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Providing customisation guidelines of mobile phones for manufacturers

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Customisation of mobile phones is a process of producing products according to individual needs on design, cost, and easiness of the phones. With the aim of identifying the most important features in customising mobile phones, 288 questionnaires were collected and analysed. The result showed that 'text message', 'battery', 'contacts', 'software updates', and 'display size' were highly required to customise. Among six factors (physical design, technical design, cost of entertainment, cost of information, cost of durability, easiness of use) obtained from a factor analysis, the most important reason for users to customise mobile phones was that they wanted to use a mobile phone easily. Cost of durability and cost of information were also important motivations for customisation of mobile phones. Finally, this research showed that gender and user experience were significant factors for customisation.

Keywords: customisation; mass customisation; personalisation; mobile phones; factor analysis

1. Introduction

The mobile phone is one of the necessities in modern society. Using many other functions or features with advanced technologies (e.g. smartphones), the mobile phone is becoming a complicated system more than just a communicating device. However, many customers do not need all functions or features of the mobile phone because they only prefer and use some of them. It will be very disappointing for customers to have no choice in functions or features of an expensive mobile phone. It is even unfair for the customers to pay for functions or features that they do not use or they do not like. Besides, users sometimes have trouble in using the mobile phones because of unwanted functions or features. Customising a mobile phone is a possible solution to the problems. Customisation is the tailoring of products to the individual needs and preferences of customers (Thirumalai and Sinha 2009).

As Wind and Rangaswamy (2001) suggested, customisation is a win–win proposition for both customers and businesses. As Chamberlin (1962) pointed out, customers are frequently willing to pay a premium that reflects the added value of satisfaction that arises from individual solutions. In fact, the customisation process helps the manufacturers a lot in digging out customer needs, increasing customers' loyalty to the brand, and taking distribution off the shelf. Dell Inc. which is among the first group of companies that have adopted customisation of personal computers shows a success of their business using the customisation strategy.

However, customisation also brings several challenges to the manufacturers (Wind and Rangaswamy 2001). Critical issues about customisation need further explorations and analyses. First, the product variety does not automatically transfer greater value to customers, since it may even generate unwanted complexity (Huffman and Kahn 1998, Dellaert and Stremersch 2005). Second, some scholars have pointed out that while some customers enjoy added values obtained from interaction with firms and product co-creation (Prahalad and Ramaswamy 2004), others may become frustrated because of low expertise and involvement (Bendapudi and Leone 2003). As a consequence, customisation may lead to confusion and customer dissatisfaction.

In this study, customisation was defined as a process either before or after purchase in which the mobile phones are produced according to the specification that a customer requires in relation to the design, the purchase cost or easiness of use. The main objective of the study is to provide manufactures of mobile phones with design guidelines for customisation reflecting customer requirements. By customising the mobile phones based on customer requirements, it is expected that increase of customer satisfaction and loyalty will lead to increase in sales and market share.

This article first introduces some related research, and then a survey procedure, analysis results, and conclusions and discussion follow.

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2. Customisation of mobile phones

The process of customisation is often referred to as the delivery of a targeted solution to the customer by obtaining customer information either previously or in real time and by tailoring the interactions between a manufacturer and the customer to customer needs (Murthi 2003). Customisation can increase not only customer satisfaction by enhancing customer value and service but also market share and sales in the long run (Simon and Dolan 1998). Although customisation has provided the manufacturer a new way to attract customers' attention, it also requires the manufacturer to bear a large variation in product demands and to have a relatively high flexibility in manufacturing. Because the customised products are normally built to order, the cost and lead-time of producing customised products have become the firm's in-house threats (Eastwood 1996). Moreover, as Pine (1993) suggested, if stocks are carried for all possible configurations, the cost of the inventory will increase dramatically and thereby undermining the mass customisation concept. Thus, customisation is a tradeoff between customers' requirements and manufacturer's cost. Mass production, on the other hand, can provide cost-efficient product by lowering manufacturing or engineering cost with the standardised products (Sievänen 2002). A decision making between customisation and mass production can be regarded as a trade-off between cost reduction and design diversity affecting customer satisfaction.

Customisation is not necessary in case that the needs of customers are uniform and can easily be satisfied by mass production (Svensson 2002). However, as mobile phones are becoming more and more complex, it is unnecessary for a mobile phone to contain all the features. Thus, customisation will be very important in the mobile phone industry providing digital content and services customised to individual customers (Hagen 1999). As shown in Figure 1, customisation of mobile phones can be realised by either mass customisation or personalisation of mobile phones in three domains: (1) the design-related domain, (2) the cost-related domain and (3) the easiness-related domain. Sections 2.1 and 2.2 explain mass customisation and personalisation in detail. Features of mobile phones for customisation were then examined and classified based on the two customisation methods and three customisation domains in Section 2.3.

2.1. Mass customisation

The cost for customisation has been dramatically reduced so manufacturers can let a customer have a mass-produced phone or a customised one according to their choices. As an approach to use advantages of

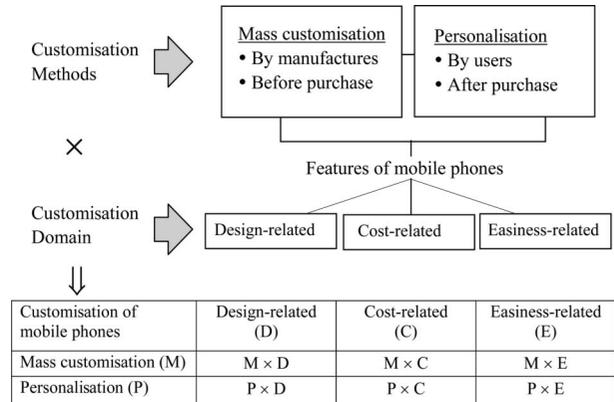


Figure 1. A customisation procedure of mobile phones.

both 'customisation' and 'mass production', 'mass customisation' has been introduced. The concept of 'mass customisation' was anticipated by Toffler (1971) and the term was coined by Davis (1987). Pine (1993) documented its place in the continuum of industrial development and mapped out the management implications for firms that decide to adopt it. 'Mass customisation' is a new paradigm for industries to provide products and services that best serve customer needs while maintaining near-mass production efficiency. Tseng and Jiao (2001) defined 'mass customisation' as 'technologies and systems that deliver goods and services that meet individual customer needs with near mass production efficiencies'. Piller (2003) addressed 'mass customisation' as 'customer co-design process of products and services, which meets the needs of each individual customer with regard to certain product features'. That is, mass customisation of mobile phones can be achieved by manufacturers during the manufacturing process reflecting user requirements before customers purchase them (Figure 1).

2.2. Personalisation

The customisation of mobile phones could be viewed from two aspects: hardware and software. From hardware point of view, the customisation process much resembles that of 'mass customisation' and is often achieved by changing, assembling, or modifying standard products according to customers' desire and requirements (Piller 2003). By contrast, customisation in software aspect could be better illustrated with the term 'personalisation', which was defined as 'a process that changes the functionality, interface, information content, or distinctiveness of a system to increase its personal relevance to an individual' (Blom 2000). With the rapid growth of smartphone sales, the last decade saw a fierce competition in the market of smartphone

operating system. 'Symbian', 'Android', 'BlackBerry OS', 'iOS', 'Palm Web OS' and 'Windows Phone 7' are several outstanding representatives of operating systems run on mobile phones that provide users with awesome features and numerous other applications available for downloads in the online application shop (Hall and Anderson 2009). These operating systems have also helped in providing customisation options in software aspect. Personalisation of mobile phones in this study refers to a customisation procedure set by users after they purchase the mobile phones (Figure 1).

2.3. Features of mobile phones for customisation and classification

Features of mobile phones could be summarised according to their distinct attributes. Chang and Chen (2005) derived 16 features, including 'security' ('biometric access', 'authentication', 'confidentiality', 'repudiation', 'password protection'), 'usability and ergonomics' ('ease of use', 'size and weight and balance'), 'performance', ('millions operations per second', 'battery life'), 'data reliability and integrity', 'durability, wireless connectivity, 'location-based capability', 'data synchronisation and application downloading', 'video/audio/image capability' and 'web-access and e-mail capability'. Ling *et al.* (2006) studied users' satisfaction with five advanced mobile phone features including 'camera', 'colour screen', 'voice-activated dialling', 'Internet browsing', and 'wireless connectivity', followed by a full study of university students' satisfaction about mobile phones with 20 features in year 2007. After removing duplicated items, 26 features were taken into consideration in this study. Those 26 features were then classified into six categories based on two dimensions (customisation method \times customisation domains) as shown in Figure 1.

Customisation methods are also classified by the time when customisation occurs. Some features such as 'display size' and 'dual SIM capability' could only be customised before purchase due to their hardware characteristics; however, customisation on some features such as 'text message' and 'software updates' are mainly achieved when customers have already bought the phone and get familiar with it. Customisation domains are related to the potential reason behind the customisation service. While some features such as 'shell colour', 'size' function largely on the aesthetic aspect of a phone and some features such as 'GPS' and 'WIFI' determine the cost, the other features are customised to make the phone easier to use. Thus, all 26 features were classified into three groups: 'design-related domain', 'cost-related domain', and 'easiness-related domain'. Table 1 shows the result of the classification. As shown in the table, 'shell colour' was placed in both mass customisation and personalisation because both methods could be applied to customise this feature.

3. Methods

A survey was conducted to examine user requirements or preferences for customisation of the mobile phones. The following subsections explain the procedure of the survey.

3.1. Questionnaire

A questionnaire using 7-point Likert scale were designed to ask preference for each of the 26 features of mobile phones and the total preference for customisation. A total of 35 questions were created (see Appendix 1). Of the 35 questions, five were redundant to measure their internal consistency. Five questions were intended to measure their general

Table 1. Classification of mobile phone features for customisation.

Feature	Design-related	Cost-related	Easiness-related
Mass customisation (before purchase)	Shell colour	Recorder	Dual SIM capacity
	Weight	Radio/game	
	Shape	Camera	
	Size	Memory card	
	Operating system	WIFI	
	Keypad layout	GPS	
		Battery	
		Display size	
		Shell material	
		Image editor/document editor/video player	
Personalisation (after purchase)	Shell colour	Earphone	Text message Contacts Calendar/calculator/clock Call E-mail Multimedia message
		Software updates	

preference for customisation of mobile phones as dependent variables, and the remaining 26 questions were used for measuring preference for customisation of 26 features of mobile phones as independent variables.

In addition to the main questions, some questions about respondent's demographic information (gender, age, the brand of the phone they own, etc.) were also added for further analysis.

3.2. Survey

The survey was conducted at Tsinghua University in Beijing in 7–14 December 2010. The questionnaires were distributed to students through two ways: paper based and online based. A total of 346 questionnaires were collected and 288 out of them were finally used for analysis after removing incomplete ones. Among the participants, male students accounted for 56% (Table 2). The majority (81%) of respondents was in the age between 20 and 24. The most popular brand

was Nokia (53%), and around 84% of the respondents have used two or more phones.

4. Result

4.1. Basic statistics

The Cronbach's alpha test (Cronbach 1951) was carried out to check internal consistency. The Cronbach's alpha coefficient for five paired questions was 0.79, which indirectly implied that the survey instrument was internally consistent.

As shown in Table 3, the mean and the standard deviation of preference for each of the 26 selected features for customising mobile phones were analysed. Overall, the respondent showed a positive attitude towards customisation of mobile phones with 4.97 of the total mean of the 26 features. The preference score for each feature was over 4, ranging from 4.24 (Radio) to 5.84 (Text message). Of the 26 features, the preference scores of 12 features – 'text message', 'battery', 'contacts', 'software update', 'display size', 'memory card', 'camera', 'calendar, calculator, clock', 'WIFI' and 'operating system' were over 5, showing relatively high preference for customisation.

As shown in Table 3, the 'text message' feature (5.84) was evaluated as the most preferred for customisation out of 26 features. This latter result is in accordance with the tendency of college students in China using the text message a lot (Ma *et al.* 2007). It means that the mobile phone companies would be better to provide diverse user interfaces for the 'text message' feature so that users can setup the user interface according to their own purposes and skills after purchasing the mobile phone. By contrast, the 'radio' feature, which received the lowest score (4.24), indirectly shows college students are losing their interest in the radio since they may have other substitutes for fun in their mobile phones such as MP3 and digital multimedia broadcasting. In this

Table 2. Respondent information of the survey.

Demographics	Item	Subjects	
		Frequency	%
Gender	Male	162	56.3
	Female	126	43.8
Age	<20	46	16.0
	20–24	232	80.6
	>24	10	3.5
Number of mobile phones that have been owned	One	45	15.6
	Two or three	160	55.6
	Four or more	83	28.8
Brand of the phone in current use	Nokia	153	53.1
	Samsung	24	8.3
	Apple	21	7.3
	Sony Ericsson	20	6.9
	Motorola	14	4.9
	Others	56	19.4

Table 3. Basic statistics of user ratings on 26 features for customisation.

Feature	Mean	Standard Deviation	Feature	Mean	Standard Deviation
Text message	5.84	1.212	Keypad layout	4.94	1.465
Battery	5.55	1.327	E-mail	4.91	1.641
Contacts	5.39	1.182	Image editor/document editor/ video player	4.90	1.546
Software update	5.36	1.420	Multimedia message	4.89	1.476
Display size	5.34	1.262	GPS	4.88	1.587
Memory card	5.32	1.446	Shell colour	4.62	1.460
Camera	5.30	1.468	Size	4.54	1.677
Calendar/calculator/clock	5.27	1.532	Recorder	4.53	1.429
WIFI	5.24	1.566	Dual SIM capability	4.52	1.653
Operating system	5.18	1.542	Weight	4.44	1.572
Shape	5.14	1.556	Game	4.34	1.743
Earphone	5.14	1.601	Shell material	4.33	1.399
Call	4.98	1.420	Radio	4.24	1.620

regard, the need for customisation seems to be highly related to usage of the feature.

The standard deviation of preference for each feature shows variability in necessity of customisation among customers. The largest standard deviation (1.743) was identified in the 'game' feature. Some explanations for the latter result can be given. First, the 'game' is the feature that only some users use. So, many users do not even need the 'game' feature, and therefore, they do not have to consider customising the 'game' feature. Second, 'game' is an application that users have to challenge and adapt themselves to the original design. It means fitting the user to the phone rather than customising the phone to the user should be more appropriate in the 'game' feature. Other ergonomic considerations such as interface design for training users or hedonics may be more necessary for the feature. Third, users have different ways to play games in a mobile phone and they may differently define customising the 'game' feature in the phone. Some users enjoy built-in games, and others may prefer to download games from the Internet after purchase. They may have different needs for customisation of the 'game' feature depending on their attitudes towards the 'game' feature. In contrast, basic functions such as 'contacts', 'text message', 'display size' and 'battery' showed relatively smaller standard deviations less than 1.4 since most of the them are basic features that most of mobile phone users frequently use, and they might have different preferences or skills in using them.

4.1. Inter-correlation analysis

Using the Pearson correlation analysis, relationships among the 26 mobile phone features were examined. A moderate or more correlations (>0.4) were identified between 37 pairs of features (Appendix 2). For example, 'GPS' and 'WIFI' (0.65), 'Recorder' and 'Radio' (0.62), 'display size' and 'battery life' (0.5), and 'size' and 'weight' (0.46) are correlated as expected.

4.2. Factor analysis

Based on the fact that many of the features were correlated, the factor analysis was conducted to find latent variables. To decide whether the factor analysis is necessary or not, the Kaiser–Meyer–Olkin (KMO) was calculated for sampling adequacy (Kaiser 1960). As shown in Table 4, all KMO values were above 0.7, implying it appropriate to carry out a factor analysis for each part.

Factor analyses with Varimax Rotation were made on each domain (design-related domain, cost-related domain, and easiness-related domain). Two factors

were identified in the design-related domain (Table 5). The total variance explained by the two factors was 61.6%. Factor 1, which explained 38.9% of the total variance, contained four features: 'shell colour', 'weight', 'shape' and 'size'. Based on the common aspect of these features, factor 1 was named 'physical design'. By contrast, factor 2 was comprised of 'operating system' and 'keypad layout'. As it was pointed out by Lin and Ye (2009) that consumers' needs for multi-function mobile phones drive development of smartphones and the operating system, competitions among different smartphone operating systems are quite intense nowadays. Additionally, the emergence and development of smartphone operating systems have also made input processes convenient. For example, a virtual keypad is built in some mobile phones with a large display size, and its layout can be easily altered by users' settings. The second factor was named 'technical design' because these two mobile phone features have a close relationship with users' information processing and interaction with mobile phone, which requires technical understanding of users.

Three factors were identified in the cost-related domain (Table 6). The total variance explained by the three factors was 55.4%. As shown in Table 6, factor 3 named 'cost of entertainment' included 'recorder', 'radio', 'image editor/document editor/video player', 'game', 'camera' and 'memory card' which need additional cost of mobile phones for entertainment.

Table 4. Kaiser–Meyer–Olkin values by domain.

Grouped mobile phone features	Design-related	Cost-related	Easiness-related
Kaiser–Meyer–Olkin Value	0.728	0.828	0.836

Table 5. Factor analysis in the design-related domain.

Features	Factor 1 (physical design)	Factor 2 (technical design)
Shell colour	0.765	0.094
Weight	0.760	0.051
Shape	0.742	0.262
Size	0.711	0.129
Operating system	−0.014	0.898
Keypad layout	0.341	0.679
Variance explained	2.336	1.363
by each factor		
% Variance explained	38.9	22.7
by each factor		
% Cumulative variance explained by the factors	38.9	61.6

Table 6. Factor analysis in the cost-related domain.

Features	Factor 3 (cost of entertainment)	Factor 4 (cost of information)	Factor 5 (cost of durability)
Recorder	0.807	0.025	0.293
Radio	0.726	0.076	0.106
Image editor/document editor/video player	0.664	0.337	0.084
Earphone	0.588	0.198	0.208
Game	0.541	0.423	-0.18
Camera	0.492	0.111	0.326
Memory card	0.447	0.249	0.411
WIFI	0.08	0.845	0.16
GPS	0.175	0.802	0.121
Software update	0.297	0.634	0.211
Battery	0.069	0.135	0.763
Display size	0.151	0.263	0.763
Shell material	0.212	-0.013	0.58
Variance explained by each factor	2.898	2.259	2.041
% Variance explained by each factor	22.3	17.4	15.7
% Cumulative variance explained by the factors	22.3	39.7	55.4

Table 7. Factor analysis in the easiness-related domain.

Features	Factor 6 (easiness of use)
Contacts	0.804
Calendar/calculator/clock	0.736
Multimedia message	0.692
Text message	0.691
Call	0.666
E-mail	0.588
Dual SIM capability	0.537
Variance explained by each factor	3.224
% Variance explained by each factor	46.1
% Cumulative variance explained by the factors	46.1

Factor 4 grouped 'WIFI', 'GPS', and 'software update'. Factor 4 was classified as 'cost of information' because the three features in factor 4 were related to cost of having or updating information. Factor 5 was labelled 'cost of durability' because it contained features related to time to use such as 'battery', 'display size' and 'shell material'. For example, a larger display size often leads to shorter battery duration, and a wearable shell material often helps protect the phone in hazard environment.

Only one factor was identified in the easiness-related domain (Table 7) and named 'easiness of use'. The total variance explained by the factor was 46.1%.

As seen in Table 7, the loading items of factor 6 contained 'contacts', 'calendar/calculator/clock', 'multimedia message', 'text message', 'call', 'E-mail' and 'dual SIM capacity'. Customisation options of these features are provided for phone users to help them

establish the user habit or adjust the user interface in their daily use of the phone.

4.3. Multiple regression analysis

4.3.1. A regression between preference and six factors

To find out important factors in determining preference for customising a mobile phone, a stepwise multiple linear regression analysis was performed (at $\alpha = 0.05$). The six factors classified from the factor analyses ('physical design', 'technical design', 'cost of entertainment', 'cost of information', 'cost of durability', and 'easiness of use') were used as independent variables and preference for customising mobile phones was used as the dependent variable of the regression model. The assumption of normality, constant variance and linearity were firstly checked and all assumptions were validated.

As shown in Table 8, three factors – 'easiness of use', 'cost of durability' and 'cost of information' – explained 27.1% of the total variance of preference for customising mobile phones. The standardised coefficients of three factors were 0.287, 0.223, and 0.207, which means preference for customising mobile phones were most influenced by preference for customising 'easiness of use', 'cost of durability' and 'cost of information' with relative importance of 40%, 31%, and 29%, respectively.

4.3.2. Regressions between preferences and features in each domain

Further stepwise multiple linear regression analyses were conducted between preference for customisation and features to examine important features influencing

customising the phone or customising the domain (at $\alpha = 0.05$). Preference for customising mobile phones and preference for customising three domains (design – related domain, cost-related domain, and easiness-related domain) were used as dependent variables and the corresponding features were used as independent variables. As shown in Table 9, the five features – ‘contacts’, ‘battery’, ‘software update’, ‘shell colour’, and ‘operating system’ – were the most influencing preference for customising mobile phones. The latter result showed that users who wanted to customise the five features have strong preference to customise mobile phones.

As one of the most frequently used functions in a mobile phone, ‘contacts’ possessed the determinant power in changing preference for customising mobile phones. Note that ‘shell colour’ is the only feature in factor ‘physical design’ that showed much influence on the total customisation preference. In addition, three features (‘shape’, ‘shell colour’, and ‘keypad layout’) for the design-related domain, four features (‘battery’, ‘memory card’, ‘WIFI’, and ‘earphone’) for the cost-related domain, and three features (‘contacts’, ‘call’, and ‘calendar/calculator/clock’) for easiness-related

domain were found as significant predictors for preference for customising the domains.

As shown in Table 9, companies need to provide diverse designs of mobile phones in shape, shell colour, and keypad layout. Among them ‘shape’ and ‘shell colour’ are considered features for mass customisation, and ‘keypad layout’ is the feature which can be customised by both mass customisation and personalisation. Considering that the ‘shell colour’ feature is relatively easy to produce in manufacturing, diversifying shell colour is one of the quick and simple ways to satisfy requirements of diverse customers. However, it is difficult to determine what ‘shape’ customers prefer. And therefore, the studies to find the shape that users like should precede the shape customisation. In addition, diverse design solutions for ‘shape’ should be more carefully provided because ‘shape’ is highly correlated with other design features.

For customers’ cost consideration, companies also need to provide customisation solutions for ‘battery’, ‘memory card’, ‘WIFI’ and ‘earphone’ which may be realised by mass customisation. For a long lasting battery, for example some users may be willing to pay additional money for the phone having it. The feature

Table 8. Stepwise regression between six factors and preference for customisation.

Predictors	Unstandardised coefficient	Standard error	Standardised coefficient	<i>p</i> -value	<i>R</i> ²
(Constant)	5.191	0.065	–	<0.05	0.271
Easiness of use	0.367	0.078	0.287	<0.05	
Cost of durability	0.285	0.073	0.223	<0.05	
Cost of information	0.265	0.071	0.207	<0.05	

Table 9. Stepwise regression between features and their domains.

Domain	Predictors	Unstandardised coefficient	Standard error	Standardised coefficient	<i>p</i> -value	<i>R</i> ²
Total	(Constant)	1.107	0.385		<0.05	0.293
	Contacts	0.235	0.065	0.217	<0.05	
	Battery	0.178	0.054	0.185	<0.05	
	Software update	0.154	0.051	0.171	<0.05	
	Shell colour	0.112	0.046	0.127	<0.05	
	Operating system	0.095	0.045	0.114	<0.05	
Design	(Constant)	2.535	0.294		<0.05	0.272
	Shape	0.243	0.054	0.289	<0.05	
	Shell colour	0.222	0.056	0.247	<0.05	
	Keypad layout	0.097	0.048	0.109	<0.05	
Cost	(Constant)	1.894	0.348		<0.05	0.277
	Battery	0.278	0.050	0.296	<0.05	
	Memory card	0.139	0.051	0.161	<0.05	
	WIFI	0.152	0.043	0.191	<0.05	
	Earphone	0.095	0.045	0.122	<0.05	
Easiness	(Constant)	2.011	0.324		<0.05	0.277
	Contacts	0.295	0.068	0.276	<0.05	
	Call	0.214	0.050	0.240	<0.05	
	Calendar/calculator/clock	0.117	0.053	0.142	<0.05	

could be customised in the sales procedure, which can easily increase customer satisfaction and total sales in the long run.

The stepwise analysis also showed the features including ‘contact’, ‘call’, and ‘calendar/calculator/clock’ were the most preferred to customise for easiness purpose. Those three features might be realised by the personalisation approach so that users can setup the features by themselves with their own purposes or skills. For this purpose, companies need to do research of understanding user requirements for personalising the features in advance.

4.4. Comparisons

4.4.1. Comparison between genders

In order to examine differences between genders, the Student’s *t*-test was conducted. As shown in Table 10, five features – ‘shell colour’, ‘shape’, ‘calendar/calculator/clock’, ‘GPS’, and ‘display size’ – of the 26 features were significantly different between genders (at $\alpha = 0.05$). Female students had stronger desire to customise features in the design-related domain such as ‘shell colour’, ‘shape’ and ‘display size’, while male students only had a stronger desire for customising ‘GPS’. The result on the ‘calendar/calculator/clock’ feature accords with the study by Ling *et al.* (2007) that female students use the alarm reminders and other basic functions more regularly and find them more useful than male students.

4.4.2. Comparison among usage history

For comparisons among users who have different extent of experience in using mobile phones, the number of mobile phones that have been owned shown in Table 2 was used. The users who have owned one phone, two or three phones, and four or more phones were labelled ‘limited experience’, ‘somewhat diverse experience’ and ‘very diverse experience’, respectively. After checking the homogeneity of variances of each variable, a one way ANOVA was

Table 10. Significant differences between genders for customisation.

Features	Mean		<i>p</i> -value
	Male	Female	
Shell colour	4.355	4.952	<0.05
Shape	4.901	5.444	<0.05
Calendar/calculator/clock	5.086	5.516	<0.05
GPS	5.049	4.659	<0.05
Display size	5.210	5.516	<0.05

then performed on preference for customising mobile phones and 26 features of mobile phones (at $\alpha = 0.05$). As shown in Table 11, significant difference among three groups was found in preference for customising the features – ‘size’, ‘weight’, ‘shape’, ‘shell material’, and ‘WIFI’ (at $\alpha = 0.05$). Other features or general preference for customisation did not show significant difference among three groups.

This was followed by a Duncan test to compare preference for customisation among three groups (‘limited experience’, ‘medium experience’ and ‘diverse experience’). As shown in Table 12, preference to customise ‘weight’ and ‘shape’ declined as customers’ usage experience increases. Another group of features including ‘size’ and ‘shell material’ showed low customisation preference when people had limited or diverse experience, but showed relatively high preference when they have medium usage experience. Interestingly, ‘WIFI’ was the only feature that showed increase of preference as users get experienced. That is, the more experienced the users are, the less likely to be interested in customising except for ‘WIFI’. Besides, ‘WIFI’ could better arouse user’s interest due to the rapid expansion of online software and quick spread of 3G Internet services.

5. Summary conclusions and discussion

Current technology has enabled more fancy and appealing features to mobile phones. However, a

Table 11. ANOVA of different use experiences for customisation.

	Sum of squares	df	Mean square	<i>F</i>	<i>p</i> -value
Size					
Between groups	18.893	2	9.447	3.414	0.034
Within groups	788.687	285	2.767		
Total	807.58	287			
Weight					
Between groups	18.18	2	9.09	3.751	0.025
Within groups	690.695	285	2.423		
Total	708.875	287			
Shape					
Between groups	15.277	2	7.638	3.205	0.042
Within groups	679.168	285	2.383		
Total	694.444	287			
Shell material					
Between groups	13.358	2	6.679	3.472	0.032
Within groups	548.305	285	1.924		
Total	561.663	287			
WIFI					
Between groups	16.542	2	8.271	3.429	0.034
Within groups	687.402	285	2.412		
Total	703.944	287			

Table 12. Significant differences among different use experiences for customisation.

Mobile phone features	Duncan grouping	
	More preferred	Less preferred
Size	Limited experience (4.58), medium experience (4.73)	Diverse experience (4.14), limited experience (4.58)
Weight	Medium experience (4.57), limited experience (4.69)	Diverse experience (4.05)
Shape	Medium experience (5.26), limited experience (5.38)	Diverse experience (4.78), medium experience (5.26)
Shell material	Limited experience (4.36), medium experience (4.49)	Diverse experience (4.00), limited experience (4.36)
WIFI	Medium experience (5.20), diverse experience (5.54)	Limited experience (4.80), medium experience (5.20)

Table 13. Summary guideline for mass customisation and personalisation.

	Above average	Below average
Mass customisation (before purchase)	Battery	Keypad layout
	Display size	GPS
	Memory card	Shell colour
	Camera	Size
	WIFI	Recorder
	Operating system	Dual SIM capacity
	Shape	Weight
Personalisation (after purchase)		Game
		Shell material
		Radio
	Text message	E-mail
	Contacts	Image editor/ document editor/ video player
	Software updates	Multimedia message
	Calendar/ calculator/ clock	
	Earphone	
	Call	

user-goal-driven design is becoming more important than a technology-driven design as digital devices are becoming complicated to use (Cooper 1999). Users usually want to customise their mobile phones in order to have a preferred design, to reduce the cost, or to use with ease. Customisation of mobile phones can be realised either with mass customisation before purchase or personalisation after purchase of mobile phones (see Table 1). The following summarises some important findings or conclusions with discussion:

- (1) A total of 26 features for customisation of mobile phones were identified, and they were then classified into six categories based on two customisation methods, (mass customisation and personalisation) and three customisation domains (design-related, cost-related, and easiness-related) (see Table 1).
- (2) Among the 26 features, 13 features were rated above average on preference for customisation

(seven features in mass customisation and six features in personalisation). As shown in Table 13, 'battery', 'display size', 'memory card', 'camera', 'WIFI', 'operating system' and 'shape' were the features that manufacturers need to customise before customers' purchase based on requirements by different target customers. That is, necessity, use, or preference of those features may be diverse and different among users influencing user satisfaction and sales of the product in the long run.

- (3) As shown in Table 13, 'text message', 'contacts', 'software updates', 'calendar/calculator/clock', 'earphone', and 'call' were the features that users want to personalise after purchase. These seem to be basic and frequently used features of mobile phones. In order to customise these features, manufacturers should provide diverse alternates of the features that users can choose by themselves.
- (4) User ratings showed three main reasons for users to customise mobile phones including: using the phone with ease, extending the lifespan, and optimising information for their own purposes (see Table 8). Mobile phone manufacturers had better consider different levels of skills of users in developing user interface. This tendency was more important for frequently used features such as 'contacts', 'text message', or 'call'. It is thought that users highly want to efficiently use the frequently used featured to save their times and efforts in using them. Manufactures should also realise that users care a lot about cost of maintenance and information access.
- (5) Among the design-related features, 'shape', 'shell colour', and 'keypad layout' were most preferred to customise (see Table 9). For this customisation, companies need to understand preference of target user group on the design features, and to find ways how to efficiently diversify the features. In addition, companies may need to quickly figure out the design trend among users and to effectively reflect the trend

to the product design based on the concept of mass customisations.

- (6) Among the cost-related features, 'battery', 'memory card' and 'WIFI' were most preferred to customise (see Table 9). Providing diverse selections in the sales process for these components could be helpful to satisfy user needs.
- (7) Among the easiness-related features, 'contact', 'call' and 'calendar/calculator/clock' were most preferred to customise (see Table 9). Providing diverse approaches or shortcuts to use of each feature to help users use it efficiently could be an appropriate solution to increase user satisfaction.
- (8) Gender was significant for customising mobile phones. Female users wanted to customise 'shell colour', 'shape', 'calendar/calculator/clock' and 'display size' more than male users did. It is considered to be a tendency of female customers to have their own styles of mobile phones. On the contrary, male users were more willing to customise 'GPS', which indirectly shows the tendency of male users more valuing practical experience of mobile phones for their own use.
- (9) User experience of mobile phones was also significant for customisation. As customers become experienced, they tend to have less interest in customising 'shape' and 'weight', but more interest in 'WIFI' (see Table 12). By contrast, customisation preference for 'size' and 'shell colour' reaches its top when customers have a medium experience. More experienced users seem to have more interest in the technical performance or functions than the design. In this regard, customisation could be a better strategy for novice users.

This research provided some customisation guidelines of mobile phones for manufacturers regarding the features to customise with different methods including mass customisation and personalisation. This study, however, did not include what are user requirements for customisation or how to customise the features reflecting their requirements. Customisation could be a good solution to satisfy conflicting requirements of diverse users, but it can also increase another dimension of complexity for users to choose. Therefore, defining a clear objective and target segmentations should precede taking an action. Further research for customisation can be also considered with diverse user segmentations to better generalise the result of the research.

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Appendix 1. Survey instrument

Design-related questions

- (1) It is important to have several size alternatives of a mobile phone before purchase.
- (2) It is important to decide the weight of a mobile phone before purchase.
- (3) There should be enough colour alternatives of a mobile phone before purchase.
- (4) I want to have options for the shape of the mobile phone before purchase.
- (5) I prefer to be able to choose the keypad layout of the mobile phone before purchase.
- (6) It is important to be able to choose the operation system of the mobile phone before purchase.
- (7) It is important to be able to change the colour of the mobile phone before purchase.

Cost-related questions

- (1) I prefer to have an option to choose the material of the shell of a mobile phone before purchase.
- (2) It is important to have alternatives of the display size of the mobile phone before purchase.
- (3) It is important to have alternatives of batteries with different capacities before purchase.
- (4) I prefer to be able to decide whether to include a camera in a mobile phone before purchase.
- (5) It is important to decide whether or not to include a recorder in the mobile phone before purchase.
- (6) If I can decide whether to include a radio in the phone before purchase, it would be great.
- (7) It is important to decide whether to include a WIFI function in a mobile phone before purchase.
- (8) It is important to decide whether or not to include GPS in a mobile phone before purchase.
- (9) It is important to be able to choose the games in a mobile phone before purchase.
- (10) It is important to be able to decide whether or not to include image editor, document editor, and video player in a mobile phone before purchase.
- (11) I hope that a mobile phone is compatible with various types of memory cards (Micro-SD, etc.).
- (12) I prefer to have alternatives of earphone of the mobile phone after purchase.

- (13) There should be more choices of the software update of the mobile phone after purchase.
- (14) I prefer to be able to decide whether or include a recorder in a mobile phone before purchasing it.

Easiness-related customisation

- (1) It's important to decide if a dual SIM card is acceptable before purchase.
- (2) I want to have alternatives to choose the form of calendar, calculator, and clock of the phone.
- (3) There should be more options for the ‘contact’ function so that I can personalise my phone.
- (4) It is important to be able to personalise the interface of voice call and video call after purchase.
- (5) It is important to have more options of the text message function so that I can use it more easily.
- (6) It is important to be able to choose the multimedia message editing interface.
- (7) It is important to have more options of the E-mail function so that I can use it more easily.
- (8) It is important to be able to change and personalise the contacts function after purchase.

General preferences

- (1) Generally speaking, I feel it is easy to use my mobile phone that I currently own.
- (2) When I buy a mobile phone, I want to have my mobile phone customised.
- (3) Customisation of design-related features (size, colour, weight, keypad layout and operating system) is important to me.
- (4) Customisation of cost-related features (material, display size, battery, camera, recorder, radio, Wi-Fi, GPS, games, memory card, headphone and software update) is important to me.
- (5) Customisation of easiness-related features (dual SIM card capacity, calendar, calculator, clock, contacts, call, multimedia message and E-mail) is important to me.
- (6) When I buy a mobile phone, I want to have my mobile phone customised.

Appendix 2. Correlations between features

Features	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1 Size	1																										
2 Weight	0.46*	1																									
3 Shape	0.44*	0.38*	1																								
4 Keypad layout	0.24*	0.36*	0.34*	1																							
5 Operating system	0.17*	0.05	0.22*	0.33*	1																						
6 Shell colour	0.36*	0.42*	0.57*	0.25*	0.14*	1																					
7 Shell material	0.26*	0.21*	0.30*	0.18*	0.29*	0.34*	1																				
8 Screen size	0.21*	0.18*	0.36*	0.35*	0.34*	0.35*	0.36*	1																			
9 Battery	0.08*	0.22*	0.19*	0.31*	0.20*	0.20*	0.26*	0.50*	1																		
10 Camera	0.10*	0.16*	0.19*	0.11*	0.15*	0.36*	0.22*	0.17*	0.32*	1																	
11 Radio	0.01*	0.07*	0.09*	0.21*	0.35*	0.11*	0.15*	0.31*	0.19*	0.25*	1																
12 WIFI	0.02*	0.05*	0.06*	0.14*	0.34*	0.16*	0.18*	0.28*	0.18*	0.25*	0.26*	1															
13 GPS	0.06*	0.03*	0.08*	0.06*	0.16*	0.13*	0.11*	0.14*	0.10*	0.24*	0.35*	0.65*	1														
14 Game	0.15*	0.08*	0.16*	0.16*	0.22*	0.16*	0.16*	0.34*	0.16*	0.31*	0.35*	0.27*	0.32*	1													
15 Image editor/document editor/video editor/player	0.19*	0.17*	0.28*	0.23*	0.23*	0.24*	0.21*	0.38*	0.27*	0.31*	0.28*	0.28*	0.30*	0.15*	1												
16 Memory card	0.16*	0.17*	0.25*	0.22*	0.23*	0.18*	0.11*	0.27*	0.24*	0.31*	0.34*	0.24*	0.21*	0.23*	0.44*	1											
17 Earphone	0.06*	0.03*	0.17*	0.20*	0.32*	0.14*	0.16*	0.27*	0.27*	0.22*	0.22*	0.45*	0.41*	0.35*	0.42*	0.39*	1										
18 Software update	0.14*	0.17*	0.22*	0.16*	0.19*	0.34*	0.34*	0.32*	0.27*	0.47*	0.62*	0.18*	0.30*	0.32*	0.49*	0.42*	0.40*	1									
19 Recorder	0.23*	0.22*	0.31*	0.17*	0.21*	0.37*	0.25*	0.28*	0.25*	0.19*	0.41*	0.12*	0.17*	0.26*	0.29*	0.35*	0.29*	0.23*	1								
20 Dual SIM capability	0.19*	0.25*	0.29*	0.30*	0.24*	0.28*	0.20*	0.38*	0.33*	0.27*	0.26*	0.18*	0.15*	0.21*	0.32*	0.34*	0.43*	0.31*	0.38*	1							
21 Calendar/calculator/clock	0.15*	0.20*	0.27*	0.17*	0.21*	0.34*	0.21*	0.35*	0.22*	0.31*	0.38*	0.28*	0.30*	0.24*	0.31*	0.31*	0.31*	0.36*	0.38*	0.37*	1						
22 Call	0.25*	0.22*	0.40*	0.15*	0.27*	0.29*	0.20*	0.42*	0.39*	0.28*	0.15*	0.19*	0.20*	0.18*	0.22*	0.38*	0.34*	0.39*	0.25*	0.25*	0.49*	1					
23 Text message	0.15*	0.19*	0.27*	0.13*	0.25*	0.35*	0.18*	0.27*	0.13*	0.23*	0.36*	0.25*	0.27*	0.21*	0.35*	0.40*	0.43*	0.35*	0.40*	0.24*	0.33*	0.41*	0.39*	1			
24 Multimedia message	0.03*	0.12*	0.15*	0.15*	0.27*	0.21*	0.25*	0.22*	0.17*	0.13*	0.31*	0.44*	0.48*	0.31*	0.33*	0.31*	0.27*	0.42*	0.34*	0.18*	0.27*	0.35*	0.23*	0.43*	1		
25 E-mail	0.22*	0.20*	0.32*	0.27*	0.31*	0.28*	0.15*	0.40*	0.43*	0.19*	0.23*	0.39*	0.32*	0.26*	0.27*	0.46*	0.41*	0.40*	0.27*	0.36*	0.59*	0.38*	0.50*	0.46*	0.41*	1	
26 Contacts	0.15*	0.14*	0.28*	0.22*	0.30*	0.26*	0.19*	0.36*	0.38*	0.18*	0.11*	0.30*	0.27*	0.22*	0.20*	0.28*	0.33*	0.36*	0.22*	0.26*	0.32*	0.22*	0.39*	0.28*	0.22*	0.43*	1
27 Total customisation potential																											

Note: *Correlation is significant at $\alpha = 0.05$; shaded cell indicates a moderate correlation.