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Editorial

Engineering and technology management for sustainable business development: Introductory remarks on the role of technology and regulation

Introduction and the role of technology

This special issue of the *Journal of Engineering and Technology Management* on "Engineering and Technology Management for Sustainable Business Development" complements special issues published in other journals on the nexus of sustainability, ethics, innovation and entrepreneurship (e.g., Boons et al., 2013; George et al., 2012; Hall et al., 2010; Hall and Wagner, 2012; Harris et al., 2009) by providing a dedicated operational and technical perspective on the challenge of innovation for sustainable business development. The Brundland definition of sustainable development can serve as a reasonable starting point for such a venture, which states that "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, p. 43).

Technology has a crucial role in fulfilling the promise of sustainable development whether as technological change or as a choice set at a given point in time. Interestingly, despite this fact, the debate is often centred on economic aspects such as the business case for sustainability. The notion of a business case poses an interesting challenge when defining sustainability as a bundle of public goods (including intra- and inter-generational equity, improvement or preservation of environmental quality and protection of human health). If a firm pursues an activity aimed at sustainable development with the intention to profit economically, stakeholders (Mitchell et al., 1997; Phillips et al., 2003) might voice concerns about the true social benefit of the activity. As a result, the reputation of the firm may be put in doubt, ultimately negatively affecting economic performance. Hence the initial assumption of a business case is contradicted. Conversely, if a firm pursues sustainable development activities initially based on purely altruistic motives, their reputation might improve since at least some customers have a positive willingness to pay for certain reputational characteristics. Again, such a scenario leads to the basic assumption of the firm acting altruistically and without accruing benefits to themselves is thus contradicted. This results in a paradox and the question arises, whether technology can help to resolve such a dilemma.[1]

[1] For a more in-depth treatment see e.g. Wagner (2012a).

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One possibility is the role of technology as the basis of innovation and entrepreneurship. In many ways, technology is at the heart of the new combinations as proposed by Schumpeter (1934). Hence, one needs to clarify if a business case for sustainability based on technology-based entrepreneurship and innovation reduces the conflicting tensions described in the above paradox. The technology and innovation management literature has developed several concepts that are indispensable for understanding the role of technology for sustainable business development. Amongst these are radical and incremental innovation (Henderson and Clark, 1990) and the distinction between product, process, service, organizational, institutional, system-oriented, and function-oriented innovation (Afuah, 1998). Furthermore, the difference between discrete and complex product architecture types is important as appropriation of profits from innovation differs between these two types with implications especially concerning the choice of business model (Davies and Brady, 2000; Hall and Martin, 2005; Matos and Silvestre, 2013).

Innovation for sustainable development requires both radical (technological) innovations that massively improve the environmental or social performance of goods or production processes while not altering consumer benefits, and utility and incremental (product- and process-related) innovations in the existing production and consumption systems due to (partly irreversible) path dependencies causing at least temporal lock-in and inertia. In this context incremental innovation makes an important contribution in the short term, at least to some degree, by improving the eco-efficiency of production processes and environmental performance of goods. Yet, incremental innovation is frequently unable to realize a globally optimal system configuration in a multi-dimensional production and consumption system space (Frenken et al., 2007; Larson, 2000).

Table 1 summarizes different realizable combinations with regard to a business case and types of innovation and relates this to the seminal work by Teece (1986), who argues that profiting from an innovation ultimately depends on the interplay of complementary assets, appropriability regimes and the existence of dominant designs (Utterback, 1994).[2]

According to the stylized facts of innovation economics it is well established that different types of firms pursue different types of innovation. More specifically, large firms prefer incremental innovations while young/small firms' gravitate to radical innovation. Similarly, product innovation has a more prominent role before a dominant design is established and process innovation thereafter. The stated position of innovation economics changes in the case of innovation for sustainable development and also the effect of complementary assets needs to be accounted for as can be seen in Table 1. For example, in the automotive industry, after the dominant design incumbents perform better with regard to innovation, whereas entrants are more successful before the establishment of a dominant design. More specifically, entrants pursue radical product innovation while incumbents prioritize incremental product innovation before the dominant design emerges in the automotive industry, whereas after the dominant design emergence, entrants shift to a mix of radical and incremental process innovation and incumbents to mainly incremental process innovation.

The role of regulation and its interaction with technology

Next to technology, regulation is another important element to be discussed in the context of engineering and technology management, since it always exists as a framework for action. For example, the EU recently announced a tightening of regulations on eco-labelling and eco-design. [3] Regulation is developed to address the average firm, however the effects on any one firm may differ substantially for any given level of stringency. For example, stringent regulations may place an unfair burden on SMEs (or potentially drive them out of the market), whereas for large international firms, they may quickly go beyond the highest level of requirements for a label and the costs of meeting the regulation requirements may not have a material impact. Firm demographics may thus play an

[2] Note that, in the case of a weak appropriability regime and the need for complementary assets, entrant innovation is hardly possible because incumbents know they can eventually block further diffusion and entrants anticipate that incumbents will deny them access to complementary assets (except for the case when the entrant already has or acquires access to complementary assets).

[3] See www.amiando.com/PolicyProductsConference2014.html?page=1052672.

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