase of the innovation process. Charter writes in this context: "Environmental considerations may be included early on in the idea generation stage as a stimulus to new or "out-of-the-box“ thinking and/or it can be used as part of a conceptual refinement process. Inclusion of environmental aspects at this stage has significant potential to reduce life-cycle impacts." [30].

Every FFE process starts with an initiative based on creative observation and idea initiation. The impulse for an idea results from the deviation between the expectations of the initiator and an observed state. This leads to the intention to close this observation gap [27]. To do so, the process of analyzing the gap and the generation of an exact problem definition should precede [31]. This is followed by the generation of solution ideas. Subsequently, the FFE process is completed by assessing and selecting a most suitable solution idea. The overall process is based on an iterative procedure [29].

In conclusion, the initiation phase of sustainable innovations, with its strong problem-solving approach, must be taken into account in particular. Gassmann & Sutter already give an initial insight into the formability of the initiation phase of the innovation process: "The early stages [...] require creativity and require a lot of patience. In such an environment, leadership means setting a vision, creating guard rails and leaving the detail work to the creative workforce. [...] The later phases of innovation are to lead more than the early stages, as the demand for creativity decreases and the implementation becomes more important." [translated from 23].

3. Development of sustainable innovations during the early phase of the innovation process

Based on the different concepts explained in section 2, a model has been developed (Figure 1) which covers the early phase of the innovation process and consists of innovation drivers, the FFE process, and sustainability drivers. The process steps in the model should not be considered as a rigid sequence but rather should be seen as an iterative process towards a solution idea. This concept is based on the assumption that a human-induced process can be ideally obtained in such an iterative way, since it follows the natural problem solving behavior of humans. The iterative approach also enables the possible reorientation of the solution finding process and allows the ex post integration of new relevant aspects. Innovation drivers have been identified for positively stimulating the FFE process. In this context, closer investigations have been carried out for three elementary drivers of the early phase of innovation: creativity, motivation and knowledge. In addition, the entire FFE process is flanked by sustainability drivers, which support the FFE process on different levels. These levels can be described as sensitization, identification, inspiration and evaluation. The systematic stimulation of these levels during the execution of the process steps and in connection with the innovation drivers describes the fundamental methodology for creating new sustainable solution ideas or inventions.

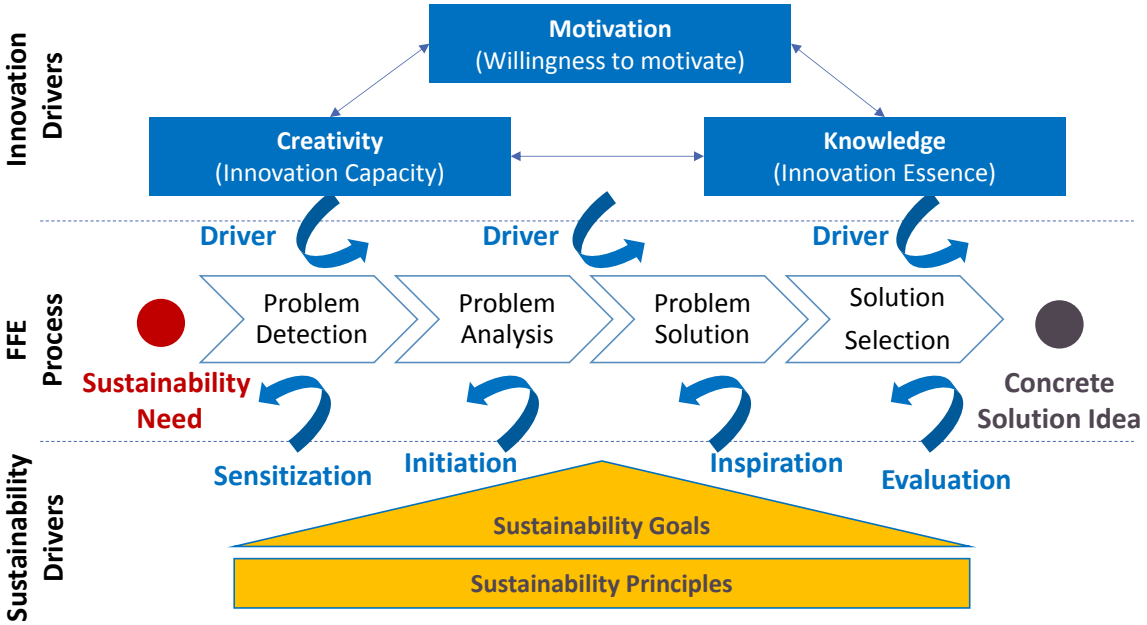

Fig. 1. Model for the development of sustainable solution ideas.

The development of an innovation can be outlined as the process of finding a new solution idea for an existing problem. Hence, the FFE process described within the model is based on a problem-solving approach for the early phase of the innovation process. The initiating moment of this process is the triggering impulse in which the individual becomes aware of a problem. This step is described by the problem detection phase. During this step, the problem is revealed by examining the deviation between a desirable state and an actual state. This activity is strongly related to a creative observation performed by the innovator. In the present model, this creative observation refers to the deviation between an unsustainable basic state and a sustainable ideal state. However, the observation is initially based on a corresponding sustainability need determined by the observer. This sustainability need is the impulse used to identify the relevant problem, which needs to be solved. The result of this first process step is a description of the initial problem situation. This process step is then followed by the phase of problem analysis. In this step, the identified problem is firstly analyzed in depth. The initial, apparent problem does not necessarily have to be the core problem to be solved in the end. The aim of this step is to identify the different causes for the problem

and, if necessary, divide the problem into sub-problems. The problem analysis phase is not intended to provide solutions for the problem, but rather to prepare and initiate the solution finding process in a targeted manner. The phase of problem analysis is completed with an exact description of the problem. For subsequent processing, this description should include both the positive identification of the question to be solved as well as the important assumption and characteristics of the problem. Additionally, a defined ideal or target state should be described during the problem analysis. The final aim of this process step is to prepare a problem letter, which summarizes all findings and aspects of the problem definition, situation and targets. After analyzing the problem, it is necessary to elaborate alternative solutions for realizing the ideal or target state. These activities are covered by the problem solution step. This step essentially focuses on the creative solution finding applied by the innovator. The step is completed with the determination of possible solution alternatives. The final step of the FFE process addresses the selection of the most suitable solution, or of various suitable solutions for the specified problem [27]. These solution ideas then can be transferred and implemented as starting point for subsequent development processes such as the New Product and Process Development. In this context, the difficulty is to describe an initially abstract solution idea and its contribution to realizing the ideal state. In this sense, the solution selection phase also contains the assessment of solution ideas in terms of their contribution to a Sustainable Development. The difficulty of this assessment is demonstrated by the example of renewable energies in the following: renewable energies have a positive impact on the resource and environmental policy of a region, but they are also competing with agriculture in terms of the land use [32]. Therefore, sustainability assessments of the new solution should only be applied 'with reservation' since certain sustainability impacts of a solution may not yet be known [32]. Thus, the assessment process should be seen as continuous and iterative. Often, new information and changing assessment parameters must be considered during the entire process of developing an innovation [33].

For supporting the FFE process, the three innovation drivers creativity, motivation and knowledge have been identified and derived from the component model of creativity [34,35]. These factors can positively stimulate the creative process and thus the innovation process in its early phase [35,36]. In this regard, creativity is one of the key drivers for initiating and shaping the early phase of the innovation process [23]. Creativity can also be described as the innovative force [24]. Knowledge is important for ensuring performance during the creative process and can be described as innovation’s essence. As a result, the mobilization and useful application of individual knowledge is an essential activity for opening up new paths for innovation [27]. The creative process in turn leads to the formation of new knowledge [37]. Motivation is the third innovation driver. In order to call up the complete potential of the other two divers, creativity and knowledge, individual motivation should be stimulated. Consequently, motivation in the context of the innovation process can also be described as the willingness to innovate [24,36]. A successful FFE process can only be performed through the effective integration of all three drivers. The more these drivers are stimulated and exhausted, the more efficiently the overall FFE process can be run. Moreover, they support the realization of higher quality results for the solution idea.

In order to develop sustainable innovations, the model in Figure 1 integrates specific Sustainability Drivers. Sustainability Drivers influence the FFE process at four stages: Sensitization, Initiation, Inspiration, and Evaluation. Sensitization introduces the concept of Sustainable Development as a starting point for raising the awareness about a relevant sustainability need. During the subsequent Initiation stage, the problem-solving process for finding a solution is initiated by considering specific goals, trends, risks, and challenges related to Sustainable Development. Additionally, the FFE process is complemented by the Inspiration stage. Sustainability principles, e.g. sufficiency, consistency, efficiency, and participation, and sustainability-related methods such as bionics, can serve as possible inspirations for conducting the problem solving process. The assessment of solution ideas by applying sustainability criteria ensures the development of a sustainable invention. This assessment is conducted within the Evaluation stage.

For a proof of concept, the model for the development of sustainable solution ideas was transferred into a concrete workshop concept. For this purpose, different creativity methods supported each phase of the FFE process. Methods applied for the problem detection phase included Mitsubishi Brainstorming, 6-Thinking-Hats, or 5-Why-Method. Ideality, Stretch Goals and Synectic are methods which have been applied for the problem analysis phase. The problem solution phase was carried out by using Storyboarding or the 635-Method as supporting methods. A first trial workshop showed that the early phase of the innovation process can be controlled despite its fuzzy characteristic.

4. Summary and Outlook

A model for the development of sustainable innovations during the early phase of the innovation process was presented. The proposed model consists of three main elements: Innovation Drivers, FFE process, and Sustainability Drivers. It allows handling the fuzzy environment during the idea generation phase for a new innovation. The output of the model is a concrete solution idea for a sustainable invention. The sustainable invention must be subsequently transformed into a competitive innovation by the integrated development of a product and business model in an environment of extreme uncertainty [38]. The so-called Diamond Model, which is outlined in Figure 2, provides a methodology for this purpose [38]. The Diamond Model is based on a highly iterative systems engineering approach for developing a customer solution on the basis of the solution idea. The customer solution represents a detailed and validated business model with a related and fully designed and tested product. By means of market dynamics of cooperation and competition in global value creation and knowledge networks, the customer solution based on a sustainable idea can be essential drivers for moving towards global Sustainable Development. Consequently, the proposed model for the development of sustainable innovations in connection with the Diamond Model can be used as a development paradigm for contributing to the realization of the UN Sustainable Development Goals through the target-oriented development of new technologies.

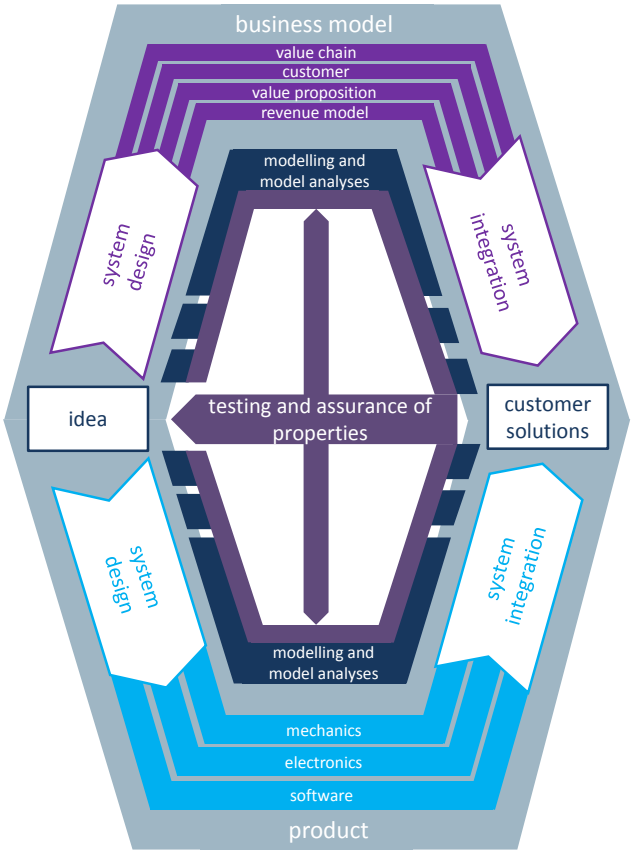

Fig. 2. Diamond Model for the integrated development of the business model as well as of the product [38]

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References

[1] World Economic Forum (WEF), Global Risks 2015, 10th Edition, 2015.
[2] World Economic Forum (WEF), Global Risks 2016, 11th Edition, 2016
[3] United Nations (UN), Sustainable Development Goals, http://www.un.org/sustainabledevelopment/sustainable-development-goals, 2016.
[4] World Commission on Environment and Development (WECD), Report of the World Commission on Environment and Development: Our Common Future, New York, 1987.
[5] R.W. Kates, A.A. Leiserowitz, T.M. Parris, What is sustainable development? Goals, indicators, values, and practice, Environment(Washington DC), 47(3), pp. 8-21, 2005.
[6] B. Hopwood, M. Mellor, G. O'Brien, Sustainable Development: Mapping Different Approaches, Sustainable Development 13, pp. 38–52, 2005
[7] E. Neumayer, Weak versus strong sustainability: exploring the limits of two opposing paradigms, Edward Elgar, 2003.
[8] T. Pricen, Principles for Sustainability: From Cooperation and Efficiency to Sufficiency, Global Environmental Politics 3, pp. 33–50, 2003.
[9] United Nations Environment Programme UNEP, Agenda 21, www.unep.org/documents.multilingual/default.asp?documentid=52, 2011.
[10] R. Constanza, The value of the world's ecosystem services and natural capital, London, 1997.
[11] World Wildlife Fund (WEF), Living Planet Report 2014: Species and spaces, people and places, 2014.
[12] P. Trott, Innovation management and new production development, Prentice Hall Financial Time, 3. ed. edition, 2005.
[13] J. Schumpeter, Theorie der wirtschaftlichen Entwicklung, Duncker & Humblot, Berlin, 1912.
[14] H. Edison, A. Nauman bin, R. Torkar, Towards innovation measurement in the software industry, The Journal of Systems and Software 86, pp. 1390–1407, 2013.
[15] R. Nidumolu, C.K. Prahalad, M.R. Rangaswami, Why sustainability is now the key driver of innovation. Harvard Business Review, (September):56–64, 2009.
[16] P. James, The sustainability circle: a new tool for product development and design, The Journal of Sustainable Product Design, (2), pp. 52–57, 1997.
[17] Organisation for Economic Cooperation and Development (OECD), Sustainable manufacturing and eco-innovation: Framework, practices and measurement, Synthesis report, 2009.
[18] K. Rennings, Redefining innovation – eco-innovation research and the contribution from ecological economics, Ecological Economics, 32(2), pp. 319–332, 2000.
[19] A.D. Little, How leading companies are using sustainability-driven innovation to win tomorrow's customers, Arthur D, Little Innovation High Ground Report, 2005.
[20] J. Horbach, Indicator Systems for Sustainable Innovation, Sustainability and Innovation, Physica-Verlag Heidelberg, Heidelberg, 2005.
[21] I. Pufé, Nachhaltigkeitsmanagement, Pocket-Power, Hanser, München, 2012.
[22] R.G. Cooper, Winning at new products: Accelerating the process from idea to launch, Addison-Wesley, Reading, Mass., 2. ed. edition, 1993.
[23] O. Gassmann, P. Sutter (ed.), Praxiswissen Innovationsmanagement: Von der Idee zum Markterfolg, Hanser Verlag, München, 3., 2013.
[24] N. Thom, Innovationsmanagement. Die Orientierung, published by Schweizerischen Volksbank, Bern, 1992.
[25] R.G. Cooper, What's Next?: After Stage-Gate: Progressive companies are developing a new generation of idea to launch processes. Research Technology Management, 57(1), pp. 20–31, 2014.
[26] P. Koen, G. Ajamian, R. Burkart, A. Clamen, J. Davidson, R. D'Amore, C. Elkins, K. Herald, M. Incorvia, A. Johnson, R. Karol, R. Seibert, A. Slavejkov, K. Wagner, Providing Clarity and a Common Language to the "Fuzzy Front End", Research Technology Management, 2001(March), pp. 46–55, 2001.
[27] J. Hauschildt, S. Salomo, Innovationsmanagement, Vahlens Handbücher der Wirtschafts- und Sozialwissenschaften, Vahlen, München, 5. edition, 2011.
[28] B. Schindlholzer, Methode zur Entwicklung von Innovationen durch Design Thinking Coaching, Dissertation, Universität St. Gallen, 2014.
[29] N.M.P. Bocken, J.M. Allwood, A.R. Willey, J.M.H. King, Development of an eco-ideation tool to identify stepwise greenhouse gas emissions reduction options for consumer goods, Journal of Cleaner Production, 19(12), pp. 1279– 1287, 2011.
[30] M. Charter, U. Tischner (ed.), Sustainable solutions: Developing products and services for the future, Greenleaf Pub, Sheeld, U.K, 2001.
[31] L.A. Allen, The Management Profession, McGraw-Hill series in management. McGraw-Hill, New York, 1964.
[32] A. Grunwald, Technikfolgenabschätzung: Eine Einführung, volume N.F., 1 of Gesellschaft - Technik - Umwelt. Ed. Sigma, Berlin, 2002.
[33] D. Vahs, R. Burmester, Innovationsmanagement: Von der Produktidee zur erfolgreichen Vermarktung, Praxisnahes Wirtschaftsstudium, Schäer-Poeschel, Stuttgart, 2005.
[34] T.M. Amabile, Motivating creativity in organizations: On doing what you love and loving what you do, California management review 40, pp. 39-58, 1997.
[35] T.M. Amabile, Creativity in context: Update to The social psychology of creativity, Westview Press, Boulder, 1996.
[36] D.E. Krause (ed.), Kreativität, Innovation und Entrepreneurship, Springer Gabler, Wiesbaden, 2013.
[37] H.-J. Bullinger (ed.), Wettbewerbsfaktor Kreativität: Strategien, Konzepte und Werkzeuge zur Steigerung der Dienstleistungsperformance, Gabler, Wiesbaden, 2000.
[38] T. Stock, G. Seliger, Methodology for the Development of Hardware Startups, Advanced Materials Research, vol. 1140, 2016.