Design of Smart Watch for Old People Based on the Benchmark of Consumers' Kansei Intention

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Abstract. Current product design is dependent on designers' experiences, knowledge and shaping ability excessively. But consumers' demand changes owing to rapid growth of market economy. The focus of the product transforms from original basic demand to deeper level of Kansei. Consumers' Kansei appeal should be reflected more and presented by shape, material, color or other shaping element of smart watch besides considering health, comfort and other elements because the relation of watch and human are relatively intimated. Old people are different from general consumer group physically and psychologically, which embodies in the degeneration of visual sense, auditory sense, reaction capacity, the force of hands and the memory ability of text and graphic. Old people are greatly different from other group in Kansei intention and user experience of using smart watch. Therefore whether appearance design or interaction design for watch should embody our care for the special group-old people to improve the product satisfaction degree and bring convenience for them. If the parameters relative to consumers' Kansei intention can be found, they can assist designers in accurately positioning the shaping and functional design features of products to improve the efficiency of design. The author conducts design evaluation on survey samples combining with Kansei engineering taking "smart watch for old people" as an example in this study to verify the idea that the shaping design of product is dependent on Kansei intention. The main results and completed work in this paper includes: Survey on shaping, interview and questionnaire appraisal of smart watch targeting at old people consumer group are carried out firstly; relative data information and picture sample pool are collected; shaping of smart watch for old people is broken down using Morphological Analysis method and survey contents to determine shaping design elements which influence image of consumers; representative image words describing the shaping of smart watch for old people are determined with cluster analysis method; and then multivariate linear relation model between consumers' Kansei intention and the shaping design of smart watch for old people is built. Quantification relation between Kansei image meaning evaluation value and shaping design elements are built and multivariate regression analysis is conducted with Quantification Theory Type Imethod on the basis of performing statistical analysis on image meaning evaluation experiment result of representative sample to obtain correlated category score, item range, constant,

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multiple correlation coefficient and determination coefficient. And on this basis mathematic relation model between all Kansei intention and design elements are built so that the aim of estimating consumers' Kansei intention is reached. Finally sample is selected to verify it, Paired-sample T check analysis on the estimation value of correlation model and the mean value of subjective evaluation is conducted and the result shows that the estimation model has reliability.

Keywords: Kansei Engineering · Smart watch · Quantification theory type I

1 Introduction

Current aging of population is not only a huge problem faced by the developing countries like China, but also a difficulty that the whole world should be faced with together. In the next five decades, world's aging tendency of population is speeding up and becoming more and more critical. According to the medium program of the United Union, the global old age population coefficient will increase from 6.9 % in 2000 to 21.4 % in 2050. The growth range is even higher than ever (2002). The increase proportion of aging population makes the social pension, life quality of elder people, products for the elder become popular topics among scholars in recent years. The rapid development of Internet, big data and artificial intelligence, especially the frequent update of electronic product, leads to huge changes in elder people's daily life. For example, there are more and more wearable smart devices for the elder people and the new functions features emerge in an endless stream, like all sorts of smart Bracelet and smart watch, etc. Therefore, these are important topics to master the general rule of elderly consumers' psychology, design products based on consumers' demands, reflect caring for the elders and increase their satisfactions ratio.

2 Research Background

As a newly rising electronic device, smart watch contains not only plentiful functions but also close connection with human body. So the designer should give more responses to consumer's emotional appeal besides considering health and comfortableness factors, and deliver through the modeling elements like shape, material and color. The former products design is more dependent on the subjective judge and thought of designer, while along with the emerging of experience economy, consumers' position is becoming more and more important in product design. The rapid development of market economy causes changes in consumers' demand and their focus point varies from the original basic needs to a deeper emotional level. As a consumer oriented human engineering technology, Kaisei Engineering (KE) focus more on users' experience and demands, which is why it is called the "Emotional Design"(Nagamachi 1995). KE is the first choice of development methods by conversing consumers' impression, feeling and demands on existing or concept products into specific design parameters (Nagamachi 1995; Schütte, 2004). This article would analyze the elder's perceptual demand for smart watch by Kaisei Engineering method.

3 Literature Review

The explosive development of intelligent products and the rapid expansion of the scope of application in recent years make the scholars pay more and more attention back to the real needs of consumers, usability, ease of use and user experience and so on. For example, Han, along with some others, took consumable electronic products as example, carried out some case studies and proposed a usability evaluation system of some meaning (2001); Beom and Kyeyoun (2009) discussed the basic framework of product usability evaluation from the customer's perceptual perception of product design taking dishwasher as the example. Costas Boletsis analyzed the feasibility of using smart watches to monitor the health of the elderly in the family (2015). According to Hartono's view (2012), the perceptual engineering is considered to be essentially superior to other similar methods. It establishes a mathematical model of the perceptual response through human sensory and external stimuli, which can reduce subjectivity to the maximum extent. The application of perceptual engineering covers many aspects nowadays, such as products and services, including interior design, automobile designs (i.e. Mazda, Nissan, NISSAN, TOYOTA, MITSUBISHI, Honda, Ford, Fiat and Hyundai, etc.), bra (i.e. Wacoal), residence (see Llinares and Page, 2011), beverage (i.e. beer), consumer electronic and service, etc. The research by Huang Cheng (2014) on the design of smart watches adopts the theory of kansei engineering quantification, combines with consumer psychology and finally concludes a professional and targeted result.

4 Research Methods and Procedure

4.1 Investigation and Analysis of Product Function

This study designs a product survey questionnaire on the smart watch function and performance for the elderly consumer groups. The questionnaire contains 16 projects in total: Time reminder, heart rate monitoring, double talk, sleep monitoring, sports step counting, weather forecast, GPS positioning, emergency assistance(SOS), medication reminders, blood pressure monitoring, electronic fence, long standby, voice control, waterproof function, camera, Bluetooth music. Measure consumers' expectation value by Likert scale: "–2, –1, 0, 1, 2" for "Strongly unwanted, unwanted, neutral, wanted, strongly wanted". The questionnaire is carried out in two ways: on-site give-out and recycle, and the network questionnaire survey. The on-site way gives out 120 pieces of questionnaire and recycles 105 valid pieces in the parks, where the elder exercise in the morning. The number of network survey participant is 652 and valid questionnaire quantity is 611. Statistical data contributes to understand the general situation of the elderly consumer demand for smart watches, which helps designers to plan and make decisions when they are developing new products. See Table 1:

We can see from the data that the expectation value of the elders is higher in SOS, long standby, medication reminders, time reminder, blood pressure monitoring and heart rate monitoring. It means that the elder care more for these functions and would like these to be realized in products. See Fig. 1:

Table 1. Consumers' intention to the functions of smart watch

Time reminder	Heart rate monitoring	Double talk	Sleep monitoring	Sports step counting	Weather forecast	GPS positioning	SOS
1.328	1.175	1.017	0.986	0.928	0.876	0.936	1.622
Medication reminders	Blood pressure monitoring	Electronic fence	Long standby	Voice control	Waterproof function	Camera	Bluetooth music
1.393	1.282	0.937	1.414	1.124	0.906	0.815	0.753

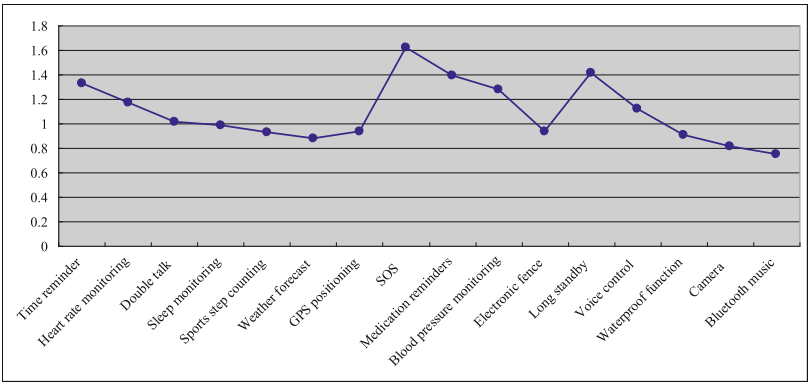


Fig. 1. Data ordering of kansei intent towards product function

Certainly there is demand for the other functions, which requires the designers to pay attention to and choose when designing. As the elder prefer something of habits and regular, their memory and response decrease correspondingly, and it is often difficult and slow to accept new things, so it is not proper to pursuit more and comprehensive in smart watch function quantity but to keep the main and necessary functions, add some new features to help them to use and learn. In addition, due to the degradation of the physiological function of the elder, the operation of electronic equipment, especially some small devices like watch, will cause a lot of inconvenience. The design of buttons and interfaces is worth our attention. They should be easy to master to avoid frustration caused by operation error. We will be able to understand the elderly consumers' preliminary kansei intention towards smart watches through the investigation and analysis of the product function, conclude a clear design objective and initial direction and form the keynote of the product function design.

4.2 Product Modeling Intention Survey

This study collects a variety of brands and styles of smart watches for elder, total 120, as experimental samples through manufacturers' website, brochure and shopping mall, etc. Classify similar products by Delphi method and KJ method and screen to 32. Remove other interference factors, such as color and brand, and display in black and

white pictures to facilitate consumers' kansei evaluation of product modeling. Select 50 adjectives by online survey, references and interviews, screen to 12 and code them by expert analysis and group discussion. Set 5 scales for each adjective according to Likert scale: very 2, better 1, neutral 0, not very −1, worst −2. Let the elderly consumers, as the test subjects, give grades to the 12 intention adjectives of the 32 experimental samples. Add up the grades and calculate the average score. See Table 2:

Table 2. Table of kansei evaluation score (average)

Sample	Kansei Adjectives											
	1	2	3	4	5	6	7	8	9	10	11	12
	Concise	Steady	Graceful	Modern	Comfortable	Technological	Fashion	Practical	Upscale	Elaborate	Demotic	Safe
	1.25	0.89	0.95	0.92	0.90	0.87	0.75	0.86	0.57	0.62	1.05	1.17
	1.01	0.52	0.83	0.91	0.76	0.97	0.88	0.71	0.60	0.52	0.63	0.72
	0.92	0.49	0.81	0.85	0.59	0.56	0.57	0.67	0.52	0.68	0.66	0.70
…	…	…	…	…	…	…	…	…	…	…	…	…
	0.82	0.86	0.70	0.69	0.60	0.64	0.60	0.54	-0.32	0.55	0.69	0.80
	0.35	0.51	0.62	0.82	0.46	0.68	0.81	-0.39	0.61	0.69	0.64	0.77
	0.79	0.63	0.72	0.84	0.49	0.58	0.69	0.55	0.51	0.71	0.60	0.66

4.3 Spatial Analysis on Kansei Semantics

In order to facilitate the cluster analysis of the sample afterwards, we will carry out the factor analysis of the statistical data of kansei evaluation score. The main function of factor analysis is to reduce dimension. After the factor analysis, the original variables form a small number of comprehensive indicators or dimensions. Then the cluster analysis is implemented on the basis of a few comprehensive indexes or dimensions, which will make the effect more concise and clear. It can also be said that clustering within a space with fewer dimensions is easier to be understood compared with the space with more dimensions. This is mainly due to the limited information processing and perception of human beings. So the final number of factors (kansei adjectives) should be as less as possible on the precondition that "less but fine". Through factor

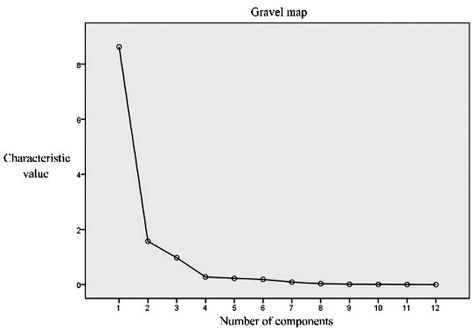


Fig. 2. Factor analysis — gravel map

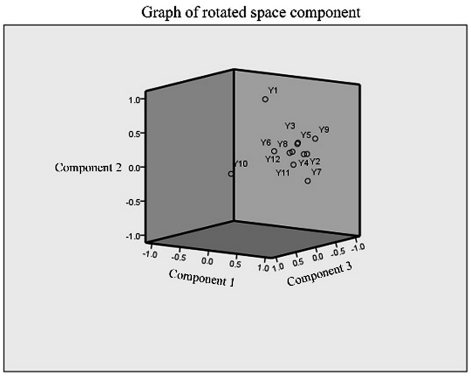


Fig. 3. Factor analysis — graph of rotated space component (three dimensional)

analysis, we get the gravel map as Fig. 2, three dimensional graph of rotated space component in Fig. 3 and common factor data sheet in Table 3.

Through the data results of factor analysis, we can choose 4 representative adjectives according to the level of the factor load: concise, graceful, comfortable and practical.

4.4 Modeling Element Analysis

Next, we use morphological analysis, assisting with the research content, to analyze the morphology of the smart watch of the elder in this study. We set the design elements into the dial, screen, watch strap, button and frame preliminarily, then we determine the modeling designing elements impacting on consumer intention by cluster analysis as dial, watch strap and button, see Table 4.

Number dial, watch strap and button as X1, X2 and X3, which are the main modeling elements in smart watch for elders. Mark their general modeling distribution as C11, C12, C13, C14, C21, C22, C23, C31, C32, C33, C34 and C35, see Table 5.

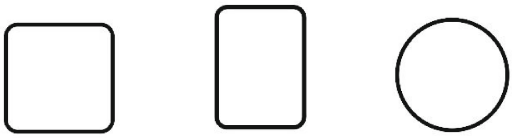
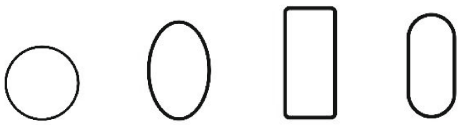
Table 3. Factor analysis — common factor data sheet

Common factor	Kansei adjectives	Factor loading	Variance contribution/%	Cumulative contribution rate/%
Factor 1 (Style)	Concise	0.959	71.911	71.911
	Graceful	0.949		
	Steady	0.916		
	Modern	0.887		
	Fashion	0.865		
	Demotic	0.842		
	Comfortable	0.865		
Factor 2 (Quality)	Technological	0.713	13.103	85.014
	Elaborate	0.681		
	Safe	0.632		
Factor 3 (Value)	Practical	0.842	8.105	93.119
	Upscale	0.678		

Table 4. Cluster analysis result

Category	Sample number	Kansei intention	Modelling feature
1	1, 5, 6, 9, 10, 15, 17, 20, 25, 28, 32	Concise, Graceful, Modern	Dial, screen, watch strap, button
2	2, 11, 13, 19, 24, 27, 30, 31	Comfortable, Modern, Practical	Dial, watch strap, button
3	7, 8, 12, 14, 21, 22, 26	Graceful, Comfortable, Demotic	Dial, frame, screen, watch strap
4	3, 4, 16, 18, 23	Concise, Practical	Dial, frame, watch strap

Table 5. Modeling designing element classification sheet

Designing Element	Classification（Modeling Distribution）
Dial（X1）	 C11 Rounded square C12 Rounded rectangle C13 Circle Others C14
Strap (X2)	C21 Integral C22 Separated C23 Others
Button(X3)	 C31 Circle C32 Ellipse C33 rectangle C34 Large rounded rectangle Others C35

4.5 The Establishment of Kansei Evaluation Matrix and Mathematical Model

According to the results of cluster analysis, select 12 typical samples from collective product samples, conclude 4 representative adjectives by factor analysis, quantify design elements into quantitative data of 1 and 0 and construct kansei evaluation matrix. We can design elements as independent variables and the average value of the kansei evaluation as the dependent variable according to the matrix. The mathematical model is established as the multiple regression equation, see Table 6.

Table 6. Kansei evaluation matrix

Sample	Kansei evaluation adjectives				Designing elements											
					Dial(X1)				Strap(X2)			Button(X3)				
NO.	Concise	Graceful	Comfortable	Practical	C11	C12	C13	C14	C21	C22	C23	C31	C32	C33	C34	C35
1	0.92	0.95	0.90	0.86	1	0	0	0	0	1	0	0	0	1	0	0
2	0.71	0.83	0.76	0.71	0	0	1	0	1	0	0	0	1	0	0	0
3	0.64	0.81	0.59	0.67	0	1	0	0	0	1	0	0	0	0	1	0
4	0.91	0.82	0.62	0.69	1	0	0	0	1	0	0	0	0	0	0	1
5	0.53	0.74	1.09	0.88	0	0	0	1	0	1	0	0	0	0	1	0
6	0.50	0.76	0.87	-0.27	0	0	1	0	0	1	0	0	0	0	1	0
7	0.66	0.59	0.97	0.72	1	0	0	0	0	1	0	1	0	0	0	0
8	0.63	0.68	-0.13	0.91	0	1	0	0	1	0	0	0	0	1	0	0
9	0.37	0.90	0.87	0.75	1	0	0	0	0	1	0	1	0	0	0	0
10	-0.19	0.57	0.63	1.10	0	1	0	0	0	0	1	0	0	0	0	1
11	0.75	0.52	0.66	0.90	1	0	0	0	1	0	0	1	0	0	0	0
12	0.76	0.90	0.56	0.75	0	1	0	0	0	1	0	0	0	1	0	0

4.6 Solution and Analysis of Mathematical Model

Solving models by quantifying theory I and obtaining important values like item scores, scope of projects (partial correlation coefficient), constant terms, multiple correlation coefficients and coefficients of determination with the help of calculation software. See it in Table 7:

Thus, taking kansei intention "concise" as an example, we can obtain its regression equation:

$$Y_{Concise} = 14C11 + 0.377C12 - 206C13 + 0.186C14 + 0.728C21 + 0.26C22 - 0.062C3 + 0.219C31 - 0.178C32 + 0.353C33 + 0.208C34 - 0.252C35 + 3.751;$$

Relevant values concerning the three kansei adjectives "graceful", "comfortable" and "practical" can be obtained in the same method. See the numbers in Table 8:

And mathematical models of which the coefficients between groups of kansei intentions and designing elements are explicit can be made according to this, so as to achieve the purpose of predicting the kansei intentions of consumers, facilitating the design of models.

Table 7. Relevant data obtained by regression analysis (kansei intentional word "concise")

Designing elements	Categories	Item scores	Scope of projects (Partial correlation coefficient)	Constant terms	Coefficients of determination	Multiple correlation coefficients
Dial (X1)	C11	0.514	0.573	3.751	0.793	0.891
	C12	0.377				
	C13	−0.206				
	C14	0.186				
Strap (X2)	C21	0.728	0.288			
	C22	0.260				
	C23	−0.062				
Button (X3)	C31	0.219	0.396			
	C32	−0.178				
	C33	0.353				
	C34	0.208				
	C35	−0.252				

Table 8. Scores of designed items about kansei intentional adjectives

Kansei adjectives	Dial(X1)	Strap(X2)	Button(X3)
Concise	0.573	0.288	0.396
Graceful	0.461	0.138	0.221
Comfortable	0.602	0.376	0.559
Practical	0.668	0.257	0.473

5 Results and Test

We can conclude from the previous research results from 4.1 to 4.6 about older consumers' rough intention or preference: that the elders pay more attention to some practical functions in smart watch, like long standby time, time reminding and medicine reminding, as well as some health care functions such as SOS, medicine reminding, blood pressure monitoring and heart rate monitoring, while some other functions are relatively inferior. Concerning appearance, the elders prefer concise, elegant, comfortable and practical watch, and the dials and buttons have greater effects on the appearance kansei intention, which require special focus of the product developers when designed. Watchband doesn't affect the appearance too much, while it does affect the degree of comfort to some extent.

Finally, select 24 samples to take verification. Obtaining one set of data through kansei predictions by modeling. Meanwhile, select another 30 testers to give kansei scores, which produce another set of data. T-Test analysis were carried out towards the predicted value and subjective evaluation means of the relational model, and the results showed that the T value in paired sample verification is 0.183, which is a bit low, while the sig (significance impact level) is 0.857, which is kind of big, illustrating there is no great difference between predicted value(calculated from the equations) and subjective

evaluation means(re-evaluation), therefore indicating that the intention-predicting model is credible. See it in Table 9.

Table 9. T-Test data analysis (scores about the kansei adjective "concise")

Paired sample correlation coefficient									
			N		Correlation coefficient		Sig.		
Pair1	Relational model predicted value & Subjective evaluation score		24		0.876		0.000		
Paired sample test									
		Paired difference					t	df	Sig (Paired sample test)
		Mean value	Standard deviation	Standard error of mean	95% confidence interval of difference				
					Lower limit	Upper limit			
Pair1	Predicted value of the relational model-Subjective evaluation score	0.00375	0.10060	0.02053	-0.03873	0.04623	0.183	23	0.857

6 Conclusions and Discussions

This study shows that consumer research can help the designers set up the functions on target and reasonably. Meanwhile, analyzing older consumers' model design towards electronic products by the means of Kansei engineering could increase the designer's accuracy, making them to know better what the products should be like. We may conclude from the above two points that designing products with the older people as center along with full investigations based on their kansei intention make the designing intention more accurate and more practical, the appearance and shape more correspond to consumers' kansei cognition and physiological characteristics, and help bring convenience and pleasure, increasing elder consumers' satisfaction.

References

Population Division, DESA, United Nations, World Population Ageing 1950–2050 (2002)

Nagamachi, M.: Kansei engineering: a new ergonomic consumer-oriented technology for product development. Int. J. Ind. Ergon. **15**, 3–11 (1995)

Norman, D.A.: Emotional Design: Why Do We Love (or Hate) Everyday Things. Basic Books, New York (2004)

Han, S.: Usability of consumer electronic products. Int. J. Ind. Ergon. **28**, 143–151 (2001)
Beom, S., Yong, G., Kyeyoun, C.: Development of a usability evaluation framework with quality function deployment: from customer sensibility to product design. Hum. Factors Ergon. Manuf. **19**, 177–194 (2009)
Boletsis, C., McCallum, S., Landmark, B.F.: The use of smartwatches for health monitoring in home-based dementia care. In: Zhou, J., Salvendy, G. (eds.) ITAP 2015. LNCS, vol. 9194, pp. 15–26. Springer, Heidelberg (2015)
Hartono, M., Tan, K.C., Ishihara, S., Peacock, B.: Incorporating Markov chain modeling and QFD into kansei engineering applied to services. Int. J. Hum. Factors Ergon. **1**, 74–97 (2012)
Nagamachi, M., Lokman, A.M.: Innovation of Kansei Engineering. CRC Press, Taylor & Francis Group, Boca Raton (2011)
Huang, C., Tang, W., Shao, J.: Research on intelligent watch modeling based on consumer psychology and perceptual engineering. Mech. Des. Manuf. Eng. **11**, 32–37 (2014)