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Methodology for lean design of disruptive innovations

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Abstract

In sustainable economies, disruptive innovations are welcome to balance the gap between the intrinsic value of technological innovations and the economic value perceived by various customer segments, as well as to transform some segments of non-consumers into consumers. Starting from the characteristics of disruptive innovation and using a structured problem solving method, a lean design methodology to support disruptiveness is proposed in this paper. Lean comes from the fact that the design process is structured to reduce ineffectiveness and maximize value. It combines market analysis with business model innovation and directed system evolution, together with a proposition of ten inventive vectors for provoking disruption of existent technologies in the market. A test of the methodology within the field of technologies for smart buildings is presented.

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Keywords: design methodology; disruptive innovation; lean; smart connected products; mobile control

1. Introduction

Technologies evolve in a rhythm that is not always synchronized with the capability of consumer segments to fully exploit their potentials [1]. Market competition forces technology-based companies to innovate continuously despite the fact that, after a certain level of development, not even the high-end consumers are capable to use all functions and features of technology [2]. This is not necessarily due to the inability of users to handle technology, but rather because they do not have business opportunities or processes that call cutting edge functions and functionalities or high level operational performances [3].

Sometimes, the business model is so expensive that certain market segments do not have access to some high-end technologies [4,5]. Unaffordability of some technologies to certain markets segments happens not only due to prices and costs emerging from the business model, but also due to the high cost of technology [6].

There are also cases where technology is very sophisticated and there are no dedicated interfaces to make it accessible for operation to ordinary users, being preserved only to niche specialists and experts [6,7].

If in such cases, where only reach actors and/or experts can access certain technologies, companies can redesign the technology from a completely new angle in order to fulfill the needs and simultaneously to produce it at accessible costs and friendly interface to touch new market segments and user segments. These situations describe zones of disruptive innovations [8,9]. It is suggestively illustrated in Figure 1.

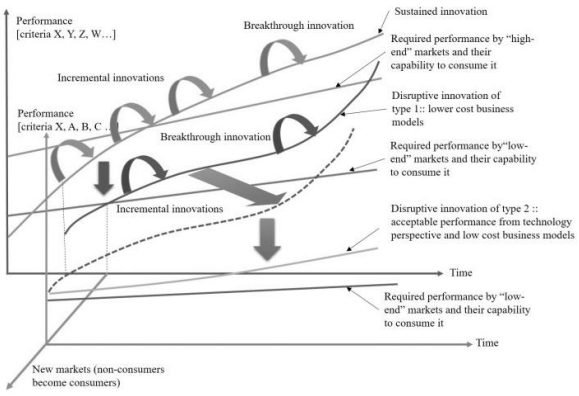

Fig. 1. Disruptive innovation (adaptation from [4])

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On long term, disruptive innovations can kill the parent technology, because one of their key effects is to disrupt markets and to open new ones [9]. It is thus the purpose of this paper to contribute to this issue. With these things in mind, the authors of this paper have formulated a methodology to approach disruptive innovation from the design perspective.

Research focus is on disruption from expensive technologies and expensive business models to cost-affordable technologies and price-accessible business models for low-end new markets.

In order to introduce this methodology, the subsequent part of the paper is organized into seven sections. A perspective on the state-of-the-art from scientific literature is revealed in section 2 of the paper. Section 3 is dedicated to present the general framework for supporting methodology ideation. Section 4 of the paper describes the design methodology for disruptive innovation. Application of the methodology is briefly introduced in the section 5 of the paper. Discussions around results are presented in section 6. The paper ends with a section of conclusions and comments on the limitations of the methodology. Further researches on refining the design method complete section 7 of the paper.

2. Literature review

Researches on design methods for disruptive innovation are not yet published in international databases. An extensive search in ISI Web of Science and SCOPUS did not return any relevant result in this area. Tangential to the topic, scientific literature reveals very good examples of disruptive innovations in different fields (e.g. 3D printing and rapid prototyping, medical devices, railway technologies, software applications, services, etc.) [10,11,12,13,14,15], but no description of the design approaches behind.

Assessment of customer analysis methods for enabling disruptive innovation is reported [3,16], but such methods are not part of a design methodology.

However, they might be very inspirational in the planning phase of designing for disruptive innovation, even if they could cover only a tiny part of the product design process. Researches exposed in the scientific literature are aware of the fact that processes required to develop disruptive innovations are not yet well understood [16]. Though, the same literature highlights that an essential part of creating disruptive innovations is collecting the proper data and information on potential and current customers, as well as their needs and behaviors [6,16,17].

Recent published researches propose an evaluation model to reduce the implementing obstacle of disruptive innovation [18], but it does provide only guidance for evaluating the success ratio of disruptive innovative design scheme objectively and does nothing on the design method of disruptive innovations.

Tools for evaluating disruptive innovation are reported in other papers, too [19]. However, the lack of critical mass of research work in the field of systematic approaches to design disruptive technologies is clearly visible.

3. Ideation framework of the design methodology

The lean design methodology for disruptive innovation was conceptualized and tested in the context of a research project where the authors of this paper have been involved to set up a smart box for controlling various aspects (temperature, gas, water, electricity, etc.) in ordinary apartments from block of flats, where majority of population with lower income lives. To build a smart residential building, related traditional technologies can easily reach 200,000 $. In order to make such technologies accessible for new markets of low-end consumers, costs must be dramatically reduced.

In order to conceptualize the design methodology, Theory of Inventive Problem Solving (TRIZ) contradiction matrix (CM) is considered [20]. TRIZ CM was selected for this purpose because it displays a space of creation driven by two important laws: law of ideality [20] and law of convergence [21]. Both laws are well-aligned with lean philosophy [22]. TRIZ CM translates pairs of conflicting problems into pairs of TRIZ generic parameters, which are afterwards introduced into a TRIZ CM to reveal propositions for generic directions of intervention (i.e. called inventive vectors). The theory behind TRIZ is broad; therefore, reader that is not familiar with TRIZ ecosystem is invited to consult specific literature.

Having in mind the goal of disruptive innovation, the following pairs of conflicting problems have to be treated:

- Low cost of technology while ensuring high technical quality
- Low cost of technology while proving the key features
- Low cost of technology while facilitating high service quality
- Easy to use/convenience while ensuring high technical quality
- Limited number of features without affecting customer satisfaction

Translating the set of five conflicts above into TRIZ generic parameters, and further into the contradiction matrix, the directions where the design methodology should act are: D1 - Instead taking an action that is dictated by the specifications of the problem, implement an opposite action; D2 - Replace hard parts of the system with soft and/or reconfigurable modules that can change their “volume”, “concentration”, “state” or “shape”; D3 - Replace an expensive system with several inexpensive systems; D4 - Divide the system into elements that are able of changing their position relative to each other. In order to define the set of methods and concepts of the design methodology, a relationship matrix between the set {D1, D2, D3, D4} and an exhaustive group of methods for planning, analysis, evaluation was considered. This exhaustive group of methods included over 100 methods proposed in the literature of engineering design. Those methods that had no strong relationship with at least one of the elements D1, D2, D3, or D4 have been eliminated in the first stage. Further, those that consume too much time or are less known in the world of practitioners have been rejected in the second stage. In the third stage have been eliminated all methods that are not related with at least three of the four elements D1, D2,