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A critical review of approaches available for design and innovation teams through the perspective of sustainability science and system innovation theories

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ABSTRACT

Sustainability is a system property; therefore, products/services/technologies/organisations cannot be sustainable on their own but they may be elements of sustainable systems. In addition, to achieve sustainability, there is a requirement for transformation of socio-technical systems which fulfil certain social functions such as energy, mobility and food. The theoretical and practical approaches proposed so far in the broad field of design and innovation for sustainability have not satisfactorily addressed system level changes. This paper provides a critical review of approaches targeting different phases of design and innovation processes. The strengths/shortcomings of these approaches are analysed based on the criteria developed by integrating insights from sustainability science and system innovation/transition management theories. Based on the critical review, a future research agenda is suggested in following areas: exploration of synergies between existing approaches/tools/methods, development of a theoretical framework for design and innovation for sustainability with references to system innovation and transition management theories, and, development of new approaches/tools/methods for the use of design and innovation teams.

1. Introduction

To achieve sustainability, there is a requirement for transformation of socio-technical systems which fulfil certain social functions such as energy, mobility and food. Companies should align their innovation strategies with on-going and expected sustainability transitions to respond the new business environment created by depleting resources, ecological thresholds, changing economic and demographic conditions (Gaziulusoy et al., 2013; Loorbach and Wijsman, 2013; Rockström et al., 2009). In the past years, researchers globally but especially in the European Research Area have generated significant amounts of knowledge on the theoretical and practical aspects of system innovations/transitions. Through cases, examples, and some models, these recent contributions explained the dynamics within the socio-technical systems, identified transition typologies, articulated policy, business, design and consumer perspectives on transitions/system innovations, and, developed transition arenas and a management approach to such transitions (e.g. de Haan and Rotmans, 2011; Geels, 2005, 2010; Geels and Schot, 2007; Grin et al., 2010; Joore, 2010; Loorbach, 2010; Loorbach and Wijsman, 2013; Loorbach et al., 2010; Quist et al., 2011; Tukker et al., 2008). However, despite an increasing focus on business models (e.g. Boons and Lüdeke-Freund, 2013; Hannon, 2012), the topics of design and (product/service) innovation have been somewhat neglected in the literature dealing with systemic transformations for sustainability. Similarly in the design/innovation field there have been only very few contributions touching upon system innovations and transitions for sustainability (e.g. Ceschin, 2012, 2014; Gaziulusoy, 2010; Gaziulusoy et al., 2013; Joore, 2008, 2010).

Focussing on design and innovation activity of companies in the context of systemic transformations for sustainability is important for several reasons. First, design/innovation activity takes place within operational and strategic levels within which the required systemic transformations will manifest over time. In transitions and system innovations theory, operational level covers short-term actions and experiments undertaken by individuals or organisations and strategic (or tactical) level is where strategies are devised to achieve visions of sustainable futures which are developed at the visionary level (Loorbach, 2010). Operational level for design/innovation teams covers all activities of concrete design and

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innovation activity until a product or service is commercialised successfully. At strategic level, decisions are taken to inform design/innovation activity happening at operational level based on internal and external changes observed or expected and in alignment with the organisational vision. Second, the new technologies and, products/services of these technologies will be developed through design/innovation activity. Third, the new markets and new user profiles of new socio-technical systems will be envisioned through design/innovation activity. Therefore, design/innovation activity (micro-level change) will significantly influence the content and direction of change in the socio-technical systems (macro-level change). Here, it should be noted that, design/innovation practitioners are labelled as change agents due their potential of influencing material culture (Sosa and Gero, 2008), however, there is a lack of understanding and professional culture which embodies consideration of system innovations and transitions as a necessary part of design/innovation practice. As a result, the agency of these practitioners cannot yet be fully geared in the context of system innovations.

There are several approaches relevant to different phases of design and innovation for sustainability processes including legislation, voluntary initiatives, and design and innovation frameworks. This paper provides a critical review of these approaches based on insights integrated from sustainability science and system innovation/transition management theories with the aim of proposing a research agenda for future research. The following section presents the method used for the integrative literature review, the approaches identified as influencing design and innovation in companies and the critical review criteria. Section 3 presents findings of the critical review which is followed by formulation of a future research agenda in Section 4.

2. Integrating insights from the literature

2.1. Method

The topic of systemic transformations for sustainability is relevant to several disciplinary areas crosscutting natural sciences and social sciences. Similarly, the topic of design and innovation for sustainability is relevant to both technical disciplines and social sciences. Both the area of systemic transformations for sustainability and the area of design and innovation are increasingly acknowledged as transdisciplinary research areas (Cronin, 2008; Hocking, 2010). Therefore, in order to establish a base for the critical review of approaches influencing design and innovation processes evaluation criteria needed to be developed by integrating insights from a very broad body of literature cross-cutting several disciplinary domains. Effectively searching for, finding, selecting, reviewing and reporting literature in transdisciplinary research is a major challenge due to the broadness of area that needs to be covered (Carew, 2004).

Pohl (2014) points out the chaotic process of transdisciplinary research in the lack of standardised theories, methods and state of the art which requires an adaptive approach informed mostly by heuristics. In order to address the challenge associated with reviewing and reporting of literature in transdisciplinary research, a heuristic and iterative tool for finding, structuring and prioritisation of the literature review process is developed and used Gaziulusoy and Boyle (2013). This tool helps the researchers to find and narrow the literature to be reviewed by identifying and refining several literature review filters across four hierarchical but interrelated levels (paradigm filters, problem/solution filters, context/scope filters, knowledge/skills filters) following an iterative, reflective inquiry. The filters are used as search terms in finding literature. They also help narrowing down of literature to be reviewed by helping with prioritisation. This reflective, iterative process enables the researcher to use the learning that takes place during the project in identification of new filters or refinement of existing ones, thus, as the project progresses literature from a broad area across disciplines relevant to the specific research project can be found, selected, prioritised, reviewed and integrated. Fig. 1 presents a snapshot summary of the iterative and heuristic process of identifying and refining filters for finding and narrowing down literature as relevant for the critical review presented in this article. For further details on the development of the heuristic tool and identification of filters the readers are referred to Gaziulusoy and Boyle (2013).

2.2. Approaches influencing design and innovation in companies

The findings of the literature review indicated that the approaches which influence design and innovation for sustainability cover three main topics: 1. Legislative and regulatory measures; 2. Voluntary initiatives, and; 3. Design and innovation frameworks.

Although legislative/regulatory measures as well as voluntary initiatives are not directly used by members of design and innovation teams, these inform company strategy directly and therefore influence the work of design and innovation teams considerably. In addition, legislative/regulatory measures and voluntary initiatives inform development of tools and methods for the use of design and innovation teams. Generally, the first steps taken by companies in relation to sustainability focus on risk reduction by compliance to regulatory requirements (Dunphy et al., 2007). According to the results of a research carried out by Cleff and Rennings (1999) to investigate determinants of innovative behaviour in companies, compliance with existing legislation is the top driver for environmental innovations. They make a distinction between product and process innovations and state that the influence of market goals is significant for product innovations but, for process innovations, environmental regulations are determinant.

There is an observable trend towards integration of relevant policies, such as innovation policy, education policy and consumer policy, with environmental policies. This is most significant in the European Union (EU), which emphasised integration of requirements of sustainable development into policy making in all areas as a fundamental goal through the Treaty of Amsterdam (EU, 1997). Not only in the EU but worldwide, end-of-pipe pollution reduction/prevention-oriented early legislation, which is effective only during manufacturing phase, is being supported by product and producer responsibility-oriented policies which have a direct influence on the design and innovation process. These policies have an integrated approach covering all life phases of products. Producer responsibility issues, which generally require producers to be responsible for the impacts of their products throughout the whole life-cycle from raw material extraction to final disposal covering reuse/recycle phases, render environmental/sustainability measures to be considered at very early stages of product development and bring design improvements. Among these policies are EU's Integrated Product Policy (IPP) (European Council (EC), 2001; 2003) which gave birth to Ecodesign of Energy Using Products (EuP) (EC, 2005).

Voluntary initiatives are policy instruments, which are undertaken by the industry without the presence of mandated provisions. These initiatives are generally closely linked with economic incentives. The benefits of these economic incentives may be direct and prompt, e.g. energy and/or material savings, or may be indirect, e.g. protecting/influencing brand recognition, or both. In some cases, where sustainability is already embedded in the company culture, the company may adopt and implement some practices without economics being the primary driver. Nevertheless, this