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Combining multiple correspondence analysis with association rule mining to conduct user-driven product design of wearable devices

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ABSTRACT

In recent years, the popularity of smart phones has boomed the emergence of wearable devices like wristband, smart watch, and sport watch since these devices are portable to record human body information, synchronize information with smart phones, and conduct real-time monitoring of physical condition. However, a recent survey indicates that near 70% respondents are not interested in buying Apple's new iWatch although the marketplace is full of competing alternatives like Samsung's Gear fit, LG's G watch, and Sony's SW3. In this study, a novel framework combining multiple correspondence analysis (MCA), association rule mining (ARM), with *K* nearest neighbor (KNN) is proposed to help brand companies address the following issues: (1) using MCA to explore the latent relationships between users' demographic profiles, user perceptions of design attributes, and user preferences for wearable devices, (2) using ARM to identify key design attributes that can best configure a specific alternative to achieve effective product differentiation (positioning), (3) using KNN to accomplish efficient product selection (recommendation). More importantly, hundreds of consumers are surveyed to justify the validity of the presented framework.

1. Introduction

In recent years, market growth in smartphones is slow and becoming more and more flattening [25,26]. Suppose you live in the developed country (i.e. West Europe, North America, and Asia Pacific regions), the future of smart phones is all about "upgrades" because people have already owned at least one by now. In contrast, wearable devices like smart watches, smart glasses, and wristbands are capturing much more eyes than before [24]. One of the most critical reasons is nothing but portability, especially in a hand-free user interface [6]. However, Google decided to terminate selling its smart glasses because of considering security, safety, and invasion of privacy. Although BI intelligence predicts an amount of over 30 billion in wearable devices can be reached before 2018 (see Fig. 1 [29]), a recent marketing survey indicates that almost 70% respondents may not be interested in buying Apple's new iWatch (http://www.reuters.com). In fact, consumers are not willing to purchase a high-priced iWatch because smartphones have already replaced the conventional watches and the low-end digital cameras for many years [30].

Today, a smart watch is well accepted to be an important area to move forwards [19]. In practice, one of the most critical concerns is learning how to lock smart-watch users into the smart-phone platform. It is equivalent to lock people into using an operating system so that when it comes to an upgrade they will not desert your brand. That means, to enlarge a market share, a manufacturer may produce a watch that is compatible with Apple's iOS, Google's Android, and Microsoft's Windows. For instance, Sony, Samsung, and Apple attempt to provide smart watches to lock their existing smartphone users. In contrast, Nike and other sport brands attempt to deliver watches that work with handsets and major in fitness or health features. Meanwhile, Epson (Seiko) and Casio has already developed a variety of sport watches for many years and they can easily switch to this field. Similar to the war in smartphones, the key point to a brand company is creating something magical and delivering its fans something to brag about [21].

In order to hold the crown as a key innovator in the consumer-electronics, only upgrading existing products is absolutely insufficient to inspire dynamically changing consumers. Needless to say, it is tough for brand companies to survive in a globally customized economy although they are always planning and launching new products for acquiring diverse customers [7,17,18]. One of the best examples is like Apple's iMac, iPod, iPhone, and iPad series, which have been heralded as an "*aesthetic*" paradigm in industrial design. Obviously, the front-end aspects like user preferences or user perceptions are not only critical to stimulating product sales, but also influential to constructing a firm's product image [11,12,16].

Inspired by Fig. 2, a novel framework is presented to bridge the research gaps between product customization, product differentiation, and product selection [14,15,22,24]. In particular, the latent relationships among user profiles, design attributes, and product alternatives are systematically explored. Without loss of generality, this study

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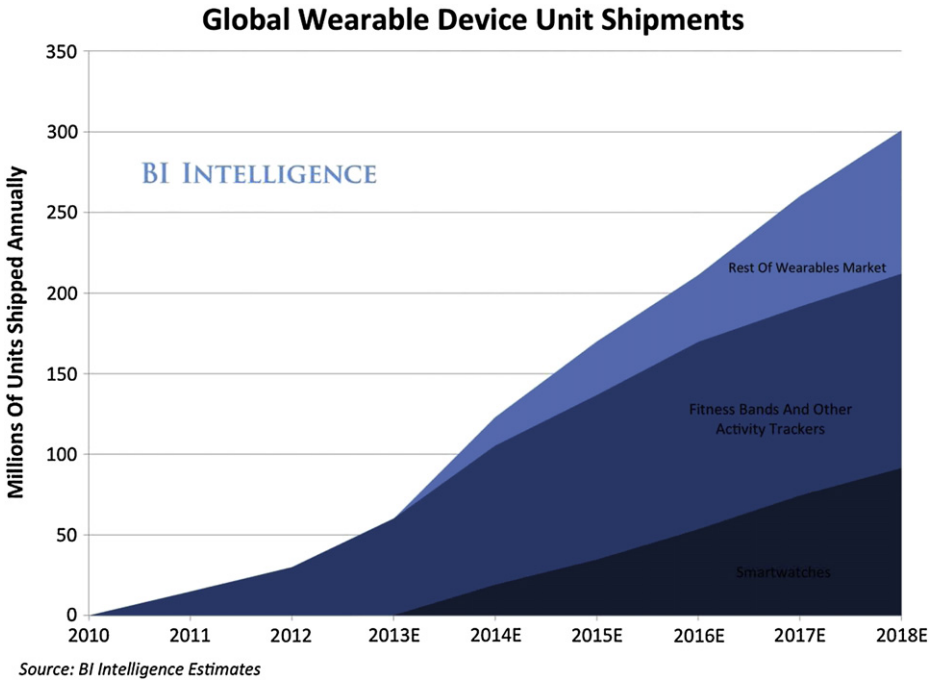

Fig. 1. A worldwide prediction on product sales of wearable devices [29]. (http://www.businessinsider.com/smart-watch-and-fitness-band-sales-2014-1).

focuses on three wearable devices, such as wristband, smart watch, and sport watch. In brief, several critical issues are addressed as follows:

- What are the impacts of user profiles on user preferences for wearable devices?
- What are the best portfolios of design features to configure various alternatives?
- How to incorporate user perceptions of design features into product selection?

Furthermore, managerial insights are offered to assist product planners in planning next-generation wearable devices. The rest of this paper is organized as follows. Section 2 overviews the concepts of product positioning (differentiation) and product recommendation (selection). The proposed framework integrating multiple correspondence analysis (MCA), association rule mining (ARM), with *K* nearest neighbor (KNN) is presented in Section 3. Section 4 illustrates a real example to develop user-driven wearable devices. Conclusions are drawn in Section 5.

2. Literature review

New product development (NPD) defined as a process of transforming an identified market opportunity into profitable product(s) for sale, in which a firm could employ it to accomplish the goal of customization, differentiation, and commercialization [5]. In general, the market is full of diverse customers who differ in usage preferences, buying behaviors, demographic profiles, and psychographic backgrounds [11,17,27]. Typical variables commonly used for carrying out market segmentation include demographic variables (i.e. age, gender, race, and salary), psychographic variables (i.e. social class, lifestyle and user perception), and behavioral variables (i.e. user preference and usage pattern).

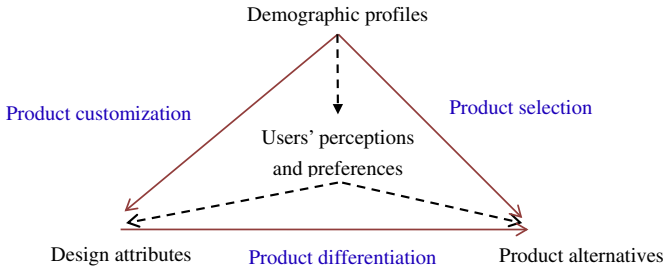

Fig. 2. The conceptual research framework.

For simplicity, this study only takes user profiles and user perceptions (see Fig. 2 again) into account. Specifically, product customization can be defined as selecting or arranging portfolios of design attributes (DAs) so as to satisfy given customer needs. In order to tackle the trade-offs between controlling product varieties and satisfying heterogeneous customers, a "STP" approach (segmentation–targeting–positioning) is commonly adopted to help companies focus their limited resources on the *ad-hoc* niche segments.

2.1. Product positioning and differentiation

In terms of strategic marketing, "*positioning*" refers to implementing a set of tactics to ensure that these characteristics can occupy a unique position in the minds of customers while "*differentiation*" means the creation of tangible or intangible characteristics in one or more dimensions between a firm's product and its main competitors' alternatives [13]. Optimal differentiation corresponds to determining which design attributes and associated levels should be configured in products to satisfy given customer requirements and to distinguish a product from existing alternatives, concurrently [12]. In simple words, product positioning is not what you do to a product but it is what you do to the prospect of customers. In practice, it is implemented through a series of steps: (1) visualizing competing alternatives and product features in a low-dimensional space, (2) constructing a predictive model to forecast how potential buyers will react to a marketing stimulus, and (3) determining the optimal position of new product (s) and identifying the niche segments [23,24].

To the best of our knowledge, typical schemes including multidimensional scaling and (MDS) and multiple correspondence analysis (MCA) are commonly to visualize the complex relationships between design attributes and product alternatives. The objective of the MDS is