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Using the theory of inventive problem solving to brainstorm innovative ideas for assessing varieties of phone-cameras ☆

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ABSTRACT

Today, to survive in an extremely turbulent business environment, traditional products characterized by limited capabilities cannot satisfy diverse customer requirements. In particular, it is observed that the boundaries between smart phones, digital cameras, and tablets are becoming more and more blurred than before. Therefore, for attracting the *ad-hoc* segments, global companies began to develop hybrid pad-phones and phone-cameras. Unfortunately, some of these products are facing poor sales without incurring much market attention. In order to overcome the aforementioned difficulty, this paper presents a novel framework to reduce the gaps between producer expectation and user perception. By means of the TRIZ (the theory of inventive problem solving), a contradiction matrix is applied to handle engineering conflicts among multi-functional alternatives to seek inventive solutions. Then, ARM (association rule mining) is conducted to identify critical features that formulate customer dissatisfaction (purchase intention). Finally, CA (conjoint analysis) is employed to derive customer utilities for benchmarking varieties of design concepts. In summary, the proposed framework cannot only help product planners efficiently generate innovative ideas, but also effectively justify the validity of design concepts.

1. Introduction

Owing to dynamically changing customer desires coupled with rapid technology advances, global markets are full of various product offerings (i.e. smart phones, tablets, digital cameras, and wearable devices) to fit the *ad-hoc* segments. In the past, companies provided products with high quality, low cost, and at most, courteous after-sale service to satisfy market majorities. Today, companies need to customize products or services to satisfy distinct segments to consolidate their market shares (Crawford & Benedetto, 2008; Wang & Chen, 2012; Yang & Shieh, 2010). For instance, Nokia and Motorola have lost huge markets in smart phones and were merged with Micro-soft and Google, respectively. In contrast, Apple and Samsung have gained their brilliant revenues arising from various hot-selling consumer electronics. As reported by the Economic Times in 2014, compact camera sales fell by 30% and camera OEM/ODM makers were forced to trim production. Apparently, the popularity of smart phones resulted in poor product sales of low-end digital cameras since the boundary between smart phones and other consumer electronics has become more and more blurred than before (Wang & Wang, 2014; Wang & Wu, 2014).

As we know, to survive in an intensively competitive environment, the key capability involves incorporating customer perceptions or preferences into the process of product positioning and differentiation (Alptekin, 2012; Lai, Lin, Yeh, & Wei, 2006). However, to successfully position products in a crowded and fragmented market, firms need to transform diverse customer requirements into attractive products (portfolios of features). Specifically, "differentiation" is creation of tangible or intangible characteristics (i.e. aesthetic features, functional performances, after-sale services, and selling prices) between a firm and its competitors whereas "positioning" refers to implementing a set of tactics to ensure these characteristics can occupy a unique position in the minds of customers (Kwong, Luo, & Tang, 2011; Wang, 2015). That means, positioning does not refer to what a company does to a product; rather, it is what a company does to the prospect of customers (Lilien & Rangaswamy, 2003).

For instance, for acquiring the niche segments, brand companies have developed several cross-boundary alternatives, such as Sony's QX series (i.e. QX10, QX100, and QX 30) and Samsung's phone-cameras (i.e. S4 zoom, galaxy camera, *K*-zoom). Unfortunately, most of the above-mentioned alternatives are facing extremely bad sales without conforming to firms' original expectations. In practice,

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identifying key features which formulate customer dissatisfaction with existing multi-functional alternatives is of importance to understand the underlying reasons behind poor sales (Wang, 2015). Ideally, designing an alternative that outperforms competitors' products in all dimensions is perfect. In reality, due to physical constraints or limited resources, an improved feature is often accompanied with worsening feature(s).

After reviewing the past studies, numerous skills have been suggested to reduce the gap between users' requirements and producers' alternatives, such as quality function deployment, multi-criteria decision making, conjoint analysis, Kano model, Kansei engineering, customer co-creation, and multi-agent automated negotiation (Işıklar & Büyüközkan, 2007; Ayağ & Özdemir, 2009; Altun, Dereli, & Baykasoğlu, 2013; Ries, 2011; Wang & Chen, 2012; Wang & Wu, 2014). In this context, a TRIZ (theory of inventive problem solving) based framework is proposed to generate innovative ideas for designing phone-cameras and to benchmark these new ideas (design concepts) for better assessment. More importantly, several critical issues are addressed as follows:

- How to handle the trade-offs between an improved feature (i.e. optical zoom) in smart phones and other worsening characteristics (i.e. thickness or weight)?
- Which features are the most critical to formulate customer dissatisfaction with existing alternatives (i.e. Sony's QX series or Samsung's phone-cameras)?
- How to redesign potential alternatives and justify marketing validity for acquiring diverse user requirements of the niche segments?

The rest of this paper is structured as follows. Section 2 briefly reviews the concept of TRIZ. Section 3 introduces the proposed framework and relevant techniques. An industrial case study on designing and assessing varieties of phone-cameras is illustrated in Section 4. Concluding remarks are drawn in Section 5.

2. Overview of the theory of inventive problem solving (TRIZ)

TRIZ was developed by the Soviet inventor Altshuller (1984), who had analyzed over 400,000 patents to construct a systematic framework (see Fig. 1) composed of a contradiction matrix (Table 1), 39 engineering parameters (Table 2), and 40 innovative principles (Table 3). Specifically, TRIZ includes a practical methodology, tool sets, a knowledge base, and model-based technology for generating new ideas and solutions for problem solving (Wikipedia, http://en.wikipedia.org/wiki/TRIZ; http://www.qaiglobalservices.com/downloads/Innovation_Management.pdf?). As indicated by Fig. 2, the entire process to implement the TRIZ includes: (1) abstraction-converting specific problems into general problems, (2) mapping-finding typical solutions for solving general

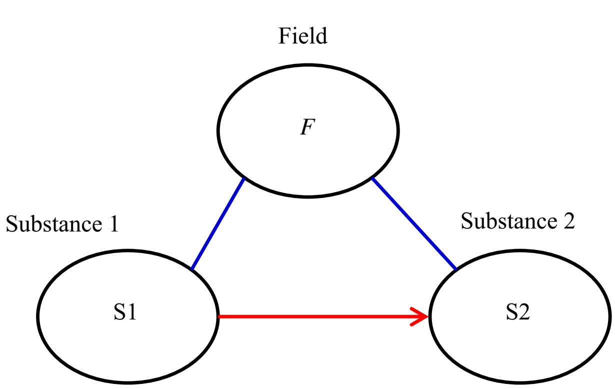

Fig. 1. TRIZ's substance-field model.

Table 1
TRIZ's contradiction matrix.

39 system characteristics	Worsening features				
	1	2	⋯	38	39
Improving features					
1	N/A				
2		N/A			
⋮			N/A		
38				N/A	
39					N/A

%N/A means "*not applicable*".

problems, and (3) concretizing-projecting typical solutions into specific solutions that can be tailored to specific domain problems. In brief, TRIZ presents a systematic approach for analyzing challenging problems where inventiveness is needed and provides a range of tools for finding inventive solutions.

To the best of our knowledge, TRIZ has been widely applied to different industries, including product/process development (Sheu & Hou, 2013; Yeh, Huang, & Yu, 2011; Zhang, Yang, & Liu, 2014), service innovation (Su & Lin, 2008), and eco-innovation (Chen & Chen, 2007; Chai, Zhang, & Tan, 2005). Furthermore, some of the above-mentioned studies have integrated QFD (quality function deployment) with TRIZ to analyze the interrelationships between customer requirements and engineering characteristics and the conflicts among them (Yamashina, Ito, & Kawada, 2002). In this context, TRIZ is adopted to accomplish phone-camera design by employing a contradiction matrix. The first step is to confirm the improved feature(s) and the worsening feature(s). Despite the market share of the low-end digital cameras have been mostly replaced by smart phones, consumers are still unsatisfied with smartphone's photo quality (Wang & Wu, 2014). For example, the area of image sensor like CCD (charge coupled device) or CMOS (complementary metal oxide semiconductor) is only 1/3.2 inch (resulting in weak light-sensitivity). Moreover, most smart phones lack of optical-zoom capability (digital zoom usually leads to poor photo quality).

For improving smartphone's photo capability, Samsung recently developed a series of Android system based phone-cameras (i.e. S4 zoom, *K*-zoom, and galaxy camera). Meanwhile, Sony also designed a portable QX series (separable camera-lenses). In this paper, TRIZ is adopted to address these examples and explain the underlying reason behind poor sale of Samsung's phone-cameras. In Section 4, three improved features (i.e. #24 – loss of information, #28 – accuracy of measurement, and #37 – difficulty of detecting & measuring) and two worsening features (i.e. #2 – weight of nonmoving object and #4 – length of nonmoving object) are addressed.

3. Proposed methodologies

In order to design multi-functional products (phone-cameras), this study proposes a TRIZ (the theory of solving inventive problems) oriented framework to incorporate customer perceptions and preferences into the entire process. For convenience, the framework shown in Fig. 3 is operated as follows:

- Initially, the concept of TRIZ is applied to seek innovative solutions for tackling engineering conflicts between improved features and worsening features.
- Secondly, association rule mining (ARM) is conducted to recognize key features that characterize customer dissatisfaction with existing alternatives.
- Thereafter, conjoint analysis (CA) is employed to elicit customer utilities of key features for assessing and benchmarking competitive alternatives (varieties).