Expert Systems with Applications 37 (2010) 4749–4760

Contents lists available at ScienceDirect

Expert Systems with Applications

journal homepage: www.elsevier.com/locate/eswa

Planning the development strategy for the mobile communication package based on consumers' choice preferences

Chia-Li Lin [a,*], Chun-Wen Chen [b], Gwo-Hshiung Tzeng [b,c,1]

[a] Graduate Institute of Human Resource and Knowledge Management, Department of Business Management, National Kaohsiung Normal University, Kaohsiung No. 116, Heping 1st Road, Lingya District, Kaohsiung City 802, Taiwan
[b] Institute of Management of Technology, National Chiao Tung University, 1001, Ta-Hsueh Road, Hsin-Chu 300, Taiwan
[c] Department of Business and Entrepreneurial Administration, Kainan University, No. 1 Kainan Road, Luchu, Taoyuan 338, Taiwan

ARTICLE INFO

Keywords:
Mobile communication
Package selection system
AHP
Fuzzy integral
Mass customization
Consumers' choice preferences

ABSTRACT

This study aims to determine the services provided by TSPs for motivating the consumers to purchase new e-era mobile phones and find their corresponding functions of products, and to plan new e-era mobile phones based on customers' attributes for satisfying the customer needs. This study uses four aspects (image of product, price of product, function of product and derived function of product) and 14 criteria to determine customer's motivations of purchase and needs on new e-era mobile phones. We also combined AHP (Analytic hierarchy process) and FIM (Fuzzy integral method) with MCDM techniques to construct the value-created evaluation model for planning the new e-era mobile phones. This study selects 27 styles of 3G mobile phones already sold on the market, and uses the different customer's attributes data to evaluate price's satisfaction (product's price) and value's satisfaction (product's image, product's function and product's derived function) for performance of these 3G mobile phones in a 2-axle evaluation map based on mass customization. This study shows three different customer's attributes (male, female, both) to measure the satisfaction performance of 3G mobile phones in a 2-axle development strategy map using data from people that are surveyed randomly by 21–30 years old. The development strategy map will provide some new strategy view for developing new e-era mobile phone market based on value and price-satisfied portfolios.

1. Introduction

In the past, the manufacturers of mobile phones dominated the development of the mobile telephone market. As a result, the telecommunication service providers (TSPs) in purchase strength and subsidy policy divided the telecommunication markets into two different types of markets. Some TSPs will subsidize and promote well-known brands of mobile phones; therefore, their operation strategy is to adopt a series of mobile phones based on consumers' preferences, and to provide the promotional mobile phones bundled with their service package through technology innovation. Other TSPs provide custom-made mobile phones, developed under the collaboration of manufacturers; therefore, their operation strategy is to develop a huge number of customized mobile phones based on the requirements of several different groups of consumers based on mass customization for reducing the production costs and for satisfying the customers' needs.

Today, the third generation mobile telecommunication technologies are to promote the use of the internet through mobile phones in e-era. Therefore, the new e-era mobile phone not only comes with a telecommunication function but it also integrates many functions of data processing, multimedia play, image and video photographs and so on depended on the customers' needs. The specifications and functions of the mobile phone generally evolved with the development of telecommunication technology. New e-era mobile phones not only follow the telecommunication agreements, but also include diverse functions and style designs. So it pushed the development of the mobile phone to move to lightweight, low power, and diverse functions that are fashionable and easy to use. Today, e-era mobile phones require diverse functions for satisfying the customers' needs. Besides, the mobile phone manufacturers and telecommunications providers must ponder on how to find the customer's needs for the next generation. We use a two dimensional (value and price) preference diagram to build the innovation strategy diagram of the mobile market.

Base on customers' needs in preferences product information is to emphasize price, brand name, and quality. According to Vinson, Scott, and Lamont (1977), they found that product image will influence the customer aspiration, no matter what color, style, or

* Corresponding author.
E-mail addresses: linchiali0704@yahoo.com.tw (C.-L. Lin), ghtzeng@mail.knu.edu.tw (G.-H. Tzeng).
[1] Distinguished Chair Professor.

0957-4174/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.eswa.2009.11.009

quality of material. These characteristics can bring the reaction of image, impression and emotions, and these characteristics will influence the attraction of the product and customer impression of the brand name. The value-created from product image means the difference in social culture symbolization, product position of market, and preference of brand name. Therefore, if product price means some kinds of cost or expense, the customer will search to maximize product value in the limitation of the budget. Therefore, the source of value-created comes from the result which customers' needs can be satisfied with product characters and functions (Woodruff, 1997). If the product or service can increase the utility/value with price and use period, then customers will purchase these products. So the new product will replace the old product by product functions, and the new product will push customers to adapt them by price strategy (Fishman & Rob, 2002). Some research analyzed the position of brands/products for mobile phone market by the preference map of multidimensional scaling method and influence-satisfaction matrix (Cha, Kim, & Lee, 2009). In order to satisfy customers' heterogeneous needs and provide mass customization manufactures, some research made a lot of effort on the recommendation system of classification-based for personalization purchase of mobile phone (Lee & Kwon, 2008; Zhang & Jiao, 2007).

Based on above literatures the concepts of mass customization are considered in our paper. How can we create a new e-era mobile phone to achieve our aspired/desired levels for good fit in custom-made and for low cost in mass production to satisfy the customers' needs? Therefore the mobile phone will become the mobile device of diverse functions for different group customers in custom-made. We can determine the customer's needs and design portfolio through the investigation of different customers of characteristics/features. The study finds customers' needs with four aspects (product image, product function, derivative function, and product price) and 14 other criteria. In this paper we propose an evaluation model for creating a new e-era mobile phone is built by combined the AHP (Analytic hierarchy process) and the FIM (Fuzzy integral Method) with MCDM techniques for finding the synthetic indexes and reducing gaps to achieve the aspired level. The research finds among criteria are not completely independent, some criteria (i.e. product design, product impression and product quality) of value-created aspects (i.e. .product image) are the multiplicative effect, and some criteria (i.e. internet service and store) of value-created aspect (i.e. product function) are the substitutive effect in real case. An empirical of 27 styles of 3G mobile phones is illustrated to demonstrate the value-created system of mobile phone market. Then our research results can help enterprise to understand the product competitive competences for mobile phone market.

The remainder of this paper is organized as follows. In Section 2, the value-created system of mobile phone market based on customer choice behavior is reviewed and discussed. In Section 3, an evaluation model for mobile phone market is proposed. In Section 4, an empirical study of mobile phone market for value-created is illustrated to demonstrate the proposed methods. Finally, conclusions and remarks are presented in Section 5.

2. Review on the package selection system of mobile communication package

Traditionally, since the information of product was lacked and the product function was more simplex, customers usually emphasized price, brand name, and quality (Rao & Monroe, 1989; Tomat, 2006; Tsao, Pitt, & Berthon, 2006; Zeithaml, 1988). Recently, customers can easily obtain information about price, quality and function of products they would like to buy through the Internet etc. Therefore, the phenomenon pushes enterprises need to understand customers' preferences in the diverse mobile phone market. A market position model of product/brand considered that the aspects (marketing mix) should include product, price, distribution, advertising and sales promotion (Cha et al., 2009). A selection model of value-added services for system operators suggest that the aspect of service function included entertainment, transaction, information, and communication (Kuo & Chen, 2006). Although some criteria were suggested in their evaluation models of mobile phone market, these authors still hope more criteria to fulfill evaluation model of mobile phone market. Therefore this study provides a value-created system of mobile phone market which included four aspects: (1) product images, (2) product functions, (3) derived function and service, and (4) package price.

2.1. Package selection system of product images

Chuang, Chang, and Hsu (2001) analyzed the preference impression of design trend and design elements for mobile phones by the morphological analysis method and defined the soft critical design elements to evaluate the suitable design solution of mobile phone. Lin, Lai, and Yeh (2007) points out that the importance of product image for customer choice of product, and provides a method which integrates Kansei and fuzzy logic. The method analyzes the integration solution between product impression and style design. Study results show that product color is more of an influence than product style in product image, and product style and color have a matching relationship each other. Besides the use of mobile phones becoming more complex with the expansion of functions, the design of the function table is more and more important. Lee, Hong, Smith-Jackson, Nussbaum, and Tomioka (2006) provides methods to find the useful information of the relationship between product features/characteristics and impression of emotion from historic sales data. Jiao, Zhang, and Helander (2006) linked specific perceptual language and the design element by affinity grouping, and improved the process of using the perceptual mining system. The method provided a communication language between customer and manufacturer. These studies give us an important idea of customer preferences of product image. Product aspect should include tangible characteristics and intangible characteristics, and advertising aspect should include advertising contents, advertising media, and advertising copy/campaign (Cha et al., 2009). A research of product design for mobile phone considered product form features should include body (length, width, thickness, volume and type), function button (type, style), number button (shape, arrangement) and panel (detail treatment) and analyze the customer' needs of product designs for different styles users (plain, sports, female, simplicity and business) (Shieh & Yang, 2008). Therefore, we know the new generation mobile phone not only needs a telecommunication function but also a fascinating style design and diverse function application. For mobile phones to attract customers to purchase them, they must have their own charismatic product image and diverse product function.

2.2. Package selection system of product functions

Mobile phone becomes the requisitions devices with the diffuseness of mobile phone. Røpke (2003) points out that the mobile phone' three motives of use include: (1) ensure safety and avoid danger, (2) aid to handle regular activity, and (3) aid to manage time and job activity. These motives of use can explain why people need mobile phone to handle some activities of communication and ensure the mobility in a diverse work environment. Teo and Pok (2003) investigated the cognitive attitude of adoption of the WAP mobile phone for internet users. The study found new technology, brand name, design style, and risk cognitive influenced

the cognitive attitude of adoption. Easy-to-use phones are important for the elderly, and the complementary ability of life is more important for the young. So technology innovation and also the ability of convenience and integration are important. Because of the characteristics of information convergence, mobile phone providers integrate application services in communication activities. Ishii and Wu pointed out that the internet use habit of the young, has become the core medium (Ishii & Wu, 2006). Communication function should include short message service, contact list, electronic dictionary, activity calendar, receiving and sending E-mail, and information function should include medical consultation, traffic information, real-time news and weather report, web resources and archive storage (Kuo & Chen, 2006). Therefore, medium culture becomes the dominant design when the internet can influence the communication behavior of the customer. Medium culture can influence the communication behavior of the integration mobile device and internet service function.

2.3. Package selection system of derived function and service

Ling, Hwang, and Salvendy (2006) discussed the mobile phone characteristics influence the satisfaction degree for obtaining the best value-created. The research results show color screen and voice dial can increase the satisfaction degree user, and the mobile phone integrates color screen and internet browsing can have higher satisfaction degree. The Asian female' preference of mobile phones of color screen is greater than European–American females. Male users use mobile phone of diverse functions (photograph, internet browsing, WAP, etc.) more than females. Mobile phone becomes diverse-function mobile devices with the development of telecommunication technology – innovation, and the mobile phone can easily search various mobile content services (news, meteorology, sport game reports, stock and exchange record, music, E-mail, etc.). Entertainment function should include popular music download, ringing tone download, electronic games, broadcast, cartoon image download and transaction function should include transaction security, on-line coupons, credit card transaction record inquiry, electronic transactions, and mobile banking (Kuo & Chen, 2006). Wei (2008) provides three explanations of motive use for mobile content service: (1) if the information ability of mobile contents is more immediate, customers will increase the need of news searches and internet browsing, (2) if the social entertainment ability of the mobile is more powerful, customers will increase the need of internet browsing and game services, and (3) if customers often use voice services and value-added service, they also prefer to use the function of news searches, internet browsing, game services. The research also points out that the function cognitive of mobile phones will influence the development of the value-added of mobile phones.

2.4. Package selection system of package price

Price aspect should include economic value of prices, price performance and other special issues on prices, and sales promotion aspect should include financial aids, promotional events and point-of-purchase promotions (Cha et al., 2009). Sharp competition in telecommunication markets requires telecommunication service providers (TSPs) to attract consumers to use their relevant services by offering subsidies. The TSP's purchase strength and subsidy policy divided telecommunication markets into two different types of markets. Some TSPs will subsidize and promote well-known brands of mobile phones; therefore, their operation strategy is to adopt a series of mobile phones based on consumers' preferences, and to provide promotional mobile phones bundled with their service package. Other TSPs provide custom-made mobile phones, developed under the collaboration of manufacturers; therefore, their operation strategy is to develop a huge number of customized mobile phones based on the requirements of several different groups of consumers.

3. Building an evaluation model for mobile phone market

An evaluation model of mobile phone markets was built based on product innovation of function portfolio for satisfying the customers' needs and providing the mass customization. The evaluation model includes three Sub-sections is shown in this section. In Sub-section 3.1 is the analysis of the purchasing motives and product functions of the mobile phone. The evaluation of the value-created system for the mobile phone markets is shown in the

Table 1
Table of purchasing motives for mobile phone market.

Aspect/criteria	Purchase motives items
Products image	
Product design	1. Style*, 2. Thickness*, 3. Color*
Products impression	1. Benefit of manufacturer brand name*, 2. The service quality of service operator.*
Products quality	1. Product guarantee [#], 2. Maintain service policy *
Products function	
Telecommunication function	1. Frequency band upgrade*, 2. Await time/conversation times [#], 3. Function of dial/telephone call [#]
Internet service	1. Increase Wi-Fi*, 2. Increase internet browsing*, 3 Increase E-mail service*
Store function	1. Difficult of memory card expanded [#], 2. Insufficient storing capacity of device [#]
Transmission function	1. Transmission of infrared ray*, 2.Transmission of blue tooth's*
Derived function	
Photograph function	1. Screen quality*, 2. Quality of Photography lens*, 3. Photography function*
Data process	1. Platform expanding*, 2. Input/output function*, 3. Data process function*
Multimedia broadcast	1. Ring tones upgrades*, 2. Increase TV function*, 3. MP3 player function*
Entertainment function	1. Screen upgrade*, 2. JAVA function*, 3.The expansion of game function*
Package price	
Mobile phone price	1. Preferential mobile phone (number bonded)* 2. Price of mobile phone (no number bonded)*
Fee rate of voice service	1. Down price of general period*, 2 Increase the period of low price* 3. Preferential fee of voice telecommunication service with other operator user*
Fee rate of value-added service	1. Preferential fee of value-added service with same operator user* 2. Preferential fee of value-added service with other operator user*

Note: Symbol '*' represents the reasons s related with increase of function and quality of product and service; Symbol [#] is related with lack of function and quality of product and service.

Sub-section 3.2. The evaluation method for criteria performance of product functions is shown in the Sub-section 3.3.

3.1. The analysis of the purchase motives and product functions of mobile phone

In this Sub-section the purchasing motives and product functions of the mobile phone will be introduced. The reasons of purchasing and re-purchasing motives for customers are introduced and shown as Table 1. Based on above Section 2 the evaluation aspects/criteria are built as shown in Table 2. The analysis of purchasing motives includes four aspects (product image, product function, derivative function and product price) and 36 reasons for considering the purchasing and re-purchasing of mobile phones. There were 36 reasons of purchasing and re-purchasing motive for mobile phone market as shown in Tables 1 and 5 reasons are related to lack of function and quality of product and service, and 31 reasons are related to increase of function and quality of product and service. Then the four aspects and 14 criteria of the value-created system for mobile phones were as shown in Table 2.

3.2. The evaluation of the value-created system for the mobile phone market

In the Sub-section, the concept of evaluation model, and the decision map of product competitive ability are proposed. Then the AHP (Analytic hierarchy process) for independent aspects/criteria and FIM (Fuzzy integral method) for interdependent aspects/criteria will be introduced. Most customers make purchase decisions for product and service. They not only aspire to improve the functions and increase the product value, but also consider product price. So the purchasers choose between product low price and high value. Therefore, a suitable value-created system should integrate price and value of product by mass customization for good fit in custom-made and for low cost in mass production to satisfy the customers' needs. The research provides an innovation strategy map to show the innovation strategy of enterprises. Fig. 1 shows the decision problem of the purchase behavior and research idea map. Although the cost-effective method can help the purchaser to make a decision, a purchaser cannot measure the effective items. A purchaser often only uses the concept of satisfaction degree, so the research shows with a two axis decision map. The cross axis (X-axis) is valued by satisfaction degree; the value is organized by three aspects (product image, product function, and derivate function). Therefore, value satisfaction degree can be increased by the improvement of functions and service. The vertical axis (Y-axis) is price satisfaction (PS) degree, and the value is organized by product price. PS degree can be increased by the reduction of function and service fee rate.

Table 2
The explanation of value-created system for mobile phone market.

Aspect/criteria	Explanations
Value-satisfied degree	
Products image	
Product design	Include style, thickness and color of mobile phone
Products impression	The cognitive of manufacturer brand name and service operator
Products quality	Product guarantee and maintenance service policy
Products function	
Telecommunication function	Frequency band, telecommunication function and power effect
Internet service	Function service of Wi-Fi (wireless), GSM, Wi-Fi (internet), E-mail
Store function	The storing capacity of device, and expand ability of memory card
Transmission function	The transmit function of transmit line, infrared ray and blue-tooth et al
Derived function	
Photograph function	Include function of photography and screen function
Data process	Include data process software, input method and operating platform.
Multimedia broadcast	Include MP3 player, TV-out, FM and multimedia broadcast
Entertainment function	Game and entertainment function
Price-satisfied degree	
Package price	
Mobile phone price	Mobile phone price and subsidy price
Fee rate of voice service	Fee rate of voice telecommunication service
Fee rate of value-added service	Fee rate of value-added service

3.2.1. Research concepts

The innovation strategy map is organized by the degree of value-satisfied and price-satisfied through mass customization (as shown in Fig. 1). These 45 degree lines represent the integrated satisfaction degree line in different customer satisfaction level. Satisfaction level of customer is improved when the integrated satisfaction degree line move to right-top, the satisfaction level of customer is reduced when the integrated satisfaction degree line move to left-down. Therefore, the each point represents a product point (one kind of mobile phone). So the integrated satisfaction degree of product is to increase when the point moves to the right-top, the integrated satisfaction degree of product is reduced when the point moves to the left-down, and the integrated satisfaction degree of product is the same when the point move in the same satisfaction level line (45 degree line). The line of $P + V = 10$ shows the basic satisfaction degree of customer's, and mean a unit increase of value satisfaction degree will reduce a unit of reduction of PS degree. The satisfaction level line (45 degree line) exists at two extreme points in $P(10, 0)$ and $P(0, 10)$. $P(10, 0)$ means the highest value satisfaction degree, and the lowest PS degree, but $P(0, 10)$ means the highest PS degree, and the lowest value satisfaction degree. The two extreme points of $P(10, 0)$ and $P(0, 10)$ do not exist in the real world, most products exist in point A (as shown in

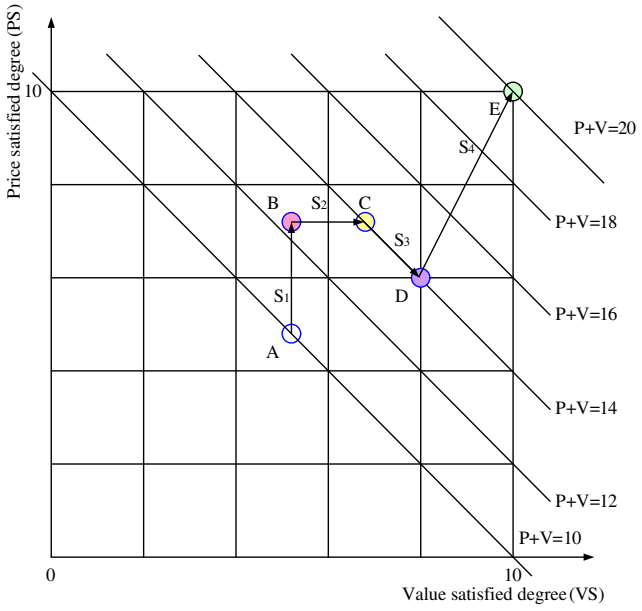

Fig. 1. The decision map of product competitive ability.

Fig. 1). Because most of the product is a common value satisfaction degree and PS degree, the advantage products must create a higher value satisfaction degree in the same or higher PS degree.

For manufacturers, they can use four innovation strategies including: (1) fix the value satisfaction degree and increase the PS degree (Low price strategy, S_1), (2) fix the PS degree and increase the value satisfaction degree (High value strategy, S_2), (3) create the diverse products in the same satisfaction level (Strategy of diverse product portfolios, S_3), (4) increase the value satisfaction degree and the value satisfaction degree by mass customization (Mass customization strategy, S_4). From point A of Fig. 1, the low price strategy (S_1) is to fix the value satisfaction degree and to increase the PS degree, and the move direction of the product point is from A to B. Low price strategy is reached by mass manufacture and scale economy. From point B of Fig. 1, we can see the high value strategy (S_2) is to fix the PS degree and to increase the value satisfaction degree, and the move direction of the product point is from B to C. The low price strategy is reached by reducing surplus function and increasing insufficient function. From point C of Fig. 1, we can see the strategy of diverse product portfolios (S_3) is to create the diverse products in same satisfaction level, and the move direction of the product point is from C to D. The strategy of diverse product portfolios is reached by increasing the opportunity of product choice. From point D of Fig. 1, we can see the mass customization strategy (S_4) is to increase value satisfaction degree and value satisfaction degree by mass customization, and the move direction of the product point is from D to E. The mass customization strategy is reached by reducing surplus function and increasing insufficient function, then reducing the price of the same needed product by mass customization manufacture. The mass customization strategy is most difficult, because it needs to integrate the customization product and mass manufacture at the same time.

The model built to evaluate the product competitive ability is based on the hybrids MCDM technique. The comparison between the proposed methods (the integration of AHP and FIM method) and the traditionally methods (the integration of AHP by SAW method, assumed among aspects/criteria are independent) would be discussed. Some commercial 3G mobile phones will be adopted to find their location of satisfaction degree in the development strategy, and will be compared with the satisfaction performance of value and price of these 3G mobile phones. Therefore, the weight difference of aspects/criteria in different attributes will be found, and the development condition of the mobile phone market will be presented. Then the analysis can assist operators to find their improvement strategies of products and services for the mobile market.

3.2.2. Analytic hierarchy process (AHP)

The AHP method was proposed by Saaty (1978, 2003, 2006), AHP was originally applied to uncertain decision problems with multiple criteria, and has been widely used in solving problems of ranking, selection, evaluation, optimization, and prediction decisions. AHP is a comprehensive framework designed to cope with the intuitive, rational response when we make multi-objective, multi-criteria, and multi-factor decisions with and without certainty for any number of alternatives.

Step 1: Confirm the criteria of decision problems.

Step 2: Build the analytic hierarchy of decision problem. In order to ensure the consistency test, the analytic hierarchy does not exceed 7 in one level.

Step 3: Pair-wise comparison of the relative importance of factors/criteria and obtain an $n \times n$ pair-wise comparison matrix; n means the number of criteria; as data shown in Table 3, the pair-wise comparison can be achieved.

Step 4: Check the logical judgment consistency using the consistency index (*C.I.*) and consistency ratio (*C.R.*). The *C.I.* value is defined as $C.I. = (\lambda_{max} - n)/(n-1)$, and the λ_{max} is the largest eigenvalue of the pair-wise comparison matrix. The *C.R.* value is defined as *C.R.* = *C.I./R.I.* (*R.I.*: random index). The *R.I.* value is decided by the value of n. In general, the values of *C.I.* and *C.R.* should be less than 0.1 or reasonably consistent (as shown in Table 4).

Step 5: Use the normalized eigenvector of the largest eigenvalue (λ_{max}) as the factor weights, as shown in Table 5. The purpose of the AHP enquiry in this paper is to construct a hierarchical evaluation system.

3.2.3. Fuzzy integral method (FIM)

In order to solve the problem of related criteria, Keeney and Raiffa (1976) provide the utility function of multiplication (assume among aspects/criteria are interdependent). Therefore, some later research adopts the concept to improve the non-added (fuzzy integral) evaluated technique for the MCDM problem. As mentioned earlier, the 2nd-level criteria within a 1st-level criterion (e.g., criteria c_{11}, c_{12}, and c_{13} in C_1) are assumed to be dependent on each other. The λ fuzzy measure is used to evaluate the importance of the dependent 2nd-level criteria. The fuzzy measure g is a set function defined on a power set $\beta(X)$ of X, and g: $\beta(X) \to [0, 1]$. The function g must satisfy the following properties (Chen & Tzeng, 2001; Tseng & Yu, 2005; Tzeng, Chiang, & Li, 2007; Tzeng, Ou Yang, Lin, & Chen, 2005).

(A) $g(\phi) = 0$, $g(X) = 1$.
(B) if $A, B \in \beta(X)$ and $A \subset B$, then $g(A) \leqslant g(B)$.

A λ fuzzy measure g_λ has the following property: $\forall A, B \in \beta(X)$, $A \cap B = \phi$; $g_\lambda(A \cup B) = g_\lambda(A) + g_\lambda(B) + \lambda g_\lambda(A) g_\lambda(B)$; and $-1 < \lambda < \infty$. Then for the definite set $X = \{x_1, x_2, \ldots, x_n\}$, the density of fuzzy measure $g_i = g_\lambda(\{x_i\})$ can be formulated as follows:

$$g_\lambda(\{x_1, x_2, \ldots, x_n\}) = \sum_{i=1}^{n} g_i + \lambda \sum_{i1=1}^{n-1} \sum_{i2=i1+1}^{n} g_{i1} g_{i2} + \cdots + \lambda^{n-1} g_1 g_2, \ldots, g_n, \quad \text{for} -1 < \lambda < \infty \tag{1}$$

In a specific case of two criteria, A and B, if $\lambda > 0$, i.e., $g_\lambda(\{A, B\}) > g_\lambda(\{A\}) + g_\lambda(\{B\})$ this implies that A and B have a multiplicative effect; If $\lambda < 0$, i.e., $g_\lambda(\{A, B\}) < g_\lambda(\{A\}) + g_\lambda(\{B\})$ this

Table 3
Pair-wise comparison.

Aspects	Product image (P1)	Product function (P2)	Derived function (P3)
Product image (P1)	1[1]	1/2[2]	5/3
Product function (P2)	2[3]	1	5/2
Derived function (P3)	3/5	2/5	1

Note 1: The parenthetic value 1 means the factor (P1) and the factor (P1) are equally important.
Note 2: The parenthetic value 1/2 means the factor (P1) is 1/2 time degree of importance than factor (P2).
Note 3: The parenthetic value 2 means the factor (P2) is 1/9 time degree of importance than factor (P1).

Table 4
The testing of consistency (*C.I.* and *C.R.* testing).

$C.I. = (\lambda_{max} - n)/(n-1)$; $n = 3$	0.005	*C.R.* = *C.I./R.I*	0.009
The threshold value	0.1	The threshold value	0.1

Note: Saaty suggested the values of *C.I.* and *C.R.* should be less than 0.1.

Table 5
Aspect weightings (pre and post normalization).

Aspect	Pre-normalization	Post-normalization (%)
Product image (P1)	0.4441	0.2795
Product function (P2)	0.8439	0.5311
Derived function (P3)	0.3009	0.1894
Total	1.5889	1.0000

Note: Pre-normalization means the largest eigenvalue as the factor weights; Post-normalization means the sum of factor weights = 1.

implies that A and B have a substitutive effect; If $\lambda = 0$, i.e., $g_\lambda(\{A,B\}) = g_\lambda(\{A\}) + g_\lambda(\{B\})$ this implies that the evaluation of the set $\{A, B\}$ equals the sum of evaluations for sets $\{A\}$ and $\{B\}$. Letting h be a measurable set function defined on the measurable space, and suppose $h(x_1) \geqq h(x_2) \geqq \cdots \geqq h(x_n)$, then the fuzzy integral of fuzzy measure $g(\cdot)$ with respect to $h(\cdot)$ can be defined as follows (Chen & Tzeng, 2001; Chiou, Tzeng, & Cheng, 2005; Murofushi & Sugeno, 1989; Sugeno, Narukawa, & Murofushi, 1998; Tseng & Yu, 2005; Tzeng et al., 2005). This study employs the value of the fuzzy integral to express the aggregated synthetic score of 1st-level criterion by fuzzy weights measure $g(\cdot)$ and evaluated score $h(\cdot)$ of each 2nd-level criteria.

$$\begin{aligned}\int hdg = {} & h(x_n)g(H_n) + [h(x_{n-1}) - h(x_n)]g(H_{n-1}) + \cdots \\ & + [h(x_1) - h(x_2)]g(H_1) = h(x_n)[g(H_n) - g(H_{n-1})] \\ & + h(x_{n-1})[g(H_{n-1}) - g(H_{n-2})] + \cdots + h(x_1)g(H_1) \end{aligned} \quad (2)$$

where $H_1 = \{x_1\}$, $H_2 = \{x_1, x_2\}, \ldots,$ $H_n = \{x_1, x_2, x_3, \ldots, x_n\} = X$. The concept of Eq. (2) can be illustrated as shown in Fig. 2, and an example is illustrated in the example project.

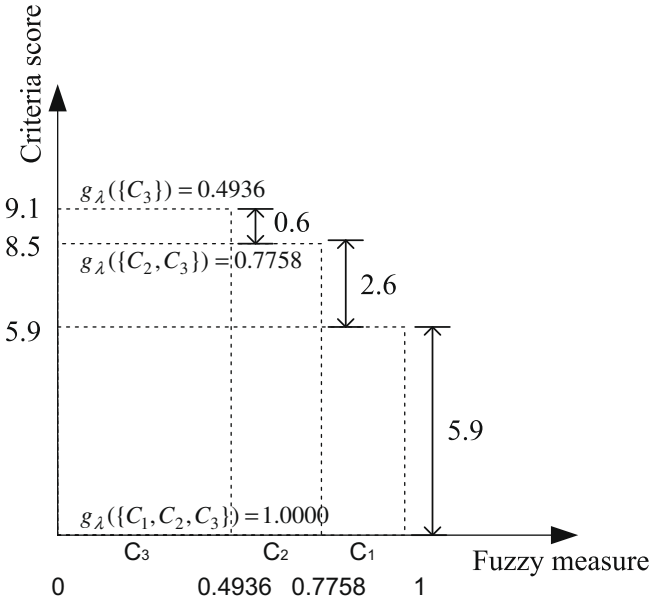

Fig. 2. Concept for fuzzy integral.

Table 6
The utility scores of criteria.

Criterion	Criteria explanation	Criteria scores
C_1	Product design	5.9
C_2	Impression of the products	8.5
C_3	Quality of the products	9.1

Table 7
The explanation of fuzzy measure.

Criteria set	Utility value of plan	Criteria explanation
C_3	0.4936	Product quality
C_{23}	0.7758	Products quality, product impression,
C_{123}	1.0000	Products quality, product impression, product design

Tables 6 and 7 show the C_1 (product image) utility value of mobile phones for the Nokia N93. The process of evaluation is as follows:

$$5.9 \times 1 + (8.5 - 5.9) \times 0.7758 + (9.1 - 8.5) \times 0.4936 = 8.2$$

3.3. Evaluation for criteria performance of product function

In order to help readers to understand our research model, the real empirical data for the group of 21–30 ages is applied to demonstrate the model. In first, the weight difference of gender attitudes based on AHP method would be analyzed, and comparison between the performance of product features/functions with two 3G mobile phones and the difference of performance value for the two mobile phones are discussed.

We want to find out the satisfaction degree by scoring the criteria. In this Sub-section we analyze the scores of value-created aspect including three value-satisfied aspects and one price-satisfied aspect. The value-created aspect includes product image, product function, and derived function. The aspect of product image includes three criteria (product design, product impression, product quality), the aspect of product function includes four criteria (Telecommunication function, Internet service, Store function, Transmission function), and the aspect of derived function includes four criteria (Photograph function, Data process, Multimedia broadcast, Entertainment function). The price created aspect includes the product price. The aspect of product price includes three criteria (Mobile phone price, Fee rate of voice telecommunication service, Fee rate of value-added service) (as shown in Table 8). From Tables 9 and 10, we can see the solution/plan scores of product image aspect, Nokia N93 is a mobile phone of serpentine of hided aerial, thick, black-and-white, because the user use average

Table 8
The weights of evaluation criteria for sex attributes.

Aspects/criteria	Full	Male	Female
Value-satisfied degree			
1. Product image	**0.2795**	**0.3414**	**0.2166**
PI1. Product design	0.0647	0.0911	0.0358
PI2. Products impression	0.0628	0.0873	0.0357
PI3. Products quality	0.1520	0.1630	0.1451
2. Product function	**0.5311**	**0.4139**	**0.6447**
PF1. Telecommunication function	0.2879	0.2297	0.3314
PF2. Internet service	0.0872	0.0628	0.1234
PF3. Store function	0.0823	0.0621	0.1064
PF4. Transmission function	0.0736	0.0592	0.0835
3. Derived function	**0.1894**	**0.2447**	**0.1387**
DF1. Photograph function	0.0682	0.0739	0.1026
DF2. Data process	0.0340	0.0512	0.0089
DF3. Multimedia broadcast	0.0490	0.0666	0.0156
DF4. Entertainment function	0.0381	0.0530	0.0116
Price-satisfied degree			
4. Package price	1.0000	1.0000	1.0000
PP1. Mobile phone price	0.5036	0.5030	0.5049
PP2. Fee rate of voice service	0.3653	0.3680	0.3601
PP3. Fee rate of value-added service	0.1310	0.1291	0.1351

Table 9
Score of the value-created system for the aspect of product image.

Style of mobile phone	Nokia N93		Sony Ericsson K800i	
Criteria/function solution	Satisfied score	Average	Satisfied score	Average
PI1. Product design				
Style	6.9	5.9	6.9	7.2
Thickness	3.4		7.2	
Color	7.4		7.4	
PI2. Product impression				
Brand name of manufacture	8.6	8.5	7.9	4.0
Service of operator	8.4		0.0	
PI3. Product quality				
Guarantee of product	8.7	9.1	4.9	7.2
Maintain service	9.5		9.5	

Table 10
Score of the product design.

Solution/plan	Satisfaction (0–10)
Style	
Serpentine (annular aerial)	5.8
Serpentine (hided aerial)	**6.9**
Slippery cover (hided aerial)	6.5
Full-length (hided aerial)	6.9
Serpentine (include aerial)	5.6
Thickness	
Thinness	8.6
Medium	7.2
Thick	**3.4**
Color	
Black-and-white	**7.4**
Gold and silver	6.9
Red and orange	5.1
Blue and green	4.8

Table 11
Score of the product function.

Style of mobile phone	Nokia N93		Sony Ericsson 800i	
Criteria/function solution	Satisfied score	Average	Satisfied score	Average
PF1. Telecommunication function				
Frequency band	6.9		6.9	
Telecommunication time of power	5.7		6.9	
Await time of power	6.1		9.0	
Telephone call	7.4		8.1	
Dial function	4.6	6.1	6.2	7.4
PF2. Internet service				
Wi-Fi (wireless)	7.3		3.6	
GPRS & 3G	6.2		6.2	
Internet function	6.6		6.0	
E-mail	6.6	6.7	6.6	5.6
PF3. Store function				
Memory card	5.8		4.6	
Storing capacity of device	5.8	5.8	5.8	5.2
PF4. Transmission function				
Transmission function	8.2	8.2	8.2	8.2

score from serpentine (hided aerial), thick, and black-and-white, 6.9, 3.4 and 7.4 separately (Table 10). We assume the equal weights to calculate the average score from these three scores (6.9, 3.4 and 7.4), then we determined the average score as 5.9. So the average score of product design criteria is equal to 5.9 (Table 10).

Table 12
Score of the derived function.

Mobile phone name	Nokia N93		Sony Ericsson K800i	
Criteria/function solution	Satisfied score	Average	Satisfied score	Average
DF1. Photograph function				
Screen	6.4		6.4	
Pixel	6.5		6.5	
Screen size	6.6		4.2	
Outside screen	7.4		3.2	
Sensitization component	4.9	6.7	4.9	6.1
Pixel of main camera lens	8.0		8.0	
Camera lens of Video	7.5		7.5	
Flash	7.0		7.0	
Continue photo	6.4		6.4	
Oneself phone	5.6		2.8	
Zoom lens	7.6		5.8	
Modulation of light and shade	7.9		7.9	
Dynamical Photograph	8.1		6.1	
Precaution shake	3.1		7.4	
Focus automatically	7.4		7.4	
DF2. Data process				
Operating system	5.2		0.0	
Input of Chinese	9.5		8.4	
Data process	8.0	7.6	0.0	2.8
DF3.Multimedia broadcast				
Ring tones of original sound	6.8		6.8	
Chord number	6.4		7.2	
FM	6.4		3.6	
TV function	5.8		3.6	
MP3 player	3.6	5.8	8.1	5.9
DF4. Entertainment function				
Screen entertainment	6.1		6.1	
JAVA	5.8		5.8	
Game	6.9		6.9	
Specially efficacy	5.8	6.1	6.8	6.4

We evaluated the derived function and product price. We gained the average score of the aspect of product function and derived function as shown in Tables 11–13. Therefore, we evaluated the integrated weight of criteria by AHP and SAW methods as shown in Table 8. This reveals that the telecommunication function, product quality and photograph function are the most important criteria of product function, product image and derived function. We use the result of criteria score of the value- created system (Tables 9 and 11–13) to calculate the value-satisfied and PS degree of each mobile phone. Besides, the research tries to relax the independent limitation of criteria, to calculate the value-satisfied and PS degree by AHP and FIM method. We know the value-satisfied and PS degree of Nokia N93 is 7.27 and 4.46 separately, by integration of each criteria weight multiple score. With the same process, we gained the value-satisfied and price-satisfied degree of Sony Ericsson K800i to be 7.04 and 5.21 as shown in Table 14.

4. An empirical study of the mobile phone market

We evaluates the value-satisfied and price-satisfied degree of 3G mobile phones, and analyze the location of 3G mobile phones by the development strategy map as shown in Fig. 1. Then the development strategy of the manufacturer of mobile phones and telecommunication can be found. Besides, we compare the satisfaction degree for some mobile phones with two methods, so the first method is to integrate the AHP and SAW methods. The second is to integrate the AHP and FIM methods. Then we show the development strategy map of the integrated AHP and SAW method with

Table 13
Score of the product price.

Mobile phone name	Nokia N93		Sony Ericsson K800i	
Criteria/function solution	Satisfied score	Average	Satisfied score	Average
PP1. Mobile phone price				
Price of mobile phone (no number bonded)	1.8	2.3	4.1	4.1
Price mobile phone (number bonded)	2.3		2.3	
PP2. Fee rate of voice service				
Voice rate of telecommunication service	6.3	6.3	6.3	6.3
PP3. Fee rate of value-added service				
Fee rate of value-added service	4.8	4.8	4.8	4.8

Table 14
Satisfied score of mobile phone based on the hybrid method (AHP and FIM).

Value-satisfied scores	AHP weight	Function performances			
		Nokia N93		Sony Ericsson K800i	
	1.0000	AHP	Fuzzy integral	AHP	Fuzzy integral
		7.27		7.04	
PI. Product image	0.2795		8.20		6.32
PF. Product function	0.5311		6.96		7.82
DF. Derived function	0.1894		6.78		5.90
Price-satisfied scores	1.0000	4.46		5.21	
PP. Package price	1.0000		4.46		5.21

twenty-seven 3G mobile phones, and show the development strategy comparative map of the integrated AHP and SAW method and the integrated AHP and FIM method with nine 3G mobile phones.

4.1. The analysis of satisfaction degree with AHP and SAW method

Table 8 demonstrates the weights of evaluation criteria for sex attributes. In the second column, that is full group between 21 and 30 years old, we can see that the value-satisfied aspect of product function (0.5311) more than that of product image (0.2795) and derived function (0.1894). It is interesting that the same phenomenon also appears in the female group [product function (0.6447), product image (0.2166) and derived function (0.1387)] and the male group [product function (0.4139), product image (0.3414) and derived function (0.2447).] The product function is distinguished among the three aspects because the product function is most used by customers. We analyzed the most important criteria of the full group for three value-satisfied aspects (product image, product function, and derived function) are product quality (0.1520), telecommunication function (0.2879), and photograph function (0.0682). The male group pays attention to product design (0.0911), product impression (0.0873), and product quality (0.1630) greater than the female group product design (0.0358), product impression (0.0357) and product quality (0.1451). The female pays attention to telecommunication function (0.3314), internet service (0.1234), store function (0.1064) and transmission function (0.0835) greater than the male group telecommunication function (0.2297), (internet service (0.0628), store function (0.0621) and transmission function (0.0592). In the derived function, the female group prefers the photograph function (0.1026), and the male group does not show obvious preference. We analyzed the criteria weight of the full group for the price-satisfied aspect (product price) is mobile phone price (0.5036), fee rate of voice service (0.3653), fee rate of value-added service (0.1310). The results don't show obvious differences between male and female groups.

The distribution of value and PS degree for the full sample, by male and females is shown in Figs. 3 and 4. and Table 15. Therefore,

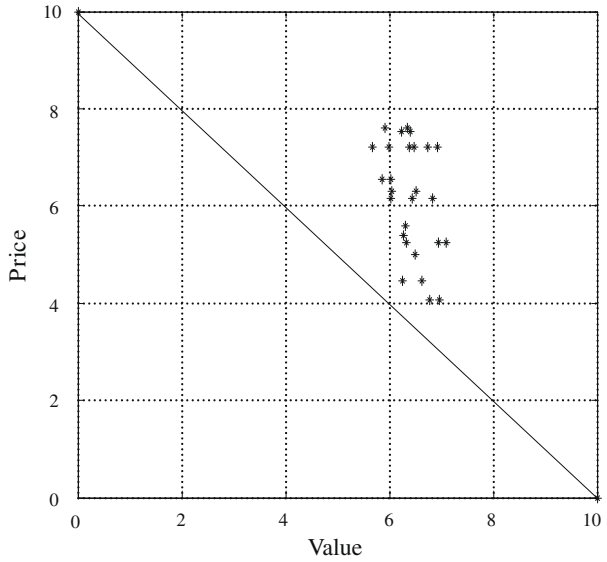

Fig. 3. The development strategy map of 21–30 years ago (AHP + SAW method).

the value satisfaction degree distributes between 5 and 7, and the PS degree distributes between 4 and 7 for the full sample. For the male group, the value satisfaction degree distributes between 5 and 7, and the PS degree distributes between 3 and 8 for male group. For the female group, the value satisfaction degree distributes between 5 and 6, and the PS degree distributes between 3 and 7 for female group. Besides, we are aware that the satisfaction degree standard of the female group is stricter than the male group, so the strategy of the manufacturer and telecommunication operator must increase product function of higher weight, and decrease the product function of lower weight. Then the manufacturer and telecommunication operator can create the customized mobile phone for a lower price, and use the mass customization manufacture method to created satisfied customers.

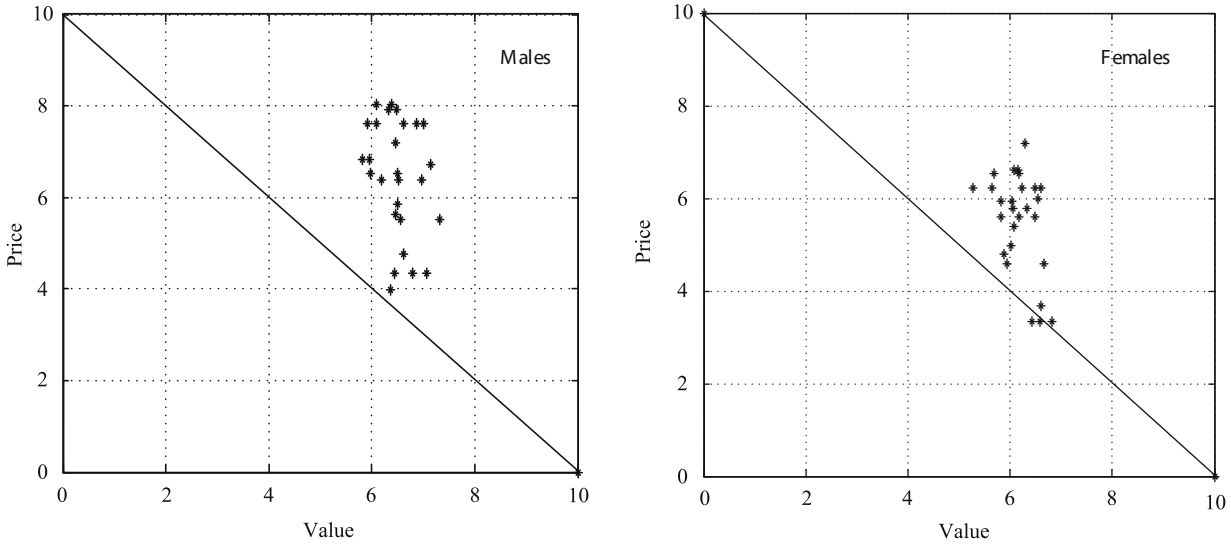

Fig. 4. The development strategy comparative map of sex attribute of 21–30 years ago (AHP + SAW method).

Table 15
The satisfaction degree of mobile telephone with AHP and SAW method.

	Brand mobile phone	21–30 Years ago satisfaction degree			Male of 21–30 years ago satisfaction degree			Female of 21–30 years ago satisfaction degree		
		VS	PS	SS	VS	PS	SS	VS	PS	SS
1	Dopod CHT9000 (C)	6.78	**4.06**	10.84	6.80	4.34	11.14	6.59	**3.33**	9.92
2	Nokia N93 (C)	6.95	**4.06**	11.02	7.06	4.34	11.40	**6.82**	**3.33**	10.15
3	Sharp WX-T91 (F)	6.25	4.46	**10.71**	6.36	**3.97**	**10.33**	6.07	5.40	11.47
4	Sony EricssonK800i (No)	6.50	5.01	11.50	6.44	4.34	10.78	6.43	**3.33**	**9.76**
5	Sharp 904SH (F)	6.62	4.46	11.08	6.61	4.77	11.38	6.60	3.67	10.27
6	Nokia N70 (C)	**7.10**	5.24	12.34	**7.31**	5.51	12.82	6.66	4.59	11.25
7	Nokia N70 (W)	6.95	5.24	12.19	7.14	6.72	13.86	6.54	5.99	12.53
8	Dopod 595 (T)	6.51	6.31	12.81	6.51	6.52	13.03	6.34	5.79	12.13
9	Toshiba 904T (T)	6.05	6.31	12.35	5.98	6.52	12.50	6.06	5.79	11.85
10	Toshiba 904T (F)	6.02	6.56	12.58	5.96	6.82	12.78	6.03	5.94	11.97
11	Toshiba 803 (C)	6.43	6.16	12.59	6.52	6.39	12.91	6.18	5.60	11.78
12	Nokia 6280 (C)	6.34	5.24	11.58	6.57	5.51	12.08	5.93	4.59	10.52
13	Nokia 6280 (T)	6.26	5.39	11.65	6.47	5.64	12.11	5.89	4.78	10.67
14	Nokia N71 (W)	6.30	5.59	11.89	6.50	5.84	12.34	6.01	4.98	10.99
15	LG U8500 (F)	5.85	6.56	12.41	**5.82**	6.82	12.64	5.83	5.94	11.77
16	Samsung SGH-Z548 (C)	6.03	6.16	12.19	6.19	6.39	12.58	5.82	5.60	11.42
17	AMOI N5000(C)	5.98	7.20	13.18	6.09	7.61	13.70	5.65	6.21	11.86
18	Sony Ericsson K610i	6.92	7.20	**14.11**	7.00	7.61	**14.61**	6.60	6.21	**12.81**
19	Motorola E770 (W)	6.40	7.54	**13.94**	6.47	7.93	14.40	6.16	6.60	**12.76**
20	Nokia 6233 (C)	6.84	6.16	13.00	6.97	6.39	13.36	6.49	5.60	12.09
21	Motorola E1070 (C)	6.38	7.20	13.58	6.47	7.20	13.67	6.29	**7.19**	**13.48**
22	Motorola E1070 (W)	6.23	7.54	13.78	6.32	7.93	14.25	6.08	6.60	12.68
23	Sony Ericsson K600i (F)	6.35	**7.60**	**13.95**	6.38	**8.03**	**14.41**	6.17	6.54	12.71
24	Sony Ericsson K750i (C)	6.74	7.20	**13.94**	6.87	7.61	**14.48**	6.48	6.21	12.69
25	Motorola V975(C)	**5.67**	7.20	12.87	5.91	7.61	13.52	**5.28**	6.21	11.49
26	Sharp WX-T71 (F)	5.92	**7.60**	13.52	6.08	**8.03**	14.11	5.69	6.54	12.23
27	BenQ-Siemens S81 (C)	6.48	7.20	13.68	6.62	7.61	14.23	6.23	6.21	12.44

Note: C, F, T, W represent four different telecommunications companies respectively, then No represent only sale mobile phone; VS: the mobile phone of lowest value-satisfied degree, PS: the mobile phone of lowest price-satisfied degree, IS: The mobile phone of lowest integrated satisfied degree.

From the full sample and male group, the result shows that the mobile phone of highest value-satisfied (VS) degree is positioned at No. 6. The mobile phone of highest price-satisfied (PS) degree is No. 23 and No. 26, the mobile phone of highest summed satisfied (IS) degree is No. 18, as shown in Table 15. For the female group, and the mobile phone of highest value satisfaction degree is No. 2, then the mobile phone of the highest PS degree is No. 21, the mobile phone of the highest integrated satisfaction degree is No. 18. From the full sample group, the mobile phone of lowest value-satisfied (VS) degree is No. 25, therefore the mobile phone of lowest price-satisfied (PS) degree is No. 1 and No. 2. The mobile phone of lowest summed satisfied (SS) degree is No. 3 as shown in Table 15. For the male group, the mobile phone of lowest VS degree is No. 15, then the mobile phone of the lowest PS degree is No. 3, and the mobile phone of the highest SS degree is No. 3. For the female group, the mobile phone of lowest VS degree is No. 25, and then the mobile phone of the lowest PS degree is No. 1, No. 2 and No. 4. The mobile phone of the highest SS degree is No. 4. Therefore, we found the phenomenon that the lowest PS degree had the highest percent to lowest SS degree. The mobile phone of low price and high subsidy policy must influence the operation of future mobile phone market. We also find another phenomenon that the mobile

Table 16
The satisfaction degree of mobile telephone with the hybrid method (AHP and FIM).

	Brand mobile phone	21–30 Years ago satisfaction degree (Full group)			Male of 21–30 years ago satisfaction degree (Male group)			Female of 21–30 years ago satisfaction degree (Female group)		
		VS	PS	SS	VS	PS	SS	VS	PS	SS
1	DP CHT9000 (C)*	6.78	4.06	10.84	6.80	4.34	11.14	6.59	3.33	9.92
	DP CHT9000 (C)**	7.09	4.46	11.55	6.84	**4.05**	**10.88**	6.86	3.76	10.62
2	DP 595 (T)*	6.51	6.31	12.81	6.51	6.52	13.03	6.34	5.79	12.13
	DP 595 (T)**	7.21	**5.58**	**12.79**	**6.41**	**6.08**	**12.49**	6.72	5.88	12.60
3	SE K800i (No)*	6.50	5.01	11.50	6.44	4.34	10.78	6.43	3.33	9.76
	SE K800i (No)**	7.04	5.21	12.25	**6.29**	**4.05**	**10.33**	**6.21**	3.76	9.97
4	SE K610i (No)*	6.92	7.20	14.11	7.00	7.61	14.61	6.60	6.21	12.81
	SE K610i (No)**	7.53	7.27	14.79	**6.95**	**6.89**	**13.84**	**6.54**	**6.18**	**12.71**
5	SE K600i (F)*	6.35	7.60	13.95	6.38	8.03	14.41	6.17	6.54	12.71
	SE K600i (F)**	7.20	7.64	14.84	6.63	**7.56**	**14.19**	6.21	**6.51**	12.72
6	SE K750i (C)*	6.74	7.20	13.94	6.87	7.61	14.48	6.48	6.21	12.69
	SE K750i (C)**	7.51	7.27	14.77	6.90	**6.89**	**13.79**	**6.13**	**6.18**	**12.31**
7	Nokia N93 (C)*	6.95	4.06	11.02	7.06	4.34	11.40	6.82	3.33	10.15
	Nokia N93 (C)**	7.27	4.46	11.74	7.23	**4.05**	**11.28**	6.98	3.76	10.73
8	Nokia 6280 (T)*	6.26	5.39	11.65	6.47	5.64	12.11	5.89	4.78	10.67
	Nokia 6280 (T)**	7.05	5.40	12.45	6.83	**5.37**	12.20	6.15	**4.65**	10.81
9	Nokia N70 (W)*	6.95	5.24	12.19	7.14	6.72	13.86	6.54	5.99	12.53
	Nokia N70 (W)**	**6.58**	5.40	**11.97**	**6.40**	**5.37**	**11.76**	**6.17**	**4.65**	10.82

Note 1: Ç, F, T, W represent different subsidy policy for four telecommunications companies, then No represent the mobile phone with no subsidy.
Note 2: * represent the analysis using the integrate AHP and SAW method, then ** represent the analysis using the integrate AHP and FIM method.

phone of highest SS degree is not the mobile phone of the highest VS degree. The diverse product portfolio of lower price can create a higher SS degree.

4.2. The analysis of satisfaction degree with the integrate AHP and FIM method

We choose nine mobile phones for a mixed portfolio from three manufacturers and four telecommunication operators. We also compare the single purchase of mobile phones and the package of the integrated mobile phone and telecommunication service. We discussed the development strategy map using the fuzzy integral method with three group of the full sample, male and female, as shown in Table 16, Figs. 5 and 6. For the full sample group, the value satisfaction degree value with the integrated AHP and FIM method is better than the AHP + SAW expected the No. 9 mobile phone. The result also suggests a PS degree with the integrated AHP and FIM method expected the No. 2 mobile phone. We analyzed the integrated satisfied degree of nine mobile phones, seven evaluation values of mobile phones with the integrated AHP and FIM method; better than the AHP + SAW expected the Nos. 2 and 9 mobile phones. So the positive criteria relationship effect exists in the greater part condition for the full sample group.

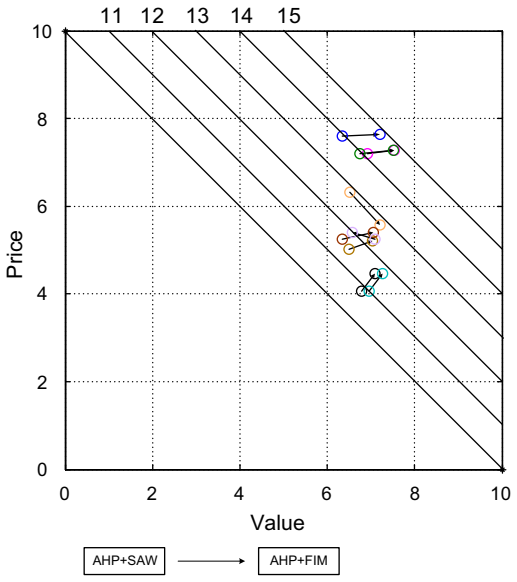

Fig. 5. The development strategy comparative of 21–30 years ago.

We analyzed the effect of the male and female group. For male sample group, the integrated satisfaction degree value with the integrated AHP and FIM method was lesser than the integrated AHP and SAW method expected the No. 8 mobile phones. We try to understand the reason of the result and find the male group that considers the price of the mobile phone and service fee is the alternate choice. When a customer purchases a mobile phone which is offered as a higher subsidy, it usually comes with a package with a higher telecommunication fee. Therefore, the subsidy effect won't increase the PS degree unless the high level of telecommunication fee can be reduced.

For the female sample group, the value satisfaction degree value with the integrated AHP and FIM method is better than the integrated AHP and SAW expected the No. 3, No. 4, No. 6 and No. 9 mobile phones. The result shows PS degree with the integrated AHP and FIM method expected the No. 4, No. 5, No. 6, No. 8, No. 9 mobile phone. The effect was not as obvious as the than full sample group. We analyzed the integrated satisfaction of nine mobile phones, seven evaluation values of mobile phone with the integrate AHP and FIM method better than the AHP + SAW expected the Nos. 4 and 6 mobile phones. The positive criteria relationship effect exists in the greater part condition for the female group. The female group considers the price of mobile phone and service fee as an alternative. Although female customers purchase high subsidy mobile phones now, they are able to enjoy a longer telecommunication time and pay their telecommunication fee in the future. Therefore, the subsidy still has its incentive for the female group.

4.3. Discussions

There was a difference of the integrated AHP and FIM with the integrated AHP and SAW method, the main reason is that the criteria relationship exists between each criterion. So we use the fuzzy integral criteria of four aspects. Therefore, the research uses the

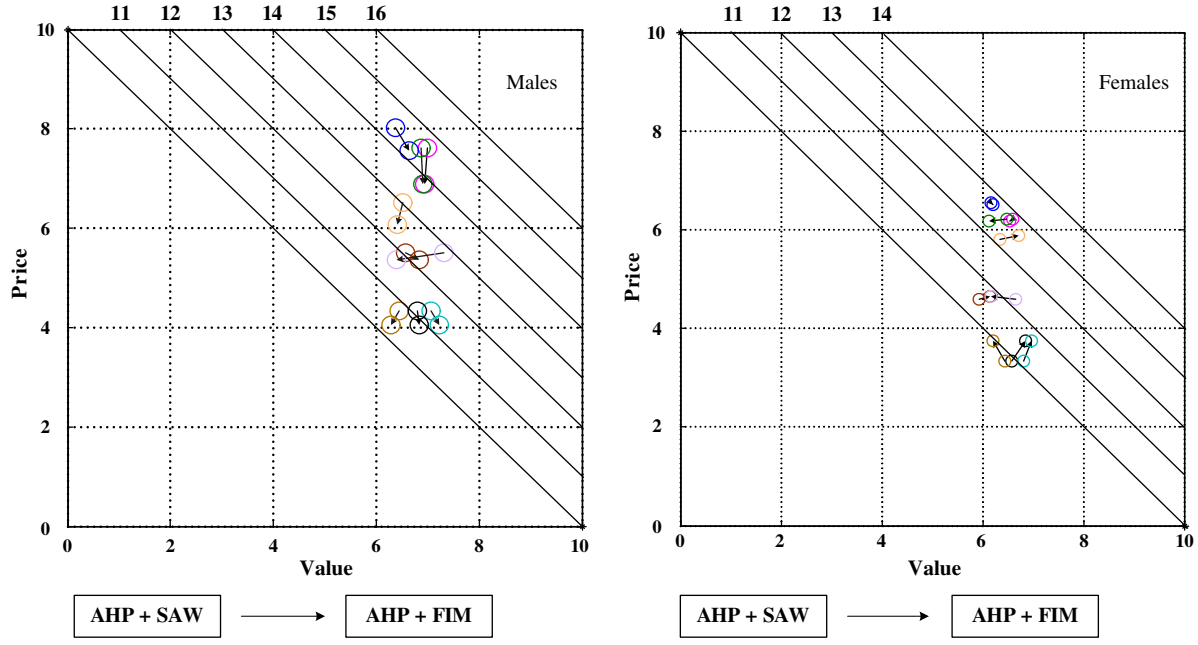

Fig. 6. Development strategy comparative map of sex attribute 21–30 years ago.

empirical data to show the phenomenon, and analyzes the effect of the full sample group, male group and female group. The positive effect exists for the full sample group and female group, but the negative effect exists for the male group. So we discuss the effect of each aspect for the full sample group with fuzzy measure of fuzzy integral method. If $\lambda > 0$, i.e., $g_\lambda(\{A,B\}) > g_\lambda(\{A\}) + g_\lambda(\{B\})$ this implies that A and B have a multiplicative effect; If $\lambda < 0$, i.e., $g_\lambda(\{A,B\}) < g_\lambda(\{A\}) + g_\lambda(\{B\})$ this implies that A and B have a substitutive effect; If $\lambda = 0$, i.e., $g_\lambda(\{A,B\}) = g_\lambda(\{A\}) + g_\lambda(\{B\})$ this implies that the evaluation of the set $\{A,B\}$ equals the sum of evaluations for sets $\{A\}$ and $\{B\}$. For the young (21–30 years old) group, we find the $\lambda = 1.4212$ in the aspect of product image, so exists a multiplicative effect between product design, product impression, and product quality. We also find the $\lambda = 1.4486$ in the aspect of product price, so exists a multiplicative effect between mobile phone price, fee rate of voice service, and fee rate of value-added service. Therefore, we find the $\lambda = -1.1520$ in the aspect of the production function, so exists a substitutive effect between telecommunication function, internet service, store function and transmission function, because the better internet service (online music service) can reduce the need of the store function. We also find the $\lambda = -0.8138$ in the aspect of derived function, so exists the substitutive effect between photographs, data processes, multimedia broadcasts and entertainment, because the better multimedia broadcast can reduce the need of entertainment function in a limited relax time.

5. Conclusions

We analyzed the four aspects and fourteen criteria of mobile phone purchases. We found the aspect of product function to be more important than product image and derived function in young groups. Product image and derived function aspects of the male group are more important than the female group. The study compared two criteria relationships of the integrated AHP and SAW method and the integrated AHP and FIM method. We used the score evaluated model to evaluate the value and PS degree for nine 3G mobile phones for the young (21–30 years old) group. We found the multiplicative effect exists in product images and the product price aspect. Therefore, the substitutive effect exists in product function and derived function aspects.

The suggestions of development strategies for manufacturers and telecommunication operators based on research results would be proposed. First, the customers' choice behavior dominated the development of the mobile phone in the next generation mobile phone market, so the manufacturers and telecommunication operators must understand the use frequency and need degree (latent purchase behavior) for different customer groups. Second, manufacturers and telecommunication operators should increase the value-created of products in the lower product and service price. This can be accomplished by eliminating the function and service of lower use frequency and need degree, and then design the product function based on the customer need of distinct customer group by mass customization manufacturers. This particular research only demonstrates some empirical results of the young group. The research model can be expanded in the future to include different customer attributes, and to analyze/examine different regional customer electric product markets in each market development period.

References

Cha, J. E., Kim, S., & Lee, Y. (2009). Application of multidimensional scaling for marketing-mix modification: A case study on mobile phone category. *Expert Systems with Applications, 36*(3), 4884–4890.

Chen, Y. W., & Tzeng, G. H. (2001). Using fuzzy integral for evaluating subjectively perceived travel costs in a traffic assignment model. *European Journal of Operational Research, 130*(3), 653–664.

Chiou, H. K., Tzeng, G. H., & Cheng, D. C. (2005). Evaluating sustainable fishing development strategies using fuzzy MCDM approach. *Omega, 33*(3), 223–234.

Chuang, M. C., Chang, C. C., & Hsu, S. H. (2001). Perceptual factors underlying user preferences toward product form of mobile phones. *International Journal of Industrial Ergonomics, 27*(4), 247–258.

Fishman, A., & Rob, R. (2002). Product innovations and quality-adjusted prices. *Economics Letters, 77*(3), 393–398.

Ishii, K., & Wu, C. I. (2006). A comparative study of media cultures among Taiwanese and Japanese youth. *Telematics and Informatics, 23*(2), 95–116.

Jiao, J., Zhang, Y., & Helander, M. (2006). A Kansei mining system for affective design. *Expert Systems with Applications, 30*(4), 658–673.

Keeney, R. L., & Raiffa, H. (1976). *Decision with multiple objectives*. New York: Wiley.

Kuo, Y. F., & Chen, P. C. (2006). Selection of mobile value-added services for system operators using fuzzy synthetic evaluation. *Expert Systems with Applications, 30*(4), 612–620.

Lee, K. C., & Kwon, S. (2008). Online shopping recommendation mechanism and its influence on consumer decisions and behaviors: A causal map approach. *Expert Systems with Applications, 35*(4), 1567–1574.

Lee, Y. S., Hong, S. W., Smith-Jackson, T. L., Nussbaum, M. A., & Tomioka, K. (2006). Systematic evaluation methodology for cell phone user interfaces. *Interacting with Computers, 18*(2), 304–325.

Lin, Y.-C., Lai, H. H., & Yeh, C. H. (2007). Consumer-oriented product form design based on fuzzy logic: A case study of mobile phones. *International Journal of Industrial Ergonomics, 37*(6), 531–543.

Ling, C., Hwang, W., & Salvendy, G. (2006). Diversified users' satisfaction with advanced mobile phone features. *Universal Access in the Information Society, 5*(2), 239–249.

Murofushi, T., & Sugeno, M. (1989). An interpretation of fuzzy measures and the Choquet integral as an integral with respect to a fuzzy measure. *Fuzzy Sets and Systems, 29*(2), 201–227.

Røpke, I. (2003). Consumption dynamics and technological change-exemplified by the mobile phone and related technologies. *Ecological Economics, 45*(2), 71–188.

Rao, A. R., & Monroe, K. B. (1989). The effect of price, brand name, and store name on buyers perceptions of product quality – An integrative review. *Journal of Marketing Research, 26*(3), 351–357.

Saaty, T. L. (1978). Exploring the interface between hierarchies, multiple objectives and fuzzy sets. *Fuzzy Sets and Systems, 1*(1), 57–68.

Saaty, T. L. (2003). Decision-making with the AHP: Why is the principal eigenvector necessary. *European Journal of Operational Research, 145*(1), 85–91.

Saaty, T. L. (2006). Rank from comparisons and from ratings in the analytic hierarchy/network processes. *European Journal of Operational Research, 168*(2), 557–570.

Shieh, M. D., & Yang, C. C. (2008). Multiclass SVM-RFE for product form feature selection. *Expert Systems with Applications, 35*(1–2), 531–541.

Sugeno, M., Narukawa, Y., & Murofushi, T. (1998). Choquet integral and fuzzy measures on locally compact space. *Fuzzy Sets and Systems, 99*(2), 205–211.

Teo, T. S. H., & Pok, S. H. (2003). Adoption of WAP-enabled mobile phones among internet users. *Omega, 31*(6), 483–498.

Tomat, G. M. (2006). Prices, product differentiation and quality measurement: A comparison between hedonic and matched model methods. *Research in Economics, 60*(1), 54–68.

Tsao, H. Y., Pitt, L. F., & Berthon, P. (2006). An experimental study of brand signal quality of products in an asymmetric information environment. *Omega, 34*(4), 397–405.

Tseng, F. M., & Yu, C. Y. (2005). Partitioned fuzzy integral multinomial logit model for Taiwan's internet telephony market. *Omega, 33*(3), 267–276.

Tzeng, G. H., Chiang, C. H., & Li, C. W. (2007). Evaluating intertwined effects in e-learning programs: A novel hybrid MCDM model based on factor analysis and DEMATEL. *Expert Systems with Applications, 32*(4), 1028–1044.

Tzeng, G. H., Ou Yang, Y. P., Lin, C. T., & Chen, C. B. (2005). Hierarchical MADM with fuzzy integral for evaluating enterprise intranet web sites. *Information Sciences, 169*(3–4), 409–426.

Vinson, D. E., Scott, J. E., & Lamont, L. M. (1977). The role of personal values in marketing and consumer behavior. *Journal of Marketing, 41*(2), 44–50.

Wei, R. (2008). Motivations for using the mobile phone for mass communications and entertainment. *Telematics and Informatics, 25*(1), 36–46.

Woodruff, R. (1997). Marketing in the 21st century customer value: The next source for competitive advantage. *Journal of the Academy of Marketing Science, 25*(3), 256.

Zeithaml, V. A. (1988). Consumer perceptions of price, quality, and value: A means-end model and synthesis of evidence. *Journal of Marketing, 52*(3), 2–22.

Zhang, Y., & Jiao, J. (2007). An associative classification-based recommendation system for personalization in B2C e-commerce applications. *Expert Systems with Applications, 33*(2), 357–367.