The role of requirement management and frugality for eco-effective product development

by Achtelik, Timo | Tiwari, Rajnish | Herstatt, Cornelius | Hamburg University of Technology | Hochschule Fresenius and Hamburg University of Technology | Hamburg University of Technology

Extant sustainability research often stresses the need for an eco-effective approach to innovation, instead of exclusively optimizing current systems through eco-efficient measures (Hauschild et al., 2020). While scholars advocate a radical transformation of business models and product innovations in light of the escalating socio-ecological crisis, the transition within industries toward more environmentally friendly products remains slow, thereby potentially indicating a need for action by educational institutions in contributing to awareness-building (Bianchi and Cordella, 2023).

Drawing from the widely discussed trajectory-paradigm-framework in economics, we highlight a significant yet neglected phenomenon contributing to this inertia (Dosi, 1982). Through a three-year action research project at a leading German automobile manufacturer, we illustrate how prevailing “performance-improving paradigms” may often lead to “over-engineered” products, resulting in performance levels that exceed market demands and fail to align with reasonable usage (Christensen, 2016).

Our empirical study specifically revolves around the importance of the internal innovation assumptions and associated requirement management. In search of the technical potential, product specifications have often undergone continuous advancement and refinement over decades, particularly within large, incumbent companies (Foster, 1985). However, we also observe how in pursuit of efficiency the significance and attention of an adequate requirement management for future developments is highly diminished. Our research demonstrates instances where innovations either surpass actual performance needs or how suitable sustainable solutions are discarded for not meeting predefined requirements (Achtelik et al., 2023).

We contend that sustainability-driven product development must consistently scrutinize underlying innovation paradigms and foster the principle of “good-enough” performances. Arguably, the initiation of radical sustainability measures based on inflated specifications undermines their eco-effectiveness. Instead of perpetually optimizing products to meet predefined specifications, it is equally important to challenge and, if necessary, reduce underlying technical requirements.

Embracing reduction and subtractive thinking as a new engineering perspective can foster more tailored and, consequently, eco-optimized innovations (Adams et al., 2021). We show, how such an intervening approach in favor of frugality can yield affordable, high-quality, and sustainable products by aligning the performance levels with specific use cases and prioritizing core functionalities (Weyrauch and Herstatt, 2017; Le Bas, 2023). As a result,

there seems to be a strong potential role for academic education in generating awareness, acceptance and cognitive capabilities for frugal approaches and to foster these through specially-designed modules in the form of life-long learning (Papageorgiou and Kokshagina, 2022).

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