Using DEMATEL and the Smartphone as a Case Study to Investigate How Consumers Evaluate Many Features of a Product Collectively

Wee-Kheng Tan, Yi-Der Yeh, Shin-Jia Chen, Yu-Cheng Lin, and Chia-Yu Kuo

***Abstract*—**Manufacturers and marketers often highlight the existing features of a product or introduce new features to increase the competitiveness of the product vis-à-vis other competing products. For this strategy to be workable, the targeted consumers must be willing to include these features in their consideration, assess them and buy-in to the arguments put forward by the manufacturers and marketers. However, consumer's evaluation of product features is often a multiple criteria decision-making problem. Given the need to consider many features at the same time, consumers may mentally group related product features and evaluate them collectively to simplify their decision making process. This study investigates the above idea by using DEMATEL and the case study of consumers evaluating the product features of smartphones. Our analysis revealed that indeed this is the case. Consumers may mentally link product features. For some product features, there are even existences of bi-directional relationship between the product features. This linkage of product features with other features has implications for new technology features and their associated applications, such as the Near Field Communication (NFC) and electronic wallets. To be successful, new product features need to entrench themselves as a collective part of the product by "locking" (linking) themselves to other existing and more established product features. Other implications arising from the analysis are also discussed.

***Keywords*—**Consumer decision making, DEMATEL, Multiple criteria decision-making problem, Product features, Smartphones.

I. Introduction

Consumer decision making is an important theme in marketing research. Some studies, such as [1]-[3], suggested that consumers follow a two-stage strategy to making choices.

Consumers include some brands which they are aware of (i.e. the awareness set) in their consideration set and make comparison within the latter set to finalize their decision. Hence, the consideration set is more restrictive in size than the awareness set. According to [4], the average size of consumers' consideration set is dependent on the consumer product types. Its product size can range from 2.2 for air freshener to 6.9 for beers.

The notion of consideration set is important as having a product in the consideration set is often a pre-condition for final purchase choice [5]. There is little chance that a product will be adopted if it is not in the consideration set.

The consumers may depend on their personal experience or external sources of product information to make the categorization. According to [6], product information can come from information provided by manufacturers and suppliers, as well as user reviews.

Product feature may have an impact on how consumers assess the quality of the products [7]-[8]. A product's inclusion in the consideration set may depend on its features. Products with features which are absent or weak in other competitors can increase its appeal [9]-[10] and enable the manufacturers to out-do their competitors.

However, there are other studies that suggested that new features do not necessarily improve consumer's product evaluation [11]. The impact of new features may depend on the level of complexity of products or the characteristics of consumers [8],[12].

Many studies aim to find product features that customers feel important or desirable. After these features have been identified, these studies proceed to provide suggestions on how to improve and market the products. Quite often, studies such as those using the Analytic Hierarchy Process (AHP) method [13] may assume that the features are independent of one another. However, everyday experience suggests otherwise.

Real-life decision making is often multiple criteria decision-making (MCDM) problem which considers multiple criteria at the same time in the decision-making environments.

In the context of consumer purchase decision-making, consumers will need to consider many criteria simultaneously when making the decision on whether to purchase the products. However, human can make poor choice if the decision is complex and involves many criteria (attributes) [14].

This study suggests that given the need to consider many product features simultaneously, consumers may mentally group product features and assess them collectively to simplify the decision making process. In other word, customers' perception of some of the product features is built and based on

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their perceptions of other inter-linked features. There may even be cases where the perception of one of the product features re-enforce and is also re-enforced by the perception of another feature, i.e. the relationship between the features is bi-directional. This idea is not far-fetched as feedback loops exist in many causal processes [15].

As a result, recursive model, which is frequently used in many system adoption studies, may be restrictive for our purpose. This study will have to adopt research method which allows for non-recursive model analysis.

Pursuing the ideas of getting the mental map of how consumers group product features is not just a matter of academic interest. It also has important practical implications. By knowing how product features are linked or re-enforced one another help the manufacturers and marketers to design and market the next generation products. In specific, manufacturers and marketers can focus more on product features which affect and influence others (the "cause" features) rather than features which are affected or influenced by other features (the "effect" features).

This study uses a case study of consumers evaluating the features of the smartphones to shed light on the above issues.

Smartphones are devices which go beyond feature phones that provide standard telecommunication capabilities. They are also handheld computer because of their more advanced computing and software power as well as their close-to-computer performance. Together with their wireless connectivity and portability features, smartphones have also been re-positioned as a "new information medium" [16]-[18].

This case study is appropriate for theoretical and practical reasons. Consumers consider many product features simultaneously when choosing smartphones. Hence, it is a MCDM problem. Given the array of complex features, it is unreasonable to suggest that consumers treat these features as independent of one another. Consumers may resort to simplification of their decision making process by associating their perception of some of the product features to a collective set of perceptions of other product features which are viewed by the consumers as being related. Hence, the nature of this case study contributes theoretically to the lack of research on the relationship between feature preferences [11], especially in the context of MCDM problem.

The smartphone industry is also of great practical importance. Consumers are adopting smartphones at a remarkable pace and see smartphones as personal expressions of their lifestyle [19].

Mobile services and applications are spreading like wild fire. Mobile services, like the entertainment services, location-based services, value-added shopping services such as comparison shopping and coupons, and financial services such as e-banking and e-payment, are provided via mobile phone to enable e-commerce activities [20]-[21]. Instead of passively accepting mobile services and applications offered by the smartphone manufacturers, users are now able to purchase and download services which meet their needs and interests (utilitarian, hedonic or more). There are plenty of business opportunities for providers of mobile phone software and mobile contents.

Smartphones are evolving rapidly with time and have short product life-cycles [22]. Competition between manufacturers is fierce. Manufacturers introduce new smartphone features at a dazzling pace to serve as the selling point to attract potential customers and to outdo their competitors. As an example, Nokia and Apple recently introduced Near Field Communication (NFC) and Siri software respectively in their latest smartphone models.

The pace of introducing new smartphone features is so rapid that while some of the new features successfully become the talk of the town, others features get cold reception. Some consumers are not knowledgeable about the latter features and use them infrequently. According to [11], adding new features can sometime lead to featuritis [23], feature creep [24] or feature fatigue [25]. Hence, having new features may not always be a plus point for the new smartphone model. Understanding how consumers evaluate the features of smartphones will allow manufacturers and marketers to enhance user experience and design the next generation of smartphones.

The Decision Making Trial and Evaluation Laboratory (DEMATEL) method [26]-[27] is developed by the Battelle Memorial Institute of Geneva. DEMATEL is a MCDM method which discovers the cause and effect relations between factors. Furthermore, it allows one to visualize its structural model [28]-[31].

Since the case study is a MCDM problem and the objective of this study is to get the consumer's mental evaluation picture of how the perception of some smartphone features is built upon the collective perception of other smartphone features, it is thus appropriate to apply DEMATEL method to obtain the cause and effect relationship and to construct the cause-effect structural model.

This paper is structured as follows: relevant literatures are first presented, follows by the research method (DEMATEL), data analysis, discussion and conclusion.

II. Literature Review

The field of product and service adoption research is complex. According to [32], the adoption research can generally be divided into four categories: diffusion research (which focuses on market); adoption approach (which focuses on individual user); gratification research (which focuses on needs of users) and domestication research (which focuses on the consequence of adoption).

There is no lacking of adoption research studies on mobile phones and smartphones. Many academic researchers and practitioners have investigated various issues related to smartphone usage.

Reference [33] found that personal innovativeness, perceived enjoyment and smartphone satisfaction positively impact compulsive usage of smartphones.

Perceived enjoyment is prevalent if the smartphones are used especially for hedonic purposes and can increase the adoption of

smartphones and mobile services. Social influence or reference groups can also positively influence the adoption of mobile devices [34].

Determining which smartphone features are attractive and important in consumer's purchase decisions is also a common research area.

Using two criteria (user-related criteria and product-related criteria), [35] used the MCDM approach to evaluate mobile phone options in respect to the users' preference order. The product-related criteria comprise basic requirements (such as reasonable price and standard part used), physical characteristics (such as weight and dimension) and technical features (such as talk time and safety standards). The sub-criteria of user-related criteria are: functionality (ease of use), brand choice and customer excitement (such as games and ringing tones).

Reference [36] investigated user's diversity in smartphone usage along four dimensions: user interactions, application use, network traffic and energy drain.

Using AHP and Data Envelopment Analysis (DEA) method, [37] compared 25 smartphones of different brands by using the following product features (attributes): price, dimensions, weights, standby time, talk time, available memory, Read Only Memory (ROM), availability of expansion slot, Infrared, Bluetooth, WiFi, GPRS, WAP, Java applications, MP3, types of messaging, resolution of digital camera, screen resolution and color display.

Form factor, the hardware configuration of a device, often appears as an important smartphone feature. Users' overall satisfaction with smartphone is higher for devices that are of a specific size ("thinner is better" and less than 0.45 inches wide), weight (light and does not exceed 5 ounces) and equipped with the latest technological advancements (such as high-quality display screens, faster processing speeds, longer battery life and touch screen capabilities) [38].

Touch screen-only smartphones generate higher satisfaction level with ease of operation than QWERTY-only based devices or smartphones with both touch screen and QWERTY functions.

The price of the device is dropping continuously. The same report also mentioned that about 42% of the owners receive free mobile phone when subscribing to a wireless service (the price plan).

Based on user's needs and interests, to enhance user experience [38], and partly for enjoyment [39]-[40], smartphone users install mobile services and applications which are of their liking. Two-thirds of the users download games and social networking applications, more than one-half use entertainment-oriented applications, while 52% download travel software (such as maps and weather software) [38].

A successful smartphone brand should engage users in an emotional experience [41]-[42]. The emotional connection between products and users can result in people assigning personality to products [43]. According to [32], finding the optimal experience of users requires a good and overall understanding of their emotional and cognitive needs. People may also see smartphone as fashion accessories [44] instead of purely from the utilitarian perspective.

Brand and marketing play vital role in increasing consumer's awareness of the smartphones. Apple has created a very strong marketing strategy for its iPhone and enforces its image as a leader in consumer electronic gadgetry [45]. Apple is ranked highest among manufacturers of smartphones in customer satisfaction, especially in ease of operation and features, followed by HTC [38].

Smartphone manufacturers often introduce new features to attract buyers. New wireless communication interfaces are introduced to enable devices to communicate [46]. A recent move is to add NFC to the phone (such as the recent Nokia launch). NFC is a high-frequency, wireless communication application that permits the exchange of digital data between devices within a radius of about 10 centimeters (which can be raised to 20 with suitable antenna). The technology is now promoted by the NFC Forum, a non-profit industry association. NFC enables smartphones to perform as e-wallet [47], enabling mobile micro-payments at physical stores and transport services.

III. Research Method - DEMATEL

DEMATEL is very suitable for studying and analyzing complicated and intertwined problems. It classifies factors of the problem into cause group (factors that have more effect on others) and effect group (factors that receive more influence from others) [48].

Through these two groups of factors, DEMATEL identifies the interdependence among factors. Using digraphs, it converts the relationship between causes and effects of factors into an intelligible cause-effect structural model of the system [29],[30]-[31]. DEMATEL and its hybrid forms have been applied to various scenarios and problems [49]-[50]. The major steps of the DEMATEL method are as follows:

Step 1 - Find the average matrix. Suppose there are n factors considered in the study and H respondents participating in the study, each respondent is asked to state the degree he or she believes states a factor i affects factor j through a score ranging from 0 as "no influence" to 4 as "very high influence". We will get H answer matrix where each answer matrix is an $n \times n$ matrix X_k with $1 \le k \le H$,. The initial direct relation matrix A is obtained as below:

$$a_{ij} = \frac{1}{H}\sum_{k=1}^{H} X_{ij}^{k} \tag{1}$$

Step 2 - Calculate the normalized initial direct-relation matrix D. The matrix D is obtained by normalizing initial direct relation matrix $D = A/s$ where:

$$s = \max\left[\max_{1\le i\le n}\sum_{j=1}^{n} a_{ij}, \max_{1\le j\le n}\sum_{i=1}^{n} a_{ij}\right] \tag{2}$$

Step 3 - Calculate the total relation matrix T. A continuous decrease of the indirect effects of problem along the powers of matrix D, for example, D^2, D^3, … , D^∞ guarantees convergent solutions to the matrix inversion similar to an absorbing Markov chain matrix. The total relation matrix T is an n x n matrix and is defined as in (3):

$$T = D + D^2 + \ldots + D^m = D(I - D)^{-1} \quad (3)$$

as $m \to \infty$ and I is an n x n identity matrix..

Step 4 - The sum of rows r and the sum of columns c of the total relation matrix T is obtained as in (4).

$$R = [r_i]_{nx1} = \left[\sum_{j=1}^{n} t_{ij}\right]_{nx1}, C = [c_j]_{1xn} = \left[\sum_{i=1}^{n} t_{ij}\right]'_{1xn} \quad (4)$$

The sum $r_i + c_i$ gives an index which represents the total effects both given and received by factor i. The difference $r_i - c_i$ shows the net effect factor i contributes to the problem. If the difference $r_i - c_i$ is positive, factor i is a net causer. If $r_i - c_i$ is negative, factor i is a net receiver.

Step 5 - Finally, a threshold value is set to draw the influence map.

IV. Survey and Analysis

A. Smartphone Features and Survey Design

Using previous studies on mobile technology and mobile phone, and product specification sheets provided by smartphone manufacturers, a preliminary list of common smartphone features was obtained.

Discussion with experts and postgraduate students was conducted to shorten the list of features so as to obtain a more manageable but representative list of features for the survey.

Brief but concise description of these features to help survey respondents to understand the scope of the respective feature was then designed to be included in the questionnaire. Using comments from the same group of experts and postgraduates, ambiguous wordings were re-phrased for better clarify.

NFC and its associated application, e-wallet, were included as they have received some attention recently and appear in some recent smartphone product launches. The final list comprises 11 features and they are listed in Table 1.

The questionnaire comprises three parts. The first part of the questionnaire asked the respondents to indicate the extent they understand each smartphone feature on a 5-point Likert scale (1 indicating "totally do not understand" to 5 indicating "understand very well"). The respondents were also asked to indicate to what extent they take into account these features (the importance element) when selecting smartphones on 5-point Likert scale (1 indicating "very unimportant" to 5 indicating "very important").

Table 1 Classification of product features

Features	Abbreviation
Price-related features (A)	
- Smartphone price (A1)	Price
- Price plan offered by telecoms operators (A2)	Price plan
Technology-related features (B)	
- Operating system (OS) (B1)	OS
- Availability of Near Field Communication (NFC) (B2)	NFC
- Data transmission method, such as Bluetooth, Infrared (B3)	Transmission
Design-related features (C)	
- Screen display such as width and touch-screen (C1)	Screen
- Body design such as shape, weight and dimension (C2)	Body
Application-related features (D)	
- Availability of e-wallets (D1)	e-wallet
- Applications (APPs) (D2)	APPs
Image-related features (E)	
- Brand (E1)	Brand
- Fashion or trendy to use (E2)	Fashion

The second part of the questionnaire deals with the DEMATEL questions. This portion comprises an 11 x 11 matrix with 110 entries (excluding the diagonal elements of the matrix) that need filling up. The respondents were asked to state the degree a feature i affects another feature j through a score of 0 to 4 with 0 indicating "no influence" and 4 indicating "very high influence".

The third part of the questionnaire asked for the basic demographics of respondents, such as gender, age, educational level, and the number and brand of smartphones they are holding or wish to have when they make future purchases.

DEMATEL survey is tedious, difficult to understand and time consuming to complete. Getting input is more challenging for this study because the respondents are the much more numerous general users instead of experts of the field (which are the subjects of investigation in many DEMATEL studies). Hence, posting survey online to solicit responses data was not adopted in this study. The more time-consuming face-to-face interview method was used intentionally so as to guide the respondents through the survey to increase the accuracy of this study. Convenience sampling method was used.

B. Profile of Questionnaire Respondents

One-hundred twenty-one (121) valid returns were received (Table 2). There was a good mix of respondents where 72 (59.5%) of the respondents were male, 116 (95.9%) received tertiary education, 89 (73.6%) were 20-40 year old.

Seventy-nine (65.3%) were smartphone users, 24 and 21 of them used HTC smartphone and iPhone respectively. Among the 42 non-smartphone users, 19 of them wished to have iPhone, follows by 13 who wished to use HTC smartphone.

Table 2 Profile of survey respondents

	No	Percentage
Gender		
- Male	72	59.5
- Female	49	40.5
Age		
- Below 20 (inclusive)	4	3.3
- 20 – 25 (inclusive)	33	27.3
- 25 – 30 (inclusive)	23	19.0
- 30 – 35 (inclusive)	19	15.7
- 35 – 40 (inclusive)	14	11.6
- 40 and above	28	23.1
Educational Level		
- High School	5	4.1
- Undergraduate	79	65.3
- Postgraduate	37	30.6
No. of Smartphones		
- 0	42	34.7
- 1	70	57.9
- 2	8	6.6
- 3 and more	1	0.8

C. *Importance-Understanding Analysis*

Table 3 summarizes the mean of the understanding and importance level of each smartphone feature.

Table 3 Mean and S.D. in degree of understanding and importance of smartphone features

	Understanding		Importance	
	Mean	S.D.	Mean	S.D.
A1: Price	3.49	1.05	3.85	1.00
A2: Price Plan	3.36	1.08	4.11	0.93
B1: OS	3.36	0.98	3.61	0.99
B2: NFC	2.63	1.14	3.19	0.89
B3: Transmission	3.27	1.11	3.67	0.92
C1: Screen	3.60	0.92	3.98	0.83
C2: Body	3.55	0.99	3.96	0.87
D1: e-Wallet	2.94	0.98	2.91	0.98
D2: APPs	3.42	1.12	3.92	0.96
E1: Brand	3.73	0.83	3.68	0.85
E2: Fashion	3.59	0.86	3.34	0.94
Overall Mean	3.36		3.66	

Note : S.D. – standard deviation

The top 3 smartphone features which respondents understood most, in descending order, are brand (mean=3.73, S.D.= 0.83), screen (mean=3.60, S.D.= 0.92) and fashion (mean=3.59, S.D.= 0.86). The 3 least understood features are NFC (mean=2.63, S.D.= 1.14), e-wallet (mean=2.94, S.D.= 0.98) and transmission (mean=3.27, S.D.= 1.11).

The top 3 most important smartphone features, in descending order, are price plan (mean=4.11, S.D.=0.93), screen (mean=3.98, S.D.=0.83) and body (mean=3.96, S.D.=0.87). The 3 least important features are e-wallet (mean=2.91, S.D.=0.98), NFC (mean=3.19, S.D.=0.89) and fashion (mean=3.34, S.D.=0.94).

The overall understanding and importance mean of smartphone features are 3.36 and 3.66 respectively. The importance-understanding matrix grid is shown in Fig. 1 with the two overall means being the dividing lines that create the 4 quadrants of the importance-understanding matrix grid.

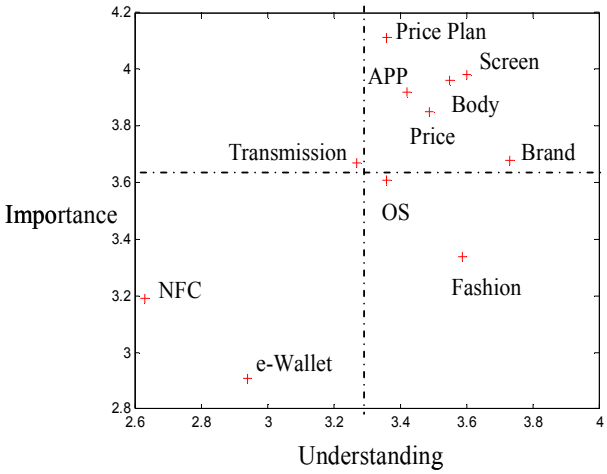

Fig. 1 Importance-understanding matrix grid

NFC and e-wallet features are in the "less important-least understood" quadrant. Transmission is the only feature in the "more important-least understood" quadrant. OS and fashion features are in the "less importance-most understood" quadrant. The other 6 smartphone features are in the "most important-most understood" quadrant.

D. *DEMATEL Analysis*

Total relation matrix T was obtained using (3). The sum of rows r and sum of columns c of T were then obtained using (4). The sum $r_i + c_i$ and difference $r_i - c_i$ were calculated and shown as Table 4.

Table 4 $r + c$ and $r - c$

	$r + c$		$r - c$	
	Value	Ranking	Value	Ranking
A1: Price	18.60	1	-0.13	(4)
A2: Price Plan	17.39	4	-0.14	(2)
B1: OS	17.55	3	0.19	4
B2: NFC	15.56	9	0.45	2
B3: Transmission	15.27	10	-0.02	(6)
C1: Screen	17.04	7	-0.14	(2)
C2: Body	16.49	8	-0.13	(4)
D1: e-Wallet	13.40	11	0.08	5
D2: APPs	17.24	6	-0.93	(1)
E1: Brand	17.97	2	0.22	3
E2: Fashion	17.25	5	0.54	1

The 3 product features with the highest $r_i + c_i$ value are price, brand and OS. The top 3 net causer features (factors) ($r_i - c_i > 0$) are fashion, NFC and brand. The top 3 net receiver feature

(factors) (r_i - c_i < 0) are APPs, screen and price plan.

The overall influence map was obtained and shown in Fig 2. For better clarify Fig. 3 and 4 show influence maps with only bi-directional relationships and uni-directional relationships respectively.

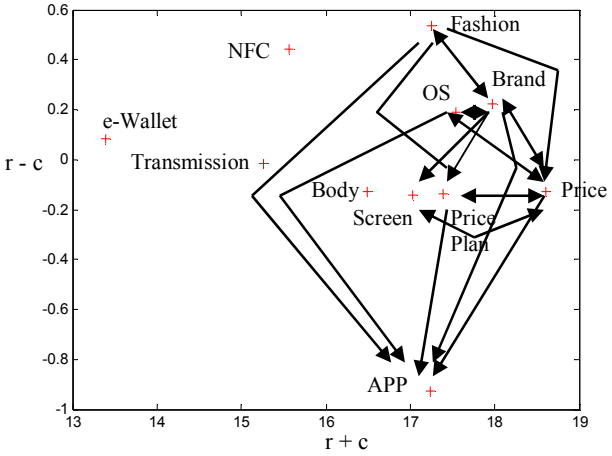

Fig. 2 Overall influence map

V. Discussions

As shown in Section IV, consumer's evaluation of the product features of smartphone is a MCDM problem. The influence maps also show that consumers mentally group product features and evaluate them collectively to simplify their decision making process.

Hence, customer's perception of some of the smartphone features is built upon and based on a collection of perceptions of other inter-linked product features. For example, consumers do not view the price of smartphones in isolation. Their perception of the price of smartphone is directly associated and inter-linked with other smartphone features such as OS (a technology-related feature), screen (a design-related feature), APPs (an application-related feature), brand (an image-related feature) and fashion (another image-related feature). Furthermore, some of the relationships are also bi-directional (such as with brand, OS, screen and price plan). The results thus justify our intention to abandon recursive model and to adopt non-recursive model in this type of study.

Generally, consumers do not view technology-related features (OS, data transmission and NFC) as important as other feature criteria such as price-related, application-related, design-related and image-related features. The consumers also do not understand NFC and data transmission as much as another technology-related feature, the OS.

Such a perception results in the much poorer performance of NFC and transmission methods in terms of the total effects given and received by these two technology-related features. It also causes NFC and transmission methods to be isolated from other smartphone features and become standalone features in the influence maps. In other word, consumers are not able to associate these two smartphone features with other features.

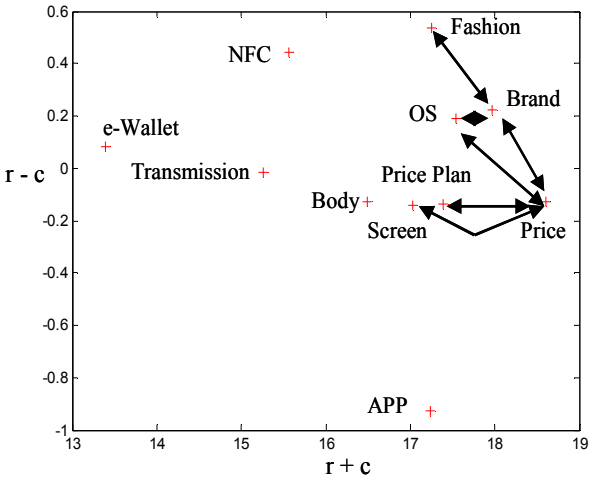

Fig. 3 Influence map (showing only bi-directional relationships)

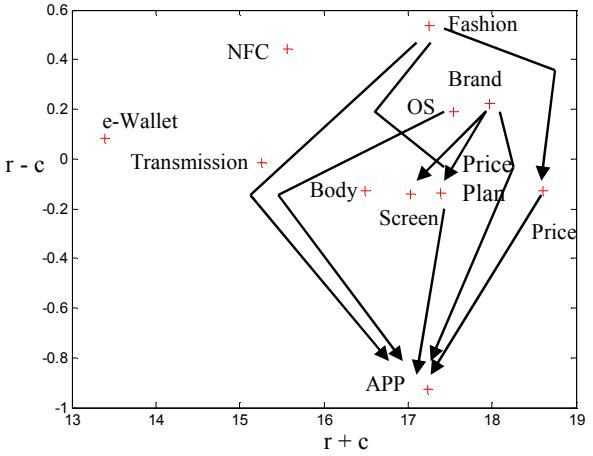

Fig. 4 Influence map (showing only uni-directional relationships)

These observations on technology-related features have several implications. Rapid incorporation of advanced and new technologies (such as NFC) in new smartphone models does not always draw the attention of the consumers or win their affection. Consumers must have some basic awareness of the technologies (similar to the concept of "awareness set") before they are willing to consider them (similar to the concept of "consideration set"), buy in, and link (tying) these technological features to other smartphone features which are more established or in which consumers know more about.

The frequent discussion of Android and iOS in mass media, and mostly in layman's language, has increased consumer's awareness of OS and enabled it to play a more important role than the other two technology-related features in the mental evaluation map of the customers (the influence maps). Hence, OS is well-locked to other smartphone features. OS has

bi-directional relationships with price and brand, and influences APPs uni-directionally.

NFC, being closely associated with e-wallet, provides further insight on the problems associated with incorporating lesser-known technology as a new feature in the new smartphone model. Its related application, e-wallet, is the second least understood and least important feature. Both the NFC and e-wallet are in the "less important-least understood" quadrant. Furthermore, both of them are also isolated and standalone features in the influence maps. Even though academic researchers, manufacturers and marketers often or attempt to associate NFC with enabling electronic payment through the e-wallets, consumers don't think there is any relationship between them. NFC and e-wallet are also unable to entrench themselves as an essential and collective part of the smartphone by "locking" (linking) themselves to other existing and more established smartphone features.

The NFC-e-wallet pair provides an important and useful message to R&D designers and marketers that it is not enough to introduce new technologies and their associated applications in products.

When they are being introduced, manufacturers and marketers must confirm whether the consumers know about them. If it is not so, there should be enough promotion before and immediately after the launch, and preferably in layman language, to increase customer's understanding and appreciation of their usefulness and importance. To make this task easier, they can design their marketing messages so that consumers can associate the new feature with other smartphone features (such as brand and fashion) which already form an integral part of the smartphones. Otherwise, customers will not be able to appreciate the good intent of manufacturers and marketers in enhancing the functions of smartphones and making the phone more useful.

Except for the lead users and early majority users, who are small in number and actively pursue the latest technology, majority of the consumers focus on how smartphone adds value and enhance their experience in areas such as ease of use and usefulness.

APPs feature is the fourth most important features after price plan, screen and body. The influence map also shows that APPs feature is the strongest net receiver feature. Price (a price-related feature), price plan (another price-related feature), OS (a technology-related feature), brand (an image-related feature) and fashion (another image-related feature) influence consumer's perception of APPs. In other word, consumers use a diversified group of features to obtain an indication of the properties of APPs feature.

Hence, manufacturers and marketers do not need to allocate too much resources and efforts to promote the huge and rich collection of APPs to their potential customers. Instead, they can focus on features which contribute to the perception of APPs (such as OS and brand of the smartphone). Consumers will logically use these features to draw their own conclusion about the richness of APPs. Obviously, such a mechanism of drawing references from other product features is lacking for NFC and e-wallet.

Fashion is the strongest net effect feature. Fashion influences perception of brand (another image-related feature), price (a price-related feature), price plan (another price-related feature) and APPs (an application-related feature) directly.

This result may be a surprise to some observers since fashion is expected to be the outcome of other smartphone features. This result is a strong indication of the success of the smartphone industry despite given its short history. It also bears witness to smartphones being a personal expression of user's lifestyle. Many consumers now take fashion associated with smartphone as a "given".

The result also shows that the smartphone industry is brand-driven. Fashion and brand are two sides of the same coin, as evidenced by their bi-directional relationship. Brand also shares direct bi-directional relationship with OS (a technology-related feature) and price (a price-related feature) and directly affects screen (a design-related feature), price plan (another price-related feature) and APPs (an application-related feature) uni-directionally.

The price of smartphone is highly inter-related with other features (price plan, OS, screen, brand). Price is influenced by fashion, and in turn influences APPs uni-directionally. Hence, customers do not view price in isolation when assessing whether a smartphone is worth its value. The mental map of the consumers also takes into account product features closely associated with price.

As long as the manufacturers and marketers manage related features carefully and are reasonable in setting their price level, it is easier to justify higher smartphone selling price by inducing consumers to link and justify price with other important features. Our interviews with some questionnaire respondents revealed that some of them even associate high price level of some smartphone models with high quality features.

On limitations and future research directions, this study considers only one case study. Hence, generalization of result to other types of consumer products may be limited. This study suggests that other consumer decision-making scenario can be considered. This study also shows that new product features (through the technology-related NFC feature and the application-related e-wallet feature in the case study) need to entrench themselves as a collective part of the product. They need to "lock" themselves to other existing and more established product features. This issue can be studied further by looking at how to initiate and speed up the "locking" mechanism. Another limitation is the sample size. The reason is DEMATEL survey is not easy to fill up and this study has to put in lot of effort to encourage participation. Despite this limitation, this study still provides useful ideas on how consumers assess product features.

VI. Conclusion

To conclude, using consumers evaluating smartphone features as the case study, this study shows that in MCDM

decision-making problem, consumers may mentally link product features to simplify the decision making process. Bi-directional relationship may also exist between product features, thereby imposing a limit to the applicability of recursive model. Since customers perceive some features as inter-linked, this research supports the argument by [11] that "if customers perceive that certain feature preferences belong together then these features can be grouped together in the R&D process, and marketed as one uniform feature set" (pp. 244).

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