



Combining conjoint analysis, scenario analysis, the Delphi method, and the innovation diffusion model to analyze the development of innovative products in Taiwan's TV market

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ABSTRACT

In science and technology industries, innovative products are launched rapidly, making the lifecycle of new products ever shorter. Thus, it is important that companies understand consumers' needs and consider expert opinion when analyzing the development of a new technology. However, no studies have combined these two perspectives with regard to the development of a new product. Therefore, this research combined conjoint analysis, scenario analysis, and the Delphi method with the innovative diffusion model to analyze the development of Taiwan's TV market over the next 10 years. The results show that the outlook for demand for light-emitting diode (LED) TVs in Taiwan is very optimistic; sales of LED TVs will surpass sales of liquid crystal display TVs in 2015 in the optimistic scenario and in 2017 in the most likely scenario.

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1. Introduction

When a new-generation product is introduced into the market, older ones, especially in high-tech industries, may either continue to exist or be replaced by the newer product. Therefore, the introduction of a new-generation product results in diffusion and substitution effects in the market. To better understand and describe this process, Fisher and Pry [1] developed the technological substitution model to analyze the penetration process of new-generation technology. However, this model does not address levels of scale for each generation, and market shares exhibit much more regularity than do absolute scales [2]. Marchetti and Nakicenovic [3] revised Fisher and Pry's [1] model to make it applicable to the analysis of more than two competitive technologies. Furthermore, Norton and Bass [2] proposed a multigenerational diffusion model that takes into account diffusion effects, substitution effects, and time-varying factors. Nevertheless, this model is limited by insufficient data for the latest generation product. Scenario analysis produces rich and complex portraits of possible future scenarios; however, it does not provide objective quantifiable forecasting results [4]. For that reason, some researchers have combined scenario analysis (to address an uncertain future) and quantitative methods to analyze the future development of new-generation technology. For example, Wang and Lan [5] combined scenario analysis and the technological substitution model to forecast new-generation technological development. Tseng et al. [6] combined scenario analysis, the Delphi method, and the technological substitution model to analyze the organic light-emitting diode (OLED) TV market. However, they did not consider consumers' heterogeneity. Jun and Park [7] were the first to propose a model that incorporates both diffusion and choice effects to capture simultaneously the diffusion and substitution processes for each successive generation of a durable technology; Jun et al. [8] and Kim et al. [9] revised this model. Lee et al. [10] proposed a two-stage model that uses consumer preferences to analyze the development of TV technology. They combined conjoint analysis (customer preference analysis) and Bass' diffusion model to estimate the market potential of large-screen TVs. However, they did not consider expert

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opinion and develop the future scenarios. In fact, TVs of many types exist and compete simultaneously, and thus consumer preference and expert opinion are very important in predicting the development of TV technologies. However, no studies have combined these two perspectives. Therefore, the present research question is how to consider consumer preference and expert opinion when analyzing the development of multigenerational technologies.

We considered both customer and expert viewpoints when analyzing the development of cathode ray tube (CRT), liquid crystal display (LCD), and light-emitting diode (LED) TV technology in Taiwan. That is, we performed conjoint analysis to analyze customers' preferences and then combined these results in the scenario analysis. Based on expert opinion, we address possible scenarios for the development of the LED TV. Furthermore, we elaborate specific scenarios and then use the innovation diffusion model to forecast sales volume of CRT, LCD, and LED TVs for each scenario over the next 10 years.

This paper is organized as follows. Section 2 describes conjoint analysis, scenario analysis, and the innovation diffusion model. Section 3 describes the methodology. Section 4 presents the empirical analysis. Section 5 discusses the results and presents conclusions.

2. Conjoint analysis, scenario analysis, and the innovative diffusion model

2.1. Conjoint analysis

Conjoint analysis is a technique for analyzing situations in which a decision maker has to consider options that vary simultaneously across two or more attributes [11]. Luce and Tukey [12] invented conjoint measurement, which was originally applied to the area of mathematical psychology. Green and Rao [13] adjusted Luce and Tukey's model, then introduced it into marketing research. Carmone et al. [14] changed the name from *conjoint measurement* to *conjoint analysis*. Thereafter, the technique was applied to many social science fields, including marketing, product management, and operation research.

In the 1980s, conjoint analysis and computer programming technologies such as adaptive conjoint analysis developed rapidly, resulting in the development of commercial conjoint analysis programs [15]. In the 1990s, an important commercial system, the Statistical Analysis System (SAS), was developed by Kuhfeld, Tobias, and Garratt [16]. Today, more than 30 years later, researchers continue to improve conjoint analysis by introducing more efficient design plans and reducing the complexity of conjoint questions. Yet no matter how it changes, the conjoint analysis process follows the six steps proposed by Green and Srinivasan [17] and shown in Table 1.

2.2. Scenario analysis

Since the 1960s, scenario analysis has been an important method for predicting future developments. It has been used in many areas, such as energy [18], hydrogen fueling systems [19], and biotechnology [20]. Some researchers have also adapted it for use in strategic management [21]. Because scenario analysis is a qualitative method, it fails to provide quantitative forecasts; rather, it provides rich and complex portraits of possible future scenarios [4]. Therefore, to improve the precision of their results, researchers may combine scenario analysis (to address an uncertain future) and other quantitative methods to analyze the future development of new-generation technology. Generally speaking, researchers collect the opinions of experts when conducting scenario analysis; however, experts' opinions often vary greatly. Therefore, some researchers combine scenario analysis and the Delphi method to generate future scenarios [22,23]. There are numerous approaches to conducting scenario analysis. Table 2 lists the procedures of six different studies used to create scenarios.

2.3. The innovative diffusion model

Norton and Bass [2] proposed the multigenerational diffusion model based on the simple diffusion model [24] and the technological substitution model [1]. They proposed that the development of every generation of a product involves not only diffusion

Table 1
Steps involved in the conjoint analysis.

Steps	Alternative methods	Our adoption method
1. Selection a preference model	Vector model, Ideal-point model, Part-worth model, Mixed model	part-worth function
2. Data collection method	Two-factor-at-a-time (trade-off analysis), Full-profile (concept evaluation)	Full-profile (concept evaluation)
3. Stimulus set construction for the full-profile method	Fractional factorial design, Random sampling from multi-variate distribution	orthogonal design
4. Stimulus presentation	Verbal description (multiple cue, stimulus card), Paragraph description, Pictorial or three-dimensional model representation	pictures and descriptions
5. Measurement scale for the dependent variable	Paired comparisons, Rank order, Rating scales, Constant-sum paired comparisons, Category assignment (Carroll, 1969)	Rating scales
6. Estimation method	MONANOVA, PREFMAP, LINMAP, Johnson's nonmetric tradeoff algorithm, Multiple regression, LOGIT, PROBIT	MONANOVA

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