

On the extent of importance and demand of the Smart Kitchen

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Abstract

Faced with the challenges of globalization, enhancing the quality of life with high-tech has become an important issue in the policy of technologically advanced countries. Therefore, the Executive Yuan of Taiwan in 2008 initiated the "Smart Taiwan" and "Quality Life" focus issues, to promote the use of new technologies, including the broadband infrastructure, remote health care, smart living spaces, smart living technology and applications, in response to the challenges of the future needs and to improve people's satisfaction in their lives.

This study aims to analyze what the users want in a smart kitchen, so that a design centered on the Smart Kitchen can be realized in a quality smart living space. This enables designers to address the characteristics and requirements of clients and design adequate user interface and functionality, and let the users get closer to have better and more convenient products. Therefore, this study employed purposive sampling method to conduct the survey. We sampled "primary users of home kitchens" in homes equipped with internet in five metropolitan regions and two sub-metropolitan regions, and send out 1445 paper questionnaires and 213 online questionnaires.

The results indicated that the importance and extent of demand on functions and equipments of the Smart Kitchen is positively pair wised correlated. The main user stated the prior functions could be reference for the designer's when designing the system. The factor's ranking of the main user's attitude toward the function and demand of the Smart Kitchen is as the following: safety, energy-saving, health, convenience and comfort. kitchen's functions need to get advanced from basic needs to enjoyed needs.

The daily activities generate vitality because of human; the so-called dwelling is transformed to be "home" for the sake of people. Therefore, the function of kitchen should not be limited in the scope of cooking only, it should be empowered to have the functions of daily dinning, family member's affection connection, health concerning as well as the place of life enjoyment.

Key words: living space, smart kitchen, importance, demand

I. Introduction

1.1 Preface

In view of global climate change and rising international energy prices, energy-saving and carbon reduction has become a universal value. According to the Bureau of Energy, a division of Ministry of Economic, Monthly Energy indicators showed that from 1990 to 2008, residential and commercial electricity consumption increased from 20.85% to 23.26% in Taiwan's total consumption. In particular, 11.54% of electricity consumption was used in residential section (Bureau of Energy, 2009). Therefore, in order to achieve the target set for 2025 in residential and commercial building energy conservation, at least 7,000,000 more homes with renewable energy are required. In addition, consumers have been expecting high-tech development to bring more user-friendly and convenient applications and services, and this has not been met. This led to the issues of Smart Living Spaces, including the emerging applications and services of Wireless Sensor Networks (WSN) and Ubiquitous Network Society (UNS).

Through UNS, the user can acquire personal services easily from various environments such as office, home, public space, or transport facilities, by using computers, mobile phones, home servers and other electronic equipments. At present, countries all over the world are developing application services in numerous directions. Taiwan can take a page out of the two neighboring countries of Japan and South Korea. The Japanese government in 2004 proposed the "U-Japan" concept in order to achieve UNS. It further launched the "xICT" policy in 2008, featuring industry and region as two new ingredients in response to the global trend, while keeping the framework of "U-Japan". The South Korean government also launched in 2004 the "U-Korea" strategy and its precursor "IT839", to use UNS technology as the core to form 8 Digital Services, 3 Infrastructures and 9 growth power industries. It is clear that UNS application services have become a key developing strategy in Japan and South Korea.

1.2 Research background and Motivation

The main subject of this study is the Smart Kitchen, we would like to stress that, besides the basis function of a kitchen, high-tech hardware and software should be applied to the Smart Kitchen to meet the users' demands, convenience and comfort. The basic functions of the kitchen include: cooking, drinking water, cleaning, storage and so on, and a space for family members to chat and communicate. Therefore, the kitchen space in a family home plays a rather important role, and all family members are users for this space. The kitchen/dining room is a space that the whole family must use every day. Past research indicated that, the kitchen is a relatively hazardous place in home for the senior, juvenile, or handicapped members of the family. This has an impact on the frequency and duration for these members to use the kitchen. Therefore, an energy saving, safe, comfortable, convenient and healthy kitchen environment is a top priority in home design.

In addition, the gender of family members is also a factor in the frequency and duration of using the kitchen. According to the DGBAS survey in 2004, 31.3% of men in Taiwan participated in domestic chores. This rate is much lower than that of France and the United States, and higher than that of Japan. On the other hand, 75% of Taiwanese females participated in household chores. Again this rate is lower than that of France or the United States, and is

slightly higher than that of Japan. This shows that in Europe and the United States, both genders participate in household chores more than in Asia. In all countries, the females do more domestic chores than the males. The gap between the two genders is most pronounced in Taiwan and Japan, amounts to 43.7 and 57.8 percentage points respectively (DGBAS, 2005). Since using the kitchen is a significant part of domestic chores, one can deduce that the women are the principal users of the kitchen equipments and spaces. Past studies have shown that the traditional ideal of "men fight out, women stay in" in Asia is still influential in Asia, and even professional women use the kitchen longer and more frequently than men, and they discipline their children with this idea. Consequently, young girls in the home are often instructed to learn the ways in the kitchen. In view of this, a kitchen designer must consider the need of female users in a functional design.

As the Smart Kitchen differs from a traditional one in its uses of high-tech hardware/software in the equipments, in addition to basic functions, it is necessary to consider the female acceptance to such technology, as they are the principal users. In the past, women have been regarded ill-fitted to science and technology, and some even consider their slowness in adapting information technology as an inborn or social trait. Many scholars pointed to the difference in male and female physiology for their difference in expertise. For example, men are better in mathematics and logic, and women are more talented in languages and social skills. Therefore, the computer and information industry was a male-dominated one. From design to career promotions, everything is completely centered on males..

According to a survey by the U.S. cable television company Oxygen Media, the trend has changed: there was a huge increase in female uses of technology products, and the gap is closing significantly. Most American women can quickly adopt a new technology and use it skillfully. An average American woman owned 6.6 electronic gadgets, while the American man owned 6.9. Also, 80% of women feel no obstacles in using technological products, and 46% of them can deal with computer problems. Therefore, the women are essentially as good as the men in using technology now.

Taipei Computer Association also found that IT consumer market has changed accordingly. The women have become such important consumers of 3C digital products, that the manufacturers have to target the female buyers and to design products to meet the female's liking. If we look at the sales figure, the worldwide sales of consumer electronic products to female customers amounted to 55 billion U.S. dollars in 2003, exceeding the figure of male customers for the first time in history. Therefore, the women, who were often neglected in the past, has officially become the most important consumers. This shows that women and technology go well together, and more and more women enjoy using technology to make their lives more interesting and convenient. This is an enormous business opportunity, and it pushes manufacturers and designers to focus on female user centered designs. This is a trend that we emphasize in this study.

1.3 The Purpose of This Study

In accordance with the background and motivation discussed above, this study polled on homes within five metropolitan regions and two sub-metropolitan regions. We targeted homes with IT equipments (computers and internet) and their principal users of the kitchen, and conducted a questionnaire survey to explore consumer's cognition of Kitchen functions, to analyze their unmet needs in the kitchen, to pinpoint elements for better designs. Secondly, we

differentiate the expectations of the Smart Kitchen from different family members, and divide the consumers into different "consumer groups" based on the types of families, to serve as a reference for market segmentation of the Smart Kitchen. Finally, we studied the extent of user acceptance of the Smart Kitchen, and we hope that our quantified questionnaires and analysis will be useful for designers for their subsequent designs. More specifically, the purposes of this study are as the following:

1. Analysis of the kitchen users' expectation and knowledge regarding the Smart Kitchen, its functions and equipments. Find out the unsatisfied demands and the conditions for a kitchen-centered quality home environment.
2. Analysis of the differences in perceptions of importance and necessity of the Smart Kitchen equipments and functions among family members, in particular, the safety requirements for handicapped, seniors and children, and the demand of female users, who will use the kitchen most frequently. The cross analysis will be a useful reference for future designs.
3. Dividing the consumers into groups according to family types, and analyzing the differences in their priorities regarding kitchen equipments and functions, for applications to meet the essence of market segmentation.
4. Analysis of the kitchen users' acceptance of technology products for the Smart Kitchen equipments and functions and its relevance to their demands.

1.4 Research questions

As mentioned above, this study intended to integrate the literature on consumers' demands on the Smart Kitchen equipments and functions, and made further empirical research. We hope to gain more insight into the dependency on family types and family members.

In marketing theory, the decision-makers usually make different marketing strategies based on different groups of consumers, target customer's characteristics and demands. The designers, however, often consider from the viewpoints of users and design to meet the needs. Therefore, in this study, to realize a Smart-Kitchen centered design in a quality living environment, we first analyze the need of the users. Therefore, we propose to explore the following questions:

1. What is the impact of family types and family members on the perception of significance and necessity of the Smart Kitchen features?
2. Is the principal kitchen user's acceptance of technology a factor in their perception of importance and necessity of the Smart Kitchen features?

II. Literature Review

2.1 User's demand and acceptance

The word "demand" contains three different meanings: (Husen & Postlethwaite, 1985): First, a demand is a gap, which recognizes the inconsistency of the target and the reality, that is, the difference between target status and actual status. Second: a demand is a want or a preference, the state of wanting or preferring, and in determining the demand we do not need to determine the target status and the actual status or their difference, just the subjective perception of wants or preference. Third: a demand is a deficit ,(Scriven & Roth 1978), i.e. the entity does

not meet the demand or to maintain a minimum standard of satisfaction. Applying these three interpretations of "demand" to the Kitchen, the object of this study, we see that there are three related issues:

1. At present, the kitchen equipment does not meet the user's actual needs, and there is a gap. For example: in an apartment with limited living space, the need to make the best use of the kitchen space to cope with varying size of a dining party is not met.

2. Understanding the kitchen user's subjective wants and preferences of the space environment. For example: automatically control the air conditioning during cooking and dining, in accordance with indoor temperature change, to maximize the user's subjective perception of comfort.

3. The kitchen's deficit in facilities/software makes it unable to meet the minimum level of satisfaction. For example: the kitchen is isolated from the living space improperly, and hence the kitchen users cannot monitor the young children in the bedroom. Therefore, this study first explored the users demands of the Smart Kitchen, for the future integration and reference for designers.

Maslow's theory of needs hierarchy (Abraham H. Maslow, 1954) can be utilized to explain the various needs of users of products. The theory classifies human needs into many different levels, including physiological needs, security needs, affiliation needs, esteem needs, and self-actualization needs. As there are many categories of needs, there are corresponding attributes of products to meet the psychological needs of users. Therefore, the technology of producing products must always be innovated and changed to meet all the needs, not just the physiological and security ones. That is, the user's desire for a product comes from the needs in multiple categories, and we must consider the more intrinsic psychological needs in addition to the obvious physiological needs.

In addition, Elizabeth (Elizabeth 1993) proposed more specifically that the three basic needs to satisfy a user are: usefulness, usability and desirability. In particular, a user interface which can be used and easily understood by users of all ages and genders is most helpful in making a product be popular. Yu (Yu 1998) pointed out that the development of electronic product is subject to the rapid development of the technology, and becomes diversified. Whether the usability and product information can be correctly and completely conveyed to the users is absolutely related to the product's acceptance. Operational problems encountered by users are also influential in the acceptance of a product on the market, and is an important factor in its success or failure on the market.

2.2 Assessing the needs of users

To know and analyze of the needs of the users is not easy for a designer. This is because of that it is not always easy to detect the needs of the users. When a user's need is not obvious, it doesn't mean that the need is not there; it is just that the need is obscure or not strongly perceived. This can only be resolved by diverse assessment model for user's needs. Only by using a complete analysis of user's need in the design, we can give the users the better product interfaces and operation methods, and improve the usefulness of the product. From the viewpoint of consumer behaviors, the adopting situation of a product affects the consumer behavior, and is subject to what the consumers' perception of the product characteristic and image. The characteristic and image varies with the environment. As the consumption happens in the adopting situation, the marketers must understand which situation their products belong to.

Such information will enable the marketers to successfully sell their products to consumers in various situations .

Similarly, from the viewpoint of user's behaviors, the adopting situation of a product also affects the user behavior, and the designer must understand the situation of his design. This information can bring his design closer to the user's life, and even make the users prefer his design. In other words, the key to satisfy a user is to provide the designer with the user's desired function in the relevant situation, so that the need can be met.

It is worth mentioning the concept of "User-Centered Design" (UCD), in which the product design is centered on users and this helps the designer to perceive and analyze the users' need. By analyzing the users' objectives and activities, mode and environment of operation, the designer can repeatedly redesign and test the products. Simply put, UCD emphasizes meeting the users' expectation, and produce product of their hearts' desire.

2.3 User's demand and interactive design

The object of this study, the Smart Kitchen, also stress an interactive system design. The ISO 9241-10 gave the principles of interaction design and pointed out that the interaction between a user and an interactive device should be in accordance with software ergonomics, and meet the seven principles for evaluations and applications: task adequacy, operability, consistency, fault tolerance, self-describability, personalization, easy to learn. Moreover, Oviatt (Oviatt 1997) also mentioned in his study of multi-modal interaction that the four principles of interactive designs are: transparent, flexible, efficient, and expressive powerfully. A designer can use these principles to make UCD.

In this study, we used questionnaire to survey the user's cognition, needs, and expectations. For example, we designed a questionnaire to understand the users' demand and acceptance of the Smart Refrigerator, its storage, health message, purchasing guides, recipes, and video/audio functions. We analyze the user's expectation and knowledge of the Smart Refrigerator. We also study whether the users understand that a Smart dining chair can adjust its functions according to the human body, the functions of a desktop living assistant, whether interactive games are interesting, whether the Smart Kitchen improve the family life. In addition, we also try to understand whether the users know about the interactive view windows in a kitchen, the security alerts, the energy-efficient lighting designs and whether they meet user's need in security, environment protection, and comfort in a Smart Kitchen. By constructing and better quality Kitchen, we can improve the living quality.

2.4 Gender, family type and family members and the demand in the kitchen use

According to past research, the family type in a home has an impact on the gender division of labor. For example, women in a nuclear family are usually career women, and the main person doing household chores. But in an extended family, these tasks may be divided between a mother-in-law and a daughter-in-law. She also noticed that eating-out is a common practice now. A young couple in 1999 was more likely to eat out than one in 1970, even after marriage. In 1999, a young husband is less likely to subject to the traditional view of genders, and less likely to regard cooking as the task of a wife. He may participate in cooking himself. Thus we see that different family types lead to different patterns in family members' usage of the kitchen. Therefore, in our study we used the relevant survey by the Directorate General of Budget and

divided family types into the categories such as: single-person household, single-parent family, couple without children family, nuclear family, grandparent-grand child family and extended family. We hope that this survey and analysis on the usage demand among family members of various types of family will be an inspiration for designers. The kitchen is a central part of family life, and must satisfy each individual family member. The difference in family types is seen in the size of the family, the gender ideology, the gender division of labor, the use of kitchen functions. Therefore, our study focused on how family types impact the demands in a Smart Kitchen, instead of just the living style of users, which is done in most product designs.

Standardized products are not enough for special group of people. They often want a more individualized or custom-made design. Therefore, there are personalized functions. Currently, there are many different forms of personalized services provided by Internet Service Providers. Caglayan, C. Harrison, and CG Harrison (1997) grouped these services into three types: customized, learning user interests, and learning community behavior.

This study targeted career women (with better financial ability, greater requirement in efficiency, and better acceptance in technology), senior citizens and children (who have higher demands in security), and men (who may be less experienced in family chores), and survey their demands in the Smart Kitchen and analyze the difference. We also study the families consisting of such members, and hope to apply the survey result to customized kitchen equipment design. We combined ideas from other sub-projects to understand the user's demands and acceptance by our empirical studies. For example, to use IP camera to shorten the virtual distance so that the image of young children in a bedroom can be seen in the kitchen, and they can be pacified by audio and video; to use RFID-equipped kitchen appliances; a interchangeable user interface, a chair that adjust its height automatically according to the user, a software that learns and manage itself, a detector of what one carries when going out. All these functions rely on smart services based on recognition of family members.

III. Research Design

3.1 Subjects

We used Directorate General of Budget's "2007 overview of computer applications". It showed the popularity of family computers and home internet. We saw that currently internet is more popular in the five metropolitan regions and two sub-metropolitan regions. Therefore, we set the targets of this study to be people meeting the following conditions: (1) the main users of the kitchen at home; (2) his/her home should have IT equipments (computers and network); (3) he/she lives in the five metropolitan regions or the two sub-metropolitan regions.

3.2 Design of questionnaire

In our questionnaire, each question is formed after Likert's scale 5 point scale, "1" for strongly disagreeing, "5" for strongly agreeing. We now describe the content design of the questionnaire.

1. Importance: we designed a total of 36 questions to measure the subjects' view of the importance of the Smart Kitchen: 11 questions on safety features, 7 on health function, 6 on energy-saving features, 6 on convenience, and 6 on comfort features.

2. Demand: there are also a total of 36 questions designed to measure the subjects' demand on the Smart Kitchen: 11 questions on safety features, 7 on health function, 6 on energy-saving features, 6 on convenience, and 6 on comfort features.
3. Technology acceptance: we devoted 8 questions to test the subjects' acceptance to technology products.

3.3 The sample survey and effective sample structure

Subject to the above conditions, we chose people living in the five metropolitan regions or the two sub-metropolitan regions with IT equipment (computers and Internet) at home and being the main users of the kitchen, for the questionnaire survey. We send out a total of 1,445 paper copies of questionnaires and 213 web questionnaire, and 1185 were sent back to us. This yields the response rate of 72.79%. After eliminating the invalid sample, we received 1001 copies of valid responses, this makes the valid returning ratio turns out to be 60.85%.

3.4 Importance-Demand Analysis

The Importance-Performance Analysis (IPA) framework was introduced by Martilla and James(1977) in marketing research in order to assist in understanding customer satisfaction as a function of both expectations concerning the significant attributes and judgments about their performance. Analyzed individually, importance and performance data may not be as meaningful as when both data sets are studied simultaneously (Graf, Hemmasi, & Nielsen, 1992). Hence, importance and performance data are plotted on a two dimensional grid with importance on the y-axis and performance on the x-axis. The data are then mapped into four quadrants (Bacon, 2003; Martilla & James, 1977).

This study applies IPA approach and modifies it into importance- demand analysis. In quadrant 1, importance is high and demand is also high, indicating the existing systems require urgent corrective action and thus should be given top priority. Items in quadrant 2 indicate low importance and high demand, This quadrant is labeled as “Concentrate Here”, which indicates that existing systems have strengths and should being promote. In contrast, the category of low importance and low performance items makes the third quadrant labeled as “Low Priority”. While the systems with such a rating of the attributes do not pose a threat they may be candidates for discontinuation. Finally, quadrant 4 represents high importance and low demand, which suggests insignificant strengths and a possibility that the resources invested may better be diverted elsewhere.

IV. Statistical analysis

4.1 Analysis of personal background information

We analyzed the 1001 valid samples according to their personal background information One can see that the female (810 persons, 80.9%) far outnumbered the male (191 persons, 19.1%), 446 persons (44.6%) have 2 children or less, and 335 persons (33.5%) are single. 870 (86.9%) of the respondents have a high school diploma or higher, and 67.6% of them go online one hour or more everyday. 53.7% of them prepare a meal daily, or less frequently. 506 (50.5%) of them belong to a core family, 119 (11.9%) to a 3-generation family (among these, 83.6% are

second generation members in the family). 200 respondents (20.0%) have a child of age 6 or less, 358 (35.8%) of them have a child of age 6-18, and 350 (35%) of them have a child older than 18. Moreover, 192 (35%) of them have a family member of age 65 or older, and 48 (4.8%) have a family member with disability.

Table 1 Background of the respondents

Demographics		Number (person)	Ratio (%)
Gender	Male	191	19.1
	Female	810	80.9
Age	Under 30	260	25.97
	31-40	344	34.37
	41-50	266	26.57
	51-60	117	11.69
	61-70	14	1.40
Full-time employed	Yes	740	73.9
	No	261	26.1
Education	Elementary School	53	5.3
	Junior middle school	78	7.8
	Senior high school	345	34.5
	University or college	423	42.3
	Graduate school (or above)	102	10.2
	others	5	0.5
Children status	No children	395	39.5
	One or more	606	60.5
Times to cook daily	3 times daily	154	15.4
	2 times daily	310	31.0
	Once a day	335	33.5
	Less than one daily	202	20.2
Hours on internet daily	Almost not	157	15.7
	Within 1 hour	168	16.8
	1 to 2 hours	152	15.2
	2 to 3 hours	155	15.5
	3 to 4 hours	122	12.2
	More than 4 hours	247	24.7
Occupation of the main economic resource of the family	Agriculture and farming	45	4.5
	Medical and social welfare	48	4.8
	Culture and leisure	22	2.2
	Public administration	53	5.3
	Utilities	10	1.0
	Transportation and communication	22	2.2
	Education	100	10.0
	Mining	8	0.8
	Manufacturing	158	15.8
Constructing	41	4.1	

	Wholesale and retailing	61	6.1
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Demographics		Number (person)	Ratio (%)
Occupation of the main economic resource of the family	Lodging and food	69	6.9
	Finance and insurance	164	16.4
	Real estate and leasing	34	3.4
	Technology	71	7.1
	Others	95	9.5
Source of income	Single income	467	46.7
	Double income	534	53.3
Average family monthly income	Under NT\$ 26,000	124	12.4
	NT\$26,001~48,000	288	28.8
	NT\$48,001~67,000	226	22.6
	NT\$67,001~90,000	158	15.8
	NT\$90,001 ~ 150,000	164	16.4
	Above NT\$150,001	41	4.1
Family type	Single-person household	103	10.3
	Couple without children	136	13.6
	Single-parent	81	8.1
	Nuclear	506	50.5
	Grandparent-grandchild	55	5.5
	Extended	119	11.9
	Others	1	0.1
Have children aged Under 6 years	No	801	80.0
	Yes	200	20.0
Have children aged Between 6 to 18 years	No	643	64.2
	Yes	358	35.8
Have children aged Above 18 years	No	651	65.0
	Yes	350	35.0
Have seniors aged above 65 years	No	809	80.8
	Yes	192	19.2
Have disabled members	No	953	95.2
	Yes	48	4.8

4.2 Statistical analysis of the extent of importance and demand

Table2 Statistical analysis of the extent of importance and demand

Functions			The extent of Importance		The extent of demand		Rank
			Mean	S.D.	Mean	S.D.	
S A F E T Y	1	Interacting with kids through the screen.	3.66	1.01	3.47	1.11	
	2	Warning of overload in electricity.	4.40	0.78	4.23	0.84	3
	3	Warning of wet floor.	4.04	0.88	3.87	0.97	
	4	Warning of gas leaking.	4.56	0.74	4.36	0.84	1
	5	Warning of kid's approaching the hot soup.	4.37	0.81	4.13	0.96	
	6	Advanced design of children's safety in gas oven.	4.45	0.75	4.14	0.96	
	7	Advanced design of children's safety in cabinets.	4.25	0.79	4.02	0.98	
	8	Gas oven-timer.	4.41	0.76	4.22	0.85	4
	9	Automatically switching off the gas stove when fire goes out.	4.46	0.76	4.30	0.86	2
	10	Switching on the range hood first, then the gas oven can be turned on.	4.07	0.91	3.94	0.97	
	11	Informing gas leaking through mobile phone message.	4.18	0.91	4.01	0.96	
H E A L T H	12	Consulting food information through computer or mobile phone.	3.37	0.94	3.32	1.01	
	13	Providing dietary suggestions based on different situations or diseases through computer nutrition system.	3.52	0.90	3.45	0.97	2
	14	Calculating the calorie and nutritious facts of the take-out foods through computer.	3.33	0.95	3.26	1.02	
	15	Informing the expiring food through phone call or mobile phone message.	3.30	1.03	3.27	1.07	
	16	Informing abnormal temperature of the refrigerator through phone call or mobile phone message.	3.34	1.03	3.42	1.05	3
	17	The function of weighting and fat detecting of the dinning chair.	3.24	1.02	3.29	1.04	
	18	Usable memo system for the aged people in the home.	3.89	0.94	3.68	1.00	1
E N E R G Y	19	Controlling the lights of other rooms or aisles in any room of the home.	3.41	1.00	3.42	1.04	3
	20	Controlling the lighting system through internet when out of the home.	3.37	1.05	3.35	1.08	
	21	Monitoring the electric appliances' situation through computer or mobile phone.	3.46	1.02	3.41	1.04	

S A V I N G	22	Controlling different room's temperature and lighting through computer or mobile phone.	3.25	1.05	3.25	1.09	
	23	Informing that the refrigerator's door is not tightly closed through computer or mobile phone.	3.50	1.02	3.45	1.04	1
	24	Indicating the consumed electricity of the kitchen through computer.	3.51	1.06	3.43	1.08	2
C O N V E N I E N C E	25	Checking the amount and expiration date of the food in the refrigerator and cabinets through computer or mobile phone.	3.27	1.00	3.22	1.05	
	26	Showing food menu selecting and purchasing list through the refrigerator's screen.	3.24	0.97	3.23	1.03	
	27	Speed message by hand writing through the interacting screen of the kitchen.	3.41	1.02	3.36	1.05	2
	28	Communicating with the visitors and opening the door through the interacting screen of the kitchen.	3.47	1.03	3.33	1.03	3
	29	Dialing out and answering the phone through the interacting screen of the kitchen.	3.49	1.02	3.43	1.02	1
	30	Dining and chatting with the remote family members through the interacting screen of the kitchen.	3.31	1.05	3.22	1.09	
C O M F O R T	31	Dinning chair's automatic homing function for user's convenience.	3.21	1.13	3.14	1.15	2
	32	Detecting the user's figure and adjust to the most comfortable position of the wisdom dinning chair.	3.29	1.07	3.22	1.12	1
	33	Automatically indicating the user's e-mail through the wisdom dinning table.	2.95	1.05	2.94	1.09	
	34	The entertaining function of the wisdom dinning table.	3.03	1.03	3.01	1.09	3
	35	The typesetting function of the wisdom dinning table.	2.97	1.05	2.94	1.10	
	36	The interacting, remote information exchanging and game playing function of the wisdom dinning table.	2.90	1.10	2.87	1.13	

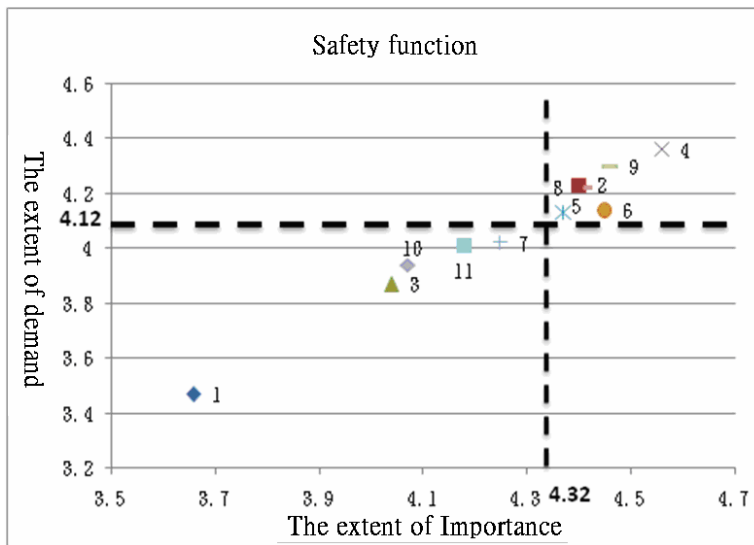


Figure 1 Safety function

Based on figure 1:

1. Functions like: Warning of overload in electricity, safety of the gas oven, warning of children's approaching the hot soup, advanced design of children's safety in gas oven, gas oven-timer and automatically switching off the gas stove when fire goes out are located in the first quadrant, it indicates that the respondents think the factors are both important and necessary, the results may be an important reference for designers.
2. Interacting with children through the screen, warning of wet floor, advanced design of children's safety in cabinets, switching on the range hood first, then the gas oven can be turned on, Informing gas leaking through mobile phone message. The above functions are located in the third quadrant, it shows that the respondents think the factors are not important and less necessary, they are also the indicators that designers may utilize to improve the function or enhance the product to attract customers.

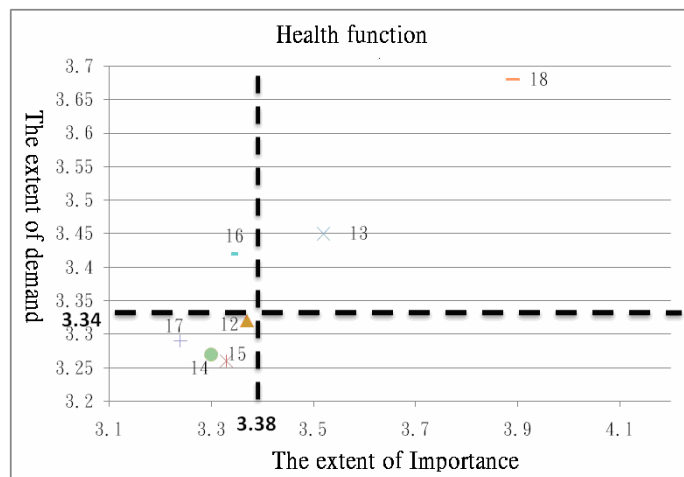


Figure 2 Health function

Results of figure 2 indicates:

1. Functions of providing dietary suggestions based on different situations or diseases through computer nutrition system and usable memo system for the aged people in the home are located in the first quadrant, it implies that the respondents think the functions are both important and necessary. Designers need to regard them as important referential factors.
2. Function of informing abnormal temperature of the refrigerator through phone call or mobile phone message is located in the second quadrant, it represents that the function is necessary but not so important. Accordingly, the function is the critical factor for the Smart Kitchen's future development; designers should improve the shortcomings of the function to increase the product's importance.
3. Functions of Interacting with children through the screen, warning of wet floor, advanced design of children's safety in cabinets, switching on the range hood first, then the gas oven can be turned on and informing gas leaking through mobile phone message are located in the third quadrant, it means that the respondents think that the functions are less important and not so necessary. Designers may improve them to increase the product's value in the future.

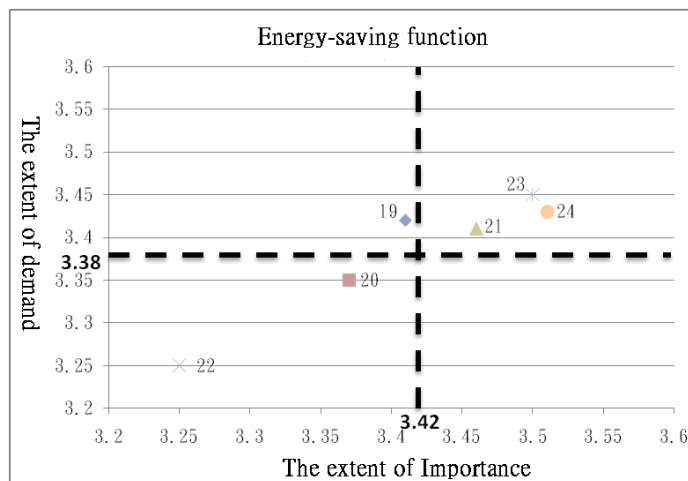


Figure3 Energy-saving function

Findings of figure 3 are:

1. Functions of monitoring the electric appliances' situation through computer or mobile phone, informing that the refrigerator's door is not tightly closed through computer or mobile phone and indicating the consumed electricity of the kitchen through computer are located in the first quadrant, it indicates that the respondents think the factors are both important and necessary, so they can be the designers important referential indicators.
2. Function of controlling the lights of other rooms or aisles in any room of the home is located in the second quadrant; it shows that the function is not important but necessary, so the function plays a critical role in the product's future development. The designers should improve the shortcomings first to enhance the product's importance.
3. Functions of controlling the lighting system through internet when out of the home, and controlling different room's temperature and lighting through computer or mobile phone are located in the third quadrant, it represents that the respondents think that the factors are less

important and not so necessary. The designers should regard the factors as important indicators to increase the product's value to attract customers in the future.

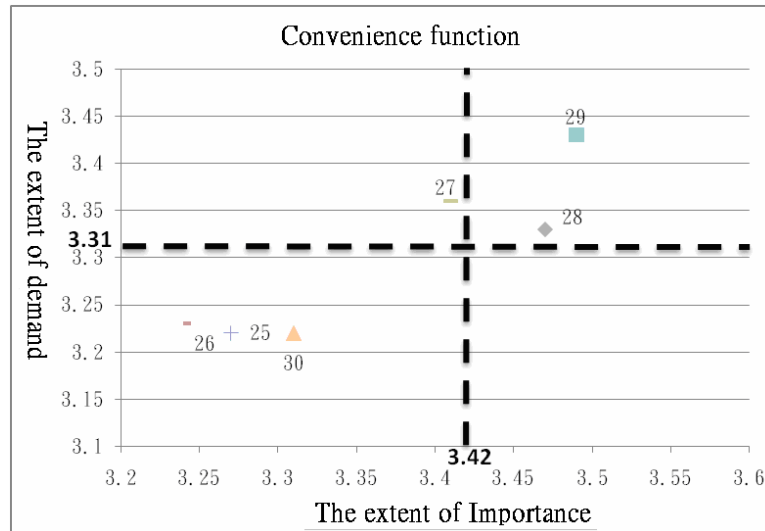


Figure 4 Convenience function

The result of figure 4 indicates:

1. Functions of dialing out and answering the phone through the interacting screen of the kitchen, and communicating with the visitors and opening the door through the interacting screen of the kitchen are located in the first quadrant, it means that the respondents think that the factors are both important and necessary, they can be the designers important referential factors when designing.
2. Function of speed message by hand writing through the interacting screen of the kitchen is located in the second quadrant; it indicates that the respondents think that the factor is necessary but less important. So the designers should improve the shortcomings of the factors to increase the degree of importance.
3. Functions of checking the amount and expiration date of the food in the refrigerator and cabinets through computer or mobile phone, and dining and chatting with the remote family members through the interacting screen of the kitchen are located in the third quadrant, this indicates that the respondents think the factors are less important and not so necessary, so the designers should regard them as important indicators to improve the quality and increase the product's value in the future.

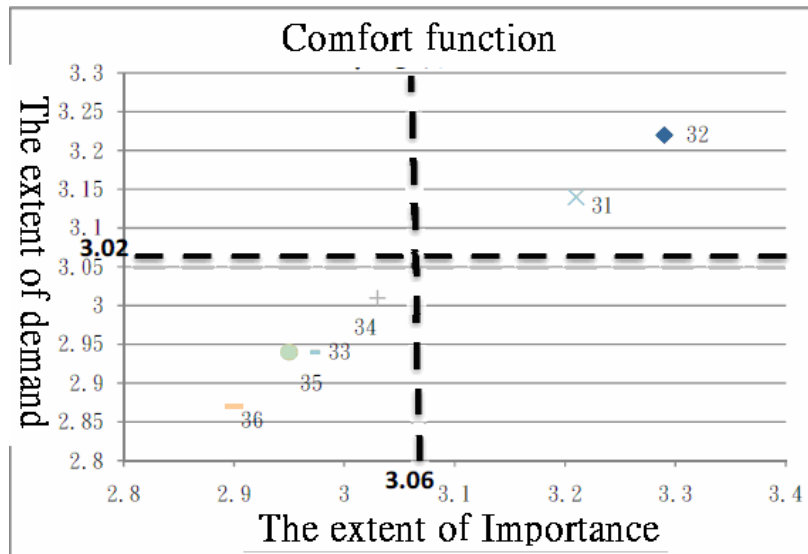


Figure 5 Comfort function

From figure 5, we can find:

1. Functions of dinning chair's automatic homing function for user's convenience, and detecting the user's figure and adjust to the most comfortable position of the wisdom dinning chair are located in the first quadrant, it indicates that the respondents think the factors are both important and necessary, so the designers can regard them as important indicators when designing.
2. Functions of automatically indicating the user's e-mail through the wisdom dinning table, the entertaining function of the wisdom dinning table, the typesetting function of the wisdom dinning table, and the interacting, remote information exchanging and game playing function of the wisdom dinning table are located in the third quadrant, it reports that the respondents think the factors are less important and not so necessary, so the designers may improve them to increase the product's function and value in the future.

V. Conclusion

This chapter is going to make a conclusion based on the results of chapter 4 with the attempt to help the designer to understand the main user's demand of the Smart Kitchen as well as remind the future designer to realize that both the opinion of the main user and other members of the family should be considered as an important factor when designing the system. Further research directions and suggestions are provided for future researchers finally.

5.1 Research limitation

The respondents of the research are the residents of five metropolitan and two sub-metropolitan areas that equipped with computer and internet facilitation, however, some of the respondents indirectly rejected to fill out the questionnaire for the items are too many, this might cause the bias of some of the respondents when filling out the questionnaire.

5.2 Conclusion

The objective of the research is to explore the main user's extent on the Smart Kitchen's importance and demand. The respondents of the questionnaire mainly come from the five metropolitan and two sub-metropolitan areas that equipped with computer and internet facilitation in Taiwan. The results are analyzed by independent sample t-test and are explained as the following:

The extent of importance and demand of the Smart Kitchen in terms of the main user: The results indicated that the importance and extent of demand on functions and equipments of the Smart Kitchen is positively pair wised correlated. Those who regard the functions and equipments of the Smart Kitchen as important factors have higher demands.

The extent of importance and demand of the Smart Kitchen in terms of the main user: The results showed that in safety dimension, the respondents think the factors (such as gas and electricity) are both important and necessary; in health dimension, the respondents think the functions (for example: computer nutrition system and usable memo system) are both important and necessary; in energy-saving dimension, the respondents think the factors (like monitoring the electric appliances' situation through computer or mobile phone, informing that the refrigerator's door is not tightly closed through computer or mobile phone) are both important and necessary; in convenience dimension, the respondents think that the factors (such as: dialing out and answering the phone through the interacting screen of the kitchen, and communicating with the visitors and opening the door through the interacting screen of the kitchen) are both important and necessary; in comfort dimension, the respondents think the factors (for example: dinning chair's automatic homing function for user's convenience, and detecting the user's figure and adjust to the most comfortable position of the wisdom dinning chair) are both important and necessary. The above stated functions could be designer's important factors when designing the system.

The factor's ranking of the main user's attitude toward the function and demand of the Smart Kitchen is as the following: safety (average score: 4.12); energy-saving (average score: 3.38); health (average score:); convenience (average score: 3.31); comfort (average score: 3.02). The cooking activities need to utilize electricity and gas, so the users regard safety as the first important factor on evaluating the Smart Kitchen system; secondly, as the price of energy is keeping going up, energy-saving is the prevalent thinking in the era of green consuming; thirdly, the full-employed respondents accounts for more than seventy percent of the whole respondents, they do hope the Smart Kitchen can have the health-oriented function and be able to maintain family member's health in modern business society; finally, the degree of convenience is slightly higher than that of comfort, it is because that modern women play the roles of occupational women and house mothers, they are the primary manpower of the family, the cleaning and fixing of the kitchen takes a lot of efforts, so if the Smart Kitchen possesses the function of convenience, it will surely be popular. Meanwhile, the function of comfort is ranked

the last in terms of necessity, the situation right matches Maslow's Theory of needs hierarchy, which states that when human's basic needs are satisfied, they'll seek for higher level needs. Similarly, kitchen's functions need to get advanced from basic needs to enjoyed needs.

The daily activities generate vitality because of human; the so-called dwelling is transformed to be "home" for the sake of people. Therefore, the function of kitchen should not be limited in the scope of cooking only, it should be empowered to have the functions of daily dining, family member's affection connection, health concerning as well as the place of life enjoyment. The study suggests that future research should combine the related issues such as gender, family life cycle, family member's job to explore the difference on the function of kitchen's demand and expectation.

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