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Game Theoretical Models in New Product Development

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INTRODUCTION

In the past four decades, research of new product development has attracted attention from both academia and practitioners. The success of new product development has been regarded as one important source of firms' competitive advantage (Krishnan & Ulrich, 2001; Luo, Kannan, Besharati, & Azarm, 2005). In order to guide decision making in product design, several consumer-driven methodologies, such as conjoint analysis, discrete choice model, etc, have been developed in the literature. These methods implicitly assume that the choice of product attribute should solely consider the market (consumer) needs. As a result, these methods seek to elicit "true" consumer preference without considering the strategic interactions among stakeholders in product design. Recently, another school of methods, which are mainly game-theoretically based, have emerged in the literature. These game theoretical models seek to open the "black box" of stakeholder interaction both *between* and *within* the organization and offer insights on how such strategic interaction will have an impact on product design. In this chapter, we are going to review some basic game theoretical modes as well as their applications in the product design literature. The methods and applications described in this chapter also have broad applicability in the research of innovation, project management and operations management.

In the following sections, we will start with a brief overview of one particular type of consumer-driven product design methods, i.e., conjoint analysis. Providing a comprehensive review of conjoint analysis is clearly beyond the scope of this chapter. The purpose, instead, is to make a clear comparison between consumer-driven methods and game theoretical models, hence achieve a better understanding of how the game theoretical models are complementary to previous methods. Next, we will review game theoretical models in both strategic and extensive forms and discuss their applications in the literature. Thoughts for future research are concluded at the end.

BACKGROUND

Conjoint analysis is a well-established multivariate research technique that facilitates conjoint elicitation of consumer preferences of competing product or service features or attributes for multiattribute options (Johnson, 1974; Green & Wind, 1975; Green & Srinivasan, 1978; Green & Srinivasan, 1990). It views products as a bundle of individual attributes, which permits the summation of the set of respondent utility or part-worths to equal the total utility of the product or service, where it is assumed, according to what is called the compensatory rule (Vriens, Oppewal, & Wedel, 1998), that respondents will select the product or service with the set of attributes representing the highest utility. Conjoint analysis therefore implies a decompositional approach of product development. In these hypothetical situations (Ding, Grewal, & Liechty, 2005), by simulating changes in existing products or the introduction of new products, con-

sumer trade-offs are surveyed to understand how designers can tailor their offerings to maximize value, convenience, suitability, and other factors in their products and services and product and service lines (Green & Wind, 1975). Nowadays, conjoint analysis is the dominant methodology for decompositional analysis (Green, Krieger, & Wind, 2001), and has nearly universal academic acceptance (Gibson, 2001). As a result, conjoint analysis has broad usage, ranging from individuals to organizational consumers (Green & Wind, 1975), and applicability, ranging from evaluating new product configurations, to package design, to pricing scheme, to competitive retaliation and market share (Green & Wind, 1975).

Typically, a conjoint analysis is composed of six steps (Green & Srinivasan, 1978). We refer readers to Green & Srinivasan (1990) for a detailed review on how to conduct conjoint analysis.

Consumer-driven method in new product development, despite of its popularity and maturity in the context of marketing, has several serious drawbacks in practice. First, it implicitly assumes that the attributes of a product are quantifiable and therefore "objective." In practice, however, it is extremely difficult to represent the overall appeal of products, especially those for which aesthetic and other holistic product attributes are important (Krishnan & Ulrich, 2001). As a result, several key aspects of product development decisions have been ignored in consumer-driven methods. For example, it is well acknowledged among industrial designers that several important qualitative aspects of products typically are not considered as conjoint attributes (Srinivasan, Lovejoy, & Beach, 1997), yet they significantly affect consumer preferences, therefore the authors argue for consumer-ready prototypes augmented by verbal description (in contrast to specifications-driven design) to better mimic a realistic buying experience rich in consumer information. These qualitative attributes include aesthetics and emotional appeal, ergonomics and usability, and a sense of quality of manufacturer, product integrity, and craftsmanship, all of which are consumer preferences.

Second, the power of consumer-driven method mainly comes from consumer preference elicitation (Luo et al., 2005). Unfortunately, the consumers' evaluation of certain products is often influenced by their lack of familiarity of the new products, the uncertainty about the benefits and risks associated with the products, their ability to understand how the products operate, as well as their perceptions of the product safety (Veryzer, 1998; Saunders, Seepersad, & Holtta-Otto, 2011). Gilbride, Allenby, and Brazell (2006) asserted that consumers have cognitive constraints and therefore respondents may lack insight into their actual purchasing preferences, and hence they will be erroneously articulated in the conjoint analysis process. Hoeffler (2003) also cautioned about likely situations where respondents do not understand how to calculate the benefits of attributes or levels, or where consumer consumption behavior would change as a result of the purchase and therefore survey results would have low predictive validity. As a result, conjoint analysis, which utilizes consumer needs' analysis to create slight generational improvements to an existing product, is often a relevant tool for incremental innovation but not a good predicator of radical innovation (Veryzer, 1998; Saunders et al., 2011). To improve the validity of consumer preference elicitation, Vriens et al. (1998) emphasized the necessity to adopt choice-based conjoint approaches over judgment-based conjoint approaches as a method that is superior at the segment and aggregate level. Strebinger, Hoffmann, Schweiger, & Otter (2000) further emphasized the need for realism in the presentation of conjoint stimuli, proclaiming real products as superior to pictorial stimuli, which are superior to verbal description. They further advocate for a degree of involvement from respondents that corresponds to the extent of involvement in the buying decision or holdout task. To further maintain realism, Hoeffler (2003) added that respondents must be given the same information (no more or less) than they would be provided in the marketplace. Luo et al. (2005) introduced the need to consider both product us-

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