

FROM GREEN IT TO SUSTAINABLE VALUE: THE PATH-DEPENDENT CONSTRUCTION OF SUSTAINABLE INNOVATION

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INTRODUCTION

Sustainable innovation goes beyond the design of ‘green technologies’, it also involves the development of supportive social and normative frameworks that complement and reinforce the adoption and diffusion of sustainable technologies (Thatchenkery, Cooperrider, and Avital, 2010). Building on a longitudinal study of sustainability in the car industry, we argue that the prevailing techno-centered discourse on Green IT/IS (Murugesan, 2008; Boudreau *et al.* 2008) and the consequent actions are myopic and unlikely to yield the desired outcome. We further suggest that sustainable innovation can be better understood and leveraged by adopting a broader set of considerations that account for the sociomaterial nature of the subject matter (Orlikowski, 2007).

Subsequently, we propose extending the prevailing scope of the Green IT/IS discourse to include a broader array of sustainable value considerations (Cooperrider, 2008; Laszlo, 2008). Sustainable value is a twofold palimpsest that denotes value as worth and value as norms. Hence, rather than dealing with ecological sustainability alone, sustainable value refers to a wider conception of value that includes economic, social and environmental value for all stakeholders involved. Moreover, sustainable value is about nourishing normative values that support and promote system-wide sustainable attitudes, behaviors, and practices.

Building on analysis of the path-dependent nature and the sociomateriality of sustainable value creation in the automotive industry, we draw a number of relevant insights with respect to the information technology domain. First, our analysis demonstrates the path-dependent nature of sustainable technological development, which is constrained and enabled by the materiality, social structures, and institutional frameworks that comprise its overall sociotechnical system. Second, the findings show that the diffusion of technological innovation should be complemented by respective social and institutional support in order to gain a sufficient momentum that can disrupt the existing evolutionary paths and construct more sustainable alternatives. Third, the study suggests that sustainable value creation requires a concerted effort of all stakeholders to reshape existing norms and values, to formulate new standards, and to reconfigure work systems for diffusing sustainable technologies.

Overall, through the *sustainable value* perspective, we provide a framework that extends the current Green IT/IS discourse beyond ecological considerations to include concurrently social,

environmental, and economic value as worth and value as norms. Moreover, we highlight the path-dependent nature of sustainability efforts and show that technological innovation alone is unlikely to trigger the desired change without complementary social and institutional support and the reformulation of the dominant cognitive, normative, and regulatory schemes. Hence, we provide further insights for understanding the construction and disruption of technological development.

In what follows, we describe the research design and data collection process. Then, we present the analysis and findings through a brief synopsis of the path-dependent process of technological innovation at three case companies in the automotive industry and describe the development of low-emission vehicles (LEV) technologies as an evolving set of sociomaterial practices. Finally, we apply the generated insights regarding the path-dependent and sociomaterial nature of sustainable value creation to information technology and discuss its implications for IT research and practice.

RESEARCH DESIGN AND DATA COLLECTION

Following a multiple-case studies approach, we analyzed three case companies—General Motors (GM), Toyota, and Daimler—in order to answer the overall research question, namely: *What insights can sustainable innovation in the automotive industry provide for sustainable IT?* A multiple case research involves the collection and comparison of data on two or more cases (Yin, 1994). The unit of analysis is the company. Results are obtained based on an extensive content analysis of 371 *Financial Times* articles from 1990 until 2009.

The case study method provided in-depth understanding of the selected case companies and the contexts in which they operated. In combination with our longitudinal dataset, it surfaced clear causal links and interactions between the social and the material (Leonardi, & Barley, 2008) as well as patterns of path dependence. Moreover, by relying on multiple case analyses, conducting cross-case comparisons (Eisenhardt, 1989), and through pattern matching we could enhance our confidence about the reliability of the findings (Yin, 1994).

Case Selection

Traditionally the automotive industry is not regarded as being particularly pro-active, innovative or environmentally friendly (Roome, 1994). Nevertheless, the automotive industry has always been one of the first targets for new environmental regulation, and hence has been the source of valuable experiences and lessons for other industries (Den Hond, 1996). Additionally, given the many parallels between the automotive and the IT industries, we use the automotive experience to generate insights about sustainable innovation of information technology.

With respect to LEV technology development, in particular General Motors, Toyota and Daimler are considered the forerunners in the industry. Furthermore, these companies have exhibited several contrasting characteristics, which made the cases particularly interesting for theoretical replication (Yin, 1994).

Data Collection

The *Financial Times* was the main data source of this study. First and foremost, we selected the *Financial Times* because of its business focus and high-quality reporting. Furthermore, in general, newspaper articles are a stable, exact, and unobtrusive source (Yin, 1994) of longitudinal

information about a company's strategies and innovation with respect to sustainable technologies. Hence, the *Financial Times* provided reliable data about the main themes of interest with respect to the underlying research question.

The data collection and dataset development process were performed in a stepwise manner that comprised several filtering stages. First, a search was conducted of *Financial Times* articles between 1990 and 2009 using search terms for the different LEV technologies. Second, the generated set of articles was filtered again using company names as query terms. Third, in order to assess whether articles were truly relevant to our data analysis, we adopted a global reading approach for the entire dataset and subsequently narrowed down the number of articles. Even with using all the key search terms, there were still a large number of articles in the dataset that turned out to be unrelated to the underlying research topic. This selection stage was performed by two independent coders and the initial percentage agreement was 91.3% (748 articles out of 819). In a face-to-face meeting, the two coders discussed and negotiated their choices until they agreed upon the relevance of every article in the dataset. After this last step, the dataset included a total of 371 *Financial Times* articles that span over 761 pages of text.

ANALYSIS AND FINDINGS

Using NVivo, the remaining articles were coded by two independent coders in a stepwise data analysis process. First, after a repeated in-depth reading of the entire dataset, an interrater reliability estimate of .8¹ based on a subset of articles provided an initial assessment of the coding scheme validity and the coding process reliability. Next, the disagreements were discussed and negotiated, and the coding procedure was fine-tuned accordingly. Subsequently, the data set was divided and each coder analyzed half the articles using both structured and open coding. Afterward, a causal chain analysis was conducted to discover patterns in the longitudinal data as well as to reveal path dependence and instances of interplay between social and technological events.

The generated findings clearly reflect the path-dependent and sociomaterial nature of sustainable innovation in the automotive industry. First, the study shows that the development and success of technologies is highly dependent on a sequence of sociomaterial contingencies including technical, economical, regulatory, social, and environmental junctures. The historical analysis reveals that the dominance of the internal combustion engine after the 1920s was due to a set of contingent events, both on a social and economic level, and in a similar vein, its persistence nowadays depends on several sources of lock-in on a technological, organizational, institutional and social level (Mahoney, 2000; Unruh, 2002).

Second, the findings indicate that a company's choice to focus primarily on one particular technology—GM's focus on electric vehicles, Toyota's focus on hybrid vehicles and Daimler's focus on fuel-cell vehicles—and largely ignore other possibilities is also determined by previous actions and decisions as well as critical incidents in their respective wider social context. In other words, the technology paths that companies follow is highly path-dependent and sociomaterial.

Third, whether or not a new technological innovation becomes successful depends on the momentum of its path and its broader social environment. Hence, the great success of hybrid vehicles, in particular Toyota's Prius, and at the same time the failure of electric and fuel cell vehicles are not solely based on technological, but also on social circumstances. The hybrid technology, as the least radical sustainable innovation, did not require a significant disruption of existing technologies, preferences, norms, and standards, rather it was based on the technology base, refueling infrastructure, functional requirements, and institutional frameworks that were

already in place for traditional cars. Hence, hybrids did not instigate a discontinuity of the dominant technological path but instead formed a parallel alternative pathway.

Electric and fuel cell cars, on the other hand, represent a radical discontinuity from the internal combustion engine, and require a fundamental reframing of preferences and expectations, values and norms, standards and regulations. For instance, GM's Hy-Wire², GM's AUTOmomy, as well as Toyota's Fine-N³ demonstrate that a technology that provides zero emissions—i.e. *environmental* value—enhanced safety, comfort, customization possibilities, and potentially lower costs—i.e. *social* value—is technologically feasible. However, in order to allow for the diffusion of such a truly sustainable alternative, multiple complementary social and institutional measures in the form of reshaping our cognitive, normative and regulatory frames are needed.

Therefore, in the same way as sociomateriality drives the continuation of our dominant technology path, it is also the key to a disruption hereof. Hence, sustainable value creation requires the concerted efforts of all stakeholders to change related norms, formulate new standards, alter prevailing preferences, and reshape dominant practices for opening up paths to sustainable innovation.

DISCUSSION

In what follows, we apply the accumulated insights regarding the path-dependent and sociomaterial nature of sustainable value creation to information technology, and discuss how it can shed light on the challenges and opportunities ahead.

Implications and Recommendations for IT Research

The conception of sustainable value offers an extension of the Green IT/IS discourse beyond ecological considerations. We argue that research adopting a sustainable value lens should not only focus on how companies can create environmental sustainability, but also on how companies, through their innovation efforts, can contribute to social sustainability by supporting efforts to strengthen matters such as diversity, human rights, employee relations, safe and clean products, as well as good governance structures.

Moreover, adopting a sustainable value lens requires research to adopt theoretical frameworks and research methods that account for the path-dependent and sociomaterial nature of sustainable innovation. This implies that researchers should look for longitudinal data rather than convenient snapshots (Avital, 2000).

Additionally, the results from this paper stress the importance of studying the multiple and complex contingencies leading to a continuation or disruption of technology paths. Moreover, given the need for shifts in cognitive, normative, and regulatory frameworks in order for the diffusion of sustainable technology, research on sustainable IT/IS should take into account the crucial role of norms and standards for understanding and encouraging sustainable innovation.

In short, we submit that sustainable value considerations offer a research agenda and a coherent framework for advancing and extending research on sustainable information technology.

Implications and Recommendations for IT Practice

Overall, for new information technologies and systems to generate sustainable value, we need to reinforce current efforts that focus on incremental and reactive innovations—related to the reduction of energy consumption and waste disposal as well as the extension of technology life spans—with more radical technological innovations that reshape current practices and reconfigure existing work systems. Merely responding to social and economic factors is

insufficient, rather, adopting the sustainable value lens, companies need to assume a proactive leading role in designing and implementing radical new technologies that provide environmental, social and economic value for all stakeholders.

Moreover, the observation that social and institutional changes are needed to complement related technological innovation shows that moving toward sustainable information technology is a shared responsibility of all stakeholders. Hence, the IT industry should seek involvement of the public, interest groups, non-profit organizations, and government agencies in order to engage in sustainable value creation through IT. In particular, given the need for a radical reformulation of consumer preferences and society's expectations of technologies, sustainable value creation requires the collective engagement of stakeholders for reshaping existing normative frameworks.

CONCLUSION

Building on a longitudinal study of sustainable innovation in the automotive industry, we have demonstrated the need for social and institutional support to complement technological innovation in order to create sustainable technologies and reshape existing norms, values, and standards. Therefore, we argue that the prevailing techno-centric discourse on Green IT/IS and the consequent actions are unlikely to yield sustainable information technologies. Instead, we suggest that adopting a sustainable value lens is indispensable for understanding the path-dependent and sociomaterial trajectory of sustainable innovation and for shaping it in line with society's best interest. Information technology, like cars, holds great perils and great promises, it lies within the power of our concerted efforts to achieve the latter over the former and create sustainable value for all.

ENDNOTES

1. Cohen's kappa coefficient is a statistical measure of inter-rater agreement which is generally thought to be a more robust measure than simple percentage agreement since it takes into account the agreement occurring by chance. A value of .8 is considered substantial agreement.
2. For hydrogen-by-wire, a drive-by-wire, i.e. electronic control, system
3. These are three very novel zero-emission vehicles that are discussed in the full paper

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