

Identifying the Disruptive Potential of the Sustainable Innovation E-Mobility

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Abstract

History has shown that technology-based innovation, so-called disruptive innovation, has led to a downturn in the success of major firms like Nokia or Kodak. Therefore, a continuous technology assessment and a timely adoption of relevant new technologies is critical for the success of a company. Recently, researchers and practitioners have shown an increased interest in sustainable innovation. Existing research recognizes the critical role played by the ex-ante evaluation of disruptive technologies]. Surprisingly, the ex-ante evaluation of the disruptive potential of sustainable innovation has not yet been closely examined. A false estimation of the disruptive potential of sustainable innovation can lead to failure of leading firms [1]. This paper presents criteria for the ex-ante evaluation of the disruptive potential of sustainable innovation. The criteria and its application to the case of e-mobility show a medium disruptive potential of this sustainable innovation.

1. Introduction

In times of climate change, sustainable innovation has become a central issue for politicians; researchers; and practitioners. Politicians have the opportunity to foster green innovation, as discussed at the Paris climate summit 2015. So-called Regulatory-push innovation is an increasingly important area in innovation research - besides market-pull and technology-push-innovation [2]. On the other hand, researchers agree on a triple bottom line of sustainability, consisting of economical, ecological and social sustainability [3]. At the same time, practitioners work on the development of sustainable innovation in products and processes. For example BMW uses 100% green energy generated by wind and water for its production site in Canada.

The importance of the management of disruptive technologies and green innovation has been growing for several years. Kodak registered as insolvent, because they lost the disruptive race of digitalization in the camera industry. Tesla is a successful winner of the disruptive change in the car industry, caused by the sustainable innovation e-mobility.

To the best of our knowledge, no criteria for the ex-ante evaluation of the disruptive potential of sustainable innovation have yet been identified. This paper has three objectives: (1) to clarify the characteristics of disruptive and sustainable innovation; (2) to use determinants to measure the disruptive potential of sustainable innovation ex-ante; and (3) to identify the disruptive potential of this sustaining innovation.

2. Theoretical background

There are two views in technology management to explain the displacement of major firms and established technologies: (1) new technologies with a superior performance and (2) new technologies with an inferior performance and difficulties of major firms by adopting their capabilities [4]. Christensen [1] explains the failure of established firms in developing disruptive technologies by its resources, values and processes, which cause the innovator's dilemma.

2.1. Technology-based disruptive Innovation

Technology based disruptive innovation can be described by the following three characteristics:

- New technology trajectories [5]: The application of new technological knowledge in existing markets or the application of existing technological knowledge in new markets are causing new technology trajectories for disruptive technologies.
- New performance attributes [1], [4]: Disruptive technologies are inferior to established technologies in certain performance attributes which are important to mainstream customers and superior to established technologies in performance attributes which are valued in niche markets.
- Disruptive to market structures: Disruptive technologies can impact market structures in four different ways: (1) decreasing market share of established firms [1], [4], (2) new markets

[2], [4]; (3) new business models [2], [6] and (4) new value networks [1], [7].

2.2. Sustainable disruptive innovation

In addition to the characteristics of disruptive innovation, sustainable disruptive innovation can be described by the following characteristics [8]: (1) the innovation objects are products, processes, services, and methods; (2) sustainable innovation is characterized by a high market orientation; (3) all sustainable innovation have the same environmental aspect: to reduce negative impact on the environment; (4) the full life cycle needs to be considered; (5) the intention for reduction of the negative impact on environment may be economical or ecological; and (6) sustainable innovation is setting a new innovation/ green standard to the firm.

3. Disruptive potential of sustainable innovation

Klenner et al. identified the following determinants of increasing the disruptive potential of innovation [9]: low number of firm entries and exits; constant competitors; high market concentration; small number of low-end offers; high market share shifts; less disposition to buy; high value network size; change in value chains; high market entry barriers and benefits; low customer loyalty; high degree of lobbying; and exogenous shocks.

The criteria for the ex-ante evaluation of the disruptive potential of sustainable innovation can be segmented into criteria of sustainable innovation and criteria of disruptive innovation. As a result, six determinants can be used to access the disruptive potential of sustainable innovation (see table I).

Table 1. Determinants Of Disruptive Sustainable Innovation

Criteria of disruptive innovation	Criteria of sustainable innovation					
	<i>Innovation object</i>	<i>Market orientation</i>	<i>Environmental aspect</i>	<i>Full life cycle</i>	<i>intention</i>	<i>Innovation/ green standard</i>
New technology trajectory	(1)					
New performance attributes		(2)	(3)	(4)		(6)
Disruptive to market structure					(5)	

Each determinant for identifying the disruptive potential of sustainable innovation can be accessed by the following criteria:

- (1) A higher performance in certain dimensions of the innovation object caused by the new technology trajectory. The higher the performance, the higher the disruptive potential on the sustainable innovation.
- (2) New performance attributes require a market orientation towards new markets or low-end markets because of decreasing disposition to buy, low customer loyalty, high market share shifts, high market entry barriers and high market entry benefits in existing main stream markets. The more these criteria are fulfilled, the higher the disruptive potential is.
- (3) Environmental aspects which influence the disruptive potential of sustainable innovation are lobbying (either political or economic) and the existence of exogenous shocks (for example natural disasters, population development). Without lobbying and with a low risk of exogenous shocks, the disruptive potential of the sustainable innovation is low.
- (4) The performance in each phase of product life cycle changes. If the performance changes in only one phase of the product life cycle, the disruptive potential is low.
- (5) The intention to develop sustainable innovation can be economical; ecological; or social. Indicators for a high disruptive potential of the sustainable innovation are a low number of firm entries and exits, constant competitors, high market concentration, small number of low-end offers, high value network size and a change in value networks. The more these criteria are fulfilled, the higher the disruptive impact on the market structure is.
- (6) The higher the degree of innovation and the better the new green standard is, the higher is the disruptive potential of the sustainable innovation, caused by new performance attributes.

4. Disruptive Potential of E-Mobility

Disruptive technologies are characterized by new technological trajectories, which lead to a higher performance in certain performance dimensions which are valued by niche markets (see figure 1). At the same time, the performance of disruptive technologies in dimensions which are valued by mainstream markets are low at the early stages of disruption. The performance of e-mobility in the dimensions local emissions; acceleration; and noise level are significantly higher, and the performances in the dimensions operating distance, battery

capacity and price are low. Therefore the disruptive potential in this criterion is high.

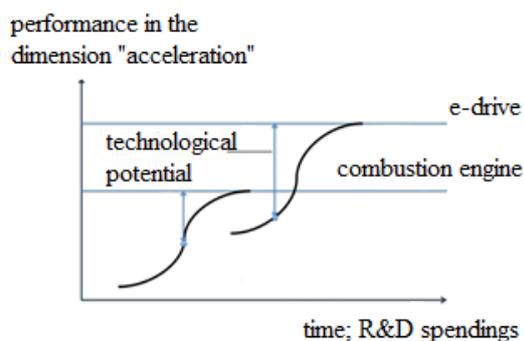


Figure 1. Technological S-Curves

New performance attributes require a market orientation towards new markets or low-end markets. The e-drive technology has opened new markets for e-mobility such as the e-bike market or the Segway market. Low-end markets for e-mobility consist of users with lower customer needs in the dimension of operating distance; users of car sharing offers without an own car; and families with a medium or high income who are less price sensitive and have more than one car in their household. The determinants of the disruptive potential are a decreasing disposition to buy, low customer loyalty, high market share shifts, high market entry barriers and high market entry benefits. In Germany a decreasing disposition to buy cars with combustion engine has been observed [10;11]. The customer loyalty in Germany is high, nevertheless an increasing customer loyalty for BMW and Mercedes; a stable customer loyalty for VW, Opel and Ford; and an increasing customer loyalty for Audi, Toyota and Renault can be observed [12]. The shift in market shares in the German automotive industry is low, but market shares in the e-car market are different from the market share of the mainstream market. Although German OEMs offer the best quality and are technology leaders for e-cars, they are losing global market shares to competitors like Tesla [13]. At the same time, market entry benefits are high due to financial investments and the importance of an established supply chain network; and market entry benefits are low due to the price competition and high customer loyalty [11]. Therefore, the disruptive potential in this criterion is medium.

Environmental aspects which influence the disruptive potential of sustainable innovation are lobbying (either political or economically) and the existence of exogenous shocks (for example natural disasters or population developments). The usage of e-cars fosters the reduction of local emissions. This positive impact plays an important role in

metropolises. For example in Hamburg, Germany, the air pollution is high due to car traffic and the harbor and the local government strongly promotes e-mobility. On the other hand, there are no EU guidelines strongly fostering e-mobility. The target of the German government of 1 million e-cars in GER by 2020 will be missed. Following the latest news, tax incentives for e-cars will be reduced in Germany in 2016. Therefore, the disruptive potential in this criterion is medium.

The costs and the CO₂-emissions of the full life cycle need to be considered in order to analyze the disruptive potential of the sustainable e-car. Until now, the performance in the production phase and recycling phase are low, and therefore also the disruptive potential of e-mobility in this criterion is low. A positive example is BMW, using green energy for the production of the i-series in its production site in Canada. An electricity mix with a higher share of renewable energies for loading the batteries; smart batteries; and car sharing services can reduce the product life cycle costs and emissions and increase the disruptive potential of e-mobility.

The intention to develop sustainable innovation can be economical; ecological; or social. New entering firms with new business models like car sharers or charging providers pursue economical gains. OEMs and major suppliers can foster their economic competitiveness by developing disruptive technologies. Ecological and social reasons for the development of e-mobility depend of and influence the corporate identity, vision, reputation and image of a company. Determinants of the disruptive potential in this dimension are a low number of firm entries and exits; constant competitors; high market concentration; small number of low-end offers; high value network size; and a change in value chains [7], [9].

The German automotive industry is characterized by a constant competition with a low number of firm entries and exits. The market concentration is high and the number of low-end offers low [11]. At the same time, the value network size in the German automotive industry is high and the change to e-mobility would cause a change in value networks. Therefore, the disruptive potential of this criterion is high.

Disruptive sustaining innovation can set new standards in products, processes and values and help solving the innovator's dilemma by Christensen [1]. The higher the degree of innovation and the better the new green standard is, the higher is the disruptive potential of the sustainable innovation, caused by new performance attributes. The switch to e-mobility sets new standards in products, processes and values of a firm. On the other hand, an E-car is an incremental innovation with a medium degree of sustainability. Therefore, the disruptive potential in this criterion is low to medium.

Table 2. criterion To Identify The Disruptive Potential Of E-Mobility

Criterion to identify the disruptive potential of e-mobility	Disruptive potential	Explanation
(1) Higher in performance in certain dimensions	High	Local emissions, acceleration, noise level
(2) Decreasing disposition to buy, low customer loyalty, high market share shifts, high market entry barriers and high market entry benefits	Medium	Decreasing market shares of German OEMs despite of technology leadership
(3) Lobbying, existence of exogenous shocks	Medium	Air pollution in metropolises; EU guidelines, <1 mio. e-cars in GER until 2020; reduced tax incentives
(4) Performance in each phase of product life cycle changes	Low	No green energy for production and renewable energies for loading
(5) Low number of firm entries and exits, constant competitors, high market concentration, small number of low-end offers, high value network size and a change in value networks	High	New business models of car sharer or charging providers; new competitors
(6) Degree of innovation; degree of sustainability	Low-medium	E-car is an incremental innovation; medium degree of sustainability

5. Conclusion

This paper has introduced criteria to identify the disruptive potential of sustainable innovation ex-ante. A three step approach has been applied: First, the identification of characteristics of disruptive innovation and sustainable innovation. Second, the determinants of the disruptive potential of sustainable innovation have been introduced, and classified into six groups. Finally, the disruptive potential of e-mobility has been evaluated.

This research suggests that e-mobility has a medium disruptive potential. For increasing the disruptive potential of e-mobility, the performance in the full life cycle needs to be improved; and incentives or exogenous shocks should increase the intention for developing this sustainable technology.

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