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Components of business concepts for the diffusion of large scaled environmental technology systems

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ABSTRACT

Strategies for sustainable development are arguably part of the most discussed issues among political and corporate actors. These discussions are spurred by global challenges such as climate change, urbanization, and critical natural resource depletion. Sustainable development will require deep structural and wide-reaching changes in current institutions, technologies, and businesses. Furthermore, new approaches are needed to facilitate the development, diffusion, and implementation of environmental technologies. In the academic discourse different concepts, e.g., ecodesign and Product/Service System design, have been proposed within the framework of sustainable development. To deliver even more system-wide environmental improvements, these concepts have been challenged to be expanded in focus beyond products and services to include large technical systems encompassing non-technological dimensions. Motivated by these, the goal of this article is twofold. First, to offer an expanded view on ecodesign of Product/Service Systems using a perspective of large technical systems. Second, to propose and discuss important components to consider when developing business concepts for the diffusion of large scaled environmental technology systems such as district heating supply, waste management, and renewable energy systems. Using qualitative semi-structured interviews and company documentation analysis, this study examines five companies that develop and diffuse large scaled environmental technology systems. As a result of these case studies, we propose components of business concepts that incorporate both technological and non-technological dimensions. Our proposed business concept components are: market (including regulation), finance, resources, activities, partnership (especially public-private partnership), ownership and responsibility, and legitimacy. Regulation, public-private partnership, and legitimacy are particularly important in the diffusion of large scaled environmental technology systems.

1. Introduction

In recent years, sustainable development has received renewed global interest as an increasing number of firms are reporting profitability from sustainability investments (Rohrbeck et al., 2013). In addition to corporate interests, there is an upsurge in political interest in sustainable development amidst public awareness and pressure (Boons et al., 2013). This renewed corporate, political, and public interest in sustainable development is spurred by major trends shaping the emerging future such as climate change, rapid population growth and urbanization, increased pollution, and scarcity of critical raw materials. The global nature of these environmentally relevant challenges means that short-term quick-fix solutions are not applicable, so it has become vital that sustainable development encompasses long-term and far-reaching changes in technology, infrastructure, lifestyles, and institutions (Rennings, 2000). Although not sufficient, technological changes are regarded as necessary for sustainable development (del Río González, 2009), and recent efforts by international organizations such as the OECD to stimulate industry towards sustainability (cf. OECD, 2009) point to the need for continued efforts in the rapid development and diffusion of environmental technologies (Rennings, 2014; Suzuki, 2015).

Since the early 1990s, academic discourse has provided insights into environmentally conscious design (ecodesign), including its concepts, models, methods, tools, and their application (e.g., Alting and Legarth, 1995; Baumann et al., 2002; Karlsson and Luttropp, 2006; Ramani et al., 2010). Ecodesign mainly addresses material

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selection, packaging, part recyclability, modular structure, and functional optimisation within physical products. In the late 1990s, research about Product/Service System (PSS) (Boehm and Thomas, 2013; Meier et al., 2010; Mont, 2002; Mont and Tukker, 2006; Tukker, 2015) emerged in part to overcome some limitations of ecodesign. PSS design enhances ecodesign by incorporating service (repair, performance guarantee, take-back, etc.) into the design space. PSS typically addresses products such as a copier, an aircraft engine, or a production machine with their related services. However, a gap exists between the long-term and far-reaching changes needed for sustainability and the insights gained from ecodesign and PSS design. This gap is characterised by three limitations. First, little literature exists about ecodesign and PSS design that targets large scaled environmental technology systems such as district heating supply, waste management, and renewable energy systems. Second, most of the literature about ecodesign and PSS deal with business-to-consumer and business-to-business context, but these large-scaled systems are often dealt with in the context of business-to-government as well. Third, these large systems are typically associated with changes in social norms, cultural values and formal institutional structures and conditions that are typically outside the focus of ecodesign and PSS design. However, non-technological changes can potentially deliver system-wide environmental improvement needed for sustainable development compared to improvements that only focus on processes and products (OECD, 2009).

Among different reasons, the lack of proper handling of the business aspects of environmental technology development is deemed as a significant barrier in their diffusion (Cerin et al., 2007). As signals for the development and diffusion of environmental technologies continue to grow strong, it has become evident that improvements are needed in the current efforts and approaches to exploit their development, diffusion, and implementation (Kanda et al., 2015). The concept of business models oriented towards sustainability can provide a link between firm efforts and system-level sustainability, and this insight is receiving attention from researchers, policy makers and business managers alike (Boons et al., 2013). Similarly, business models are expected to provide relevant support for firm-level development and diffusion of environmental technologies, particularly within the framework of sustainability. What makes such business models even more compelling is that current short-term profitability-oriented business models and strategies can cause economic, ecological, and ethical problems and stifle the diffusion of environmental technologies including the expected environmental benefits.

The goal of this article is thus twofold: to offer an expanded view on ecodesign of Product/Service Systems (PSS) using a perspective of large technical systems, and to propose and discuss important components to consider when developing business concepts for the diffusion of large scaled environmental technology systems. The expansion of the focus of PSS to include insights from large technical systems is motivated by the distinguishing characteristic of environmental technologies, which is to improve environmental performance. Even though environmental performance is influenced by several factors, the design dimension is decisive for several technologies (Carrillo-Hermosilla et al., 2010). Thus, an expansion of PSS design from products and services to large technical systems embodies potentially radical environmental improvements in comparison with environmental improvements from modifications in products and services. Furthermore, to deliver such environmental improvements, these large technical systems need market introduction and diffusion. Ultimately, the capacity of environmental technologies to contribute to sustainability transitions depends on the interplay between the design dimension and factors influencing market introduction, including the engagement of key stakeholders (Carrillo-Hermosilla et al., 2010). This link between the design dimension and diffusion is what the twofold research questions guiding this study aim to provide.

To achieve these goals, we discuss environmental technology diffusion and the concepts of ecodesign and PSS design in Section 2, ending with a theoretical expansion of PSS design to large technical systems which corresponds to the first goal of the article. In Section 3, we then present the research method used to answer the second goal. Next, in Section 4 our findings from the empirical case studies are presented. In Section 5, we go on to propose and discuss components of business concepts for the diffusion of environmental technology, corresponding to the second goal of the article. Finally, in Section 6 we conclude on the research goals and identify further research opportunities.

2. Expansion of ecodesign from products and services to large technical systems

This section starts broadly with the concept of environmental technology, including its definition in the context of this article, before narrowing down to a review of some conceptual frameworks on the diffusion of environmental technologies. We then highlight some particular characteristics of large technical systems which could influence their diffusion. In addition, we discuss the concepts of ecodesign and PSS design, ending with a theoretical expansion in the focus on these concepts to encompass large technical systems, which corresponds to the first goal of the article. Furthermore, these discussions also serve as inputs both for the empirical data collection and analysis.

2.1. Environmental technology diffusion

The term “environmental technology” (ET) is used synonymously with a variety of terms such as “environmentally sound technology”, “cleantech”, “green technology”, and “low carbon technology”. Since the term has no internationally agreed upon definition, different definitions exist in the academic and public domains (See Guziana, 2011 for a broader review on different definitions on the term). For example, Kemp (1997, p.11) defines environmental technology broadly as each “technique, process or product which conserves or restores environmental qualities” (cited in Guziana, 2011). In the public discourse, the EU (2004, p.2) defines environmental technologies as: “all technologies whose use is less environmentally harmful than relevant alternatives. They encompass technologies and processes to manage pollution (e.g. air pollution control, waste management), less polluting and less resource-intensive products and services and ways to manage resources more efficiently (e.g. water supply, energy-saving technologies)”. Despite the academic debates on the definition of the term, the realisation of actual environmental improvements as against the intention for environmental improvement, the radical or incremental nature of such technologies, and whether the term encompasses both technical and non-technical aspects, a defining characteristic of environmental technologies is their environmental improvements. Thus, in this article we refer to “environmental technology” as technologies (products, services, and large technical systems) whose development and use actually provide or are intended to provide better environmental performance from a life cycle perspective compared to their relevant alternatives. Our understanding of the term is purposively broad and includes different types of technologies developed by the studied companies targeted at waste management, renewable energy and district heating supply. In addition, we embrace both the actual realisation of environmental benefits and the intention to do so with technical