A CONCEPTUAL DESIGN OF A MOBILE HEALTHCARE DEVICE – AN APPLICATION OF THREE-STAGE QFD WITH ANP AND TRIZ

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ABSTRACT

This research sets up a conceptual design of a future mobile healthcare device through the quality function development (QFD) with the analytic network process (ANP) and the theory of inventive problem solving (TRIZ). We use a three-stage QFD in order to consider the customers' requirements, extend the whole design process, and calculate the weight of the house of quality (HOQ) by implanting ANP. Some contradictions to the top-side items of the "house" (or "how" parts) are able to be overcome by TRIZ. After integration of the three methods, the analysis characterizes the features and their priorities for the future device. We believe that the device will push the healthcare system to be more efficient and provide a better service for an aging society.

Keywords: Conceptual design; QFD; ANP; TRIZ Mobile healthcare device; House of quality.

1. Introduction

The viewpoints towards health care are nowadays more and more important with the impending societies of the developed countries, because of technological developments in information and communication and the increasing demand for sophisticated health care. Medical companies in many countries are now designing and developing healthcare devices that are smaller and lighter. For example, Hidalgo, one of Cambridge Wireless' longest standing founder members, in 2012 launched the Equivital EQ02 LifeMonitor, which is a small detection device that can detect, record, and transport users' health condition (Vivonoetics, 2013). As a result, the future trend of the medical technology and service industry is that users can receive immediate health care services by using a mobile healthcare device and can easily receive a telemedicine service. Therefore, the purpose of our research is a future conceptual design of a mobile healthcare device by employing creative and innovative thinking and integrating product development methods in order to break through the limit and restriction of design. We develop the general process of the conceptual design, which considers not only the customers' requirements, but also the product functions and the costs. We believe that this process can be applied to the conceptual design of many different areas and provide useful information to a research and development (R&D) department.

This paper proposes a process of a product's conceptual design that consists of three main methods: QFD (quality function development), ANP (analytic network process), and TRIZ (theory of inventive problem solving). QFD is a structured approach for integrating the "voice of the customers" into a new product design (Sullivan, 1986). We propose a sequence for house of quality (HOQ) with three stages or phases of development: product deployment, component deployment, and cost deployment. We further consider ANP so as to prioritize the importance or weights for the left-side items of each "house" (or "what" items)

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for interdependence. Some contradictions on the top-side items of the "house" (or "how" items) are able to be overcome by TRIZ. The detailed process generates a feasible conceptual design draft of a mobile healthcare device for managing people's healthy condition in their daily life. In addition, we factor customer requirements into every aspect of the process.

Our mobile healthcare device combines many detectors, such as blood glucose meter, blood pressure meter, heartbeat detection, etc., and includes healthcare software that analyzes, records, and manages users' information of their health condition. We believe that this conceptual design of a mobile healthcare device can provide a new direction to the healthcare industry.

2. Literature Review

A good product design has to include customers' requirements and the product's functions and cost. QFD is a method to process customers' requirements (Hauser an Clausing, 1988) into a product specification. Because there are many factors and their weights to be determined, and even contractions among them, other techniques such as ANP and TRIZ play supporting roles in the process to eliminate difficulties and gain benefits (Carnevalli and Miguel, 2008). To direct the new product development, we review related works in regards to three areas: (i) QFD, (ii) integration of QFD and TRIZ, and (iii) integration of QFD and ANP.

2.1 QFD

QFD is a general concept that provides a method of translating customers' requirements into suitable technical requirements for each stage of product development and production (Sullivan, 1986). It achieves these goals by using the house of quality (HOQ), which is presented by a matrix describing the relationship between customers' requirements, function, and characteristics (Hauser and Clausing, 1988). A typical HOQ consists of several elements to make the translation. In addition, QFD on the whole involves a sequence of "houses" from design characteristics, specific components, and production process to a quality plan (Stevenson, 2009). However, the number of needed "houses" depends on the target and its complexity at problem solving. For instance, Chan and Wu (1998) organized four stages: translate requirements into technical measures, technical measures into parts characteristics, parts characteristics into process operations, and process operations into day-to-day production requirements.

QFD was derived from the quality requirements of Japan's manufacturing industry in the late 1960s and has been used worldwide in many industries and businesses. Due to the complexity of deployment, various quantitative methods have been suggested to improve the reliability and objectiveness of QFD (Chan and Wu, 2002). One well-known method is the analytic hierarchy process (AHP) to prioritize customers' requirements. According to the review by Ho (2008), 16 papers combine QFD and AHP, applying the integration to different areas. However, the limitations are the independences among customers' requirements, leading to ANP as an appropriate method instead.

2.2 Integration of QFD and ANP

ANP is a generalization of AHP dealing with dependence and feedback in the entire decision structure (Saaty, 2004). There are various ways to support QFD. A straightforward way to use AHP/ANP is to determine the weights of customers' requirements or demanded quality, and then put them into QFD process. Karsak et al. (2002) proposed a model added ANP for the inherent dependencies in the QFD process. Partovi and Corredoira (2002) used ANP to determine the intensity of synergy effects among column variables of two sequential HOQs for the benefit of the sport of soccer. Partovi (2006 and 2007) considered ANP as having the same role for facility location selection and process selection, respectively, in three HOQs. Raharjo et al. (2008) argued that previous works using ANP are limited and proposed a general network framework for ANP with five clusters: goal, demanded quality, quality characteristic, new product design (NPD) risk, and competitors. Lee et al. (2008) suggested an ANP-based multi-criteria decision making model in which a four-dimension HOQ makes three translations. Here, HOQ helps the decision-making process go more smoothly. Geng et al. (2010) presented an ANP network with three clusters to determine the initial important weights for HOQ. Büyüközkan and Berkol (2011) employed

ANP to determine the importance levels in the HOQ. Some other techniques, e.g., goal programming, are also embedded for a special purpose in the integrated process.

2.3 Integration of QFD and TRIZ

TRIZ is a systematic approach for analyzing the kinds of challenging problems where inventiveness is needed (Altshuller, 1984), and it has been applied to various areas, especially for the effective development of new technical systems (Ilevbare et al., 2013). Yamashina et al. (2002) argued that previous works could not effectively integrate QFD and TRIZ effectively and proposed the innovative product development process in which QFD is used for obtaining customers' requirements. Wang et al. (2005) pointed out the same weakness of previous studies, integrated TRIZ by QFD for obtaining customers' inputs, and realized both methods on a set of software. Recently, the combinations of QFD and TRIZ have been targeted at some real-world applications, e.g., the re-use of consumer packaged goods (Vezzetti, et al, 2011) and the design of a customized tracheal stent (Melgoza et al., 2012). Here, TRIZ is the core of the product/service development, while QFD is for setting customers' requirements. On the contrary, Yeh et al. (2011) proposed a four-phase QFD for the design of a notebook PC in which TRIZ is exploited to solve the problem in each phase. The QFD study is the main framework of the development.

Based on these reviews, we propose a three-stage (or phase) QFD model with ANP and TRIZ for a conceptual design of a future mobile healthcare device for better coherence.

3. The proposed model

In the proposed integrated model the main framework is a three-stage HOQ that can collect the variable considerations, including customers' requirements as well as the product's functions, components, and costs for the conceptual design process. In the first two houses, ANP obtains the priorities of the left-side items with dependence and feedback. To let the whole conceptual design become more complete and innovative, TRIZ is considered to eliminate the contradictions among the top-side items of the second-stage HOQ so as to find a better solution to the mobile healthcare device.

We divide the suggested procedure into six steps as follows.

Step 1: Identify three HOQ items
Step 2: Calculate the priorities of the left-side items
Step 3: Acquire the what-how relationship
Step 4: Obtain the important ratings of HOWs
Step 5: Eliminate the contradiction of components
Step 6: Point out the main developments

3.1 Identification of three HOQ items

We execute questionnaires, in-depth interviews, and scenario analysis to obtain data on customers' requirements, product functions, component items, and their costs. The data are then supplied to each HOQ. The first-stage HOQ (HOQ1) is for product deployment. We assign a list of the customers' requirements to the left side of the first house and put the items of product functions at the top side of the house. We then transfer the items of the product functions into the left side of the second-stage HOQ (HOQ2), i.e., component deployment, and allocate the items of the component to the top side of the second-stage HOQ. In a similar way, we relocate the items of the components to the left side of the third-stage HOQ (HOQ3), i.e., cost deployment, and set the items of the costs to the top of the house.

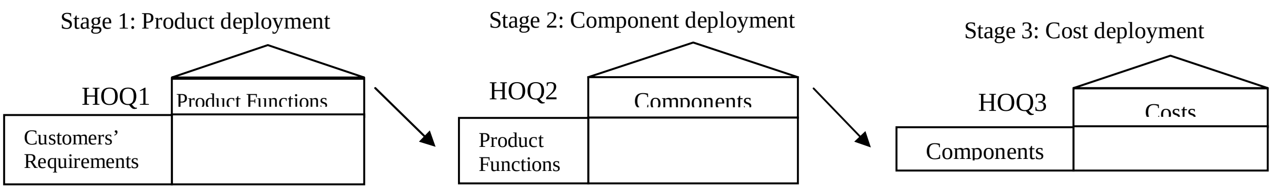

Figure 1. A three-stage HOQ

3.2 Calculating the priorities of the left-side items

Two methods are utilized to calculate the priorities of the different structures of HOQ. For HOQ1 and

HOQ2, there are a feedback and dependence among items, and so we use ANP to obtain the priorities of the left-side items. However, it is obvious that we have to calculate each component's priorities in HOQ3. Thus, we take the arithmetic mean to calculate the priorities of HOQ3's left-side items.

3.2.1 Procedure of ANP

For HOQ1 and HOQ2, we select ANP to compute their priorities of left-side items. The process can be divided into three phases.

Phase1: Establish the structures

In HOQ1, the goal of the ANP structure is customers' requirements, and the criteria that influences the goal is HOQ1's left-side items. In the same way, the goal is the product functions, and the criteria that influences the goal is the left-side items of HOQ2. By using questionnaires, we can ensure the relations of both networks.

Figure 2 illustrates the network structure of the left-side items for HOQ1. A single arrow indicates a one-way relationship. For example, the arrow that leaves from demand 2 and feeds into demand 3 implies the relationship of demand 2 having an influence on demand 3.

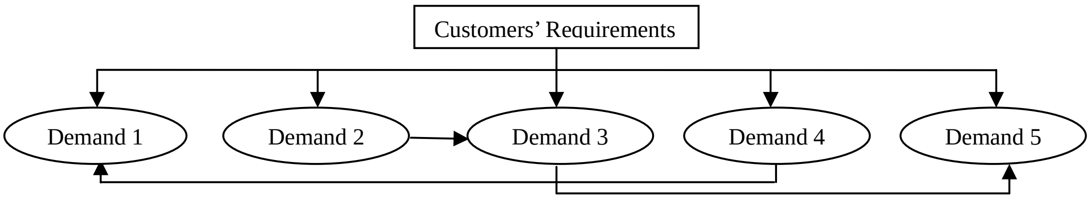

Figure 2. The network structure of the left-side items for HOQ1

Phase2: Make pair-wise comparisons

We ask selected experts to evaluate all items' criteria pair-wise. They have to consider the questions, including "Which criteria should be emphasized more?" and "How much more?". The responses are represented in numbers, which are based on Saaty's 1-9 fundamental scale (Saaty, 1980). Similar questions about the relations of the interdependences among the criteria are also executed. The experts have to answer some questions such as "Which criteria will influence C1 more: C2 or C3?" and "How much more?" (Saaty, 2004). Hence, various pair-wise comparison matrices are constructed for each criterion. All comparisons will be examined by the consistency ratio to confirm their consistency.

Phase 3: Establish a supermatrix and calculate the limiting priorities

After arranging the local priorities vectors of the pair-wise comparison matrices, we obtain an unweighted supermatrix. We then weight the blocks of the supermatrix by the corresponding priorities, which are derived from the clusters, to a weighted supermatrix, whose columns are stochastic. We multiply the supermatrix by itself until the priorities of each column are stable and limiting priorities are obtained.

3.2.2 Procedure of arithmetic mean

We ask three experts to evaluate the importance of components and to fill in the questionnaire, which is measured by the 5-point Likert scale. After getting the importance of components, we use the arithmetic mean to aggregate the priority of each component.

3.3 Acquiring what-how relationship values

The experts fill in the values of importance in the HOQ relationship matrices of what-how. Traditionally, the relationship between the top-side items and left-side items is described as strong, medium, weak, and no relationship by the value of 9, 3, 1, or 0, respectively (Stevenson, 2009).

3.4 Combining the priority and the relationship: Obtaining the important ratings of HOWs

The main output of the HOQ process is the important rating of the HOWs. As a result, we have to consider the priorities of the left-side items and the relation matrix of HOQ simultaneously. In order to calculate the important ratings of the HOWs, we generally take a simple additive weighting formula (Stevenson, 2009):

$$\text{Important ratings of a HOW} = \sum (\text{the priorities of WHATS} \times \text{relationship of value between WHATs and HOWs}) \qquad (1)$$

3.5 Eliminating the contradictions of components

In the HOQ2, there is a correlation matrix on the roof. The correlation between the top-side items of HOQ2 indicates that “+” is a positive correlation between two items, meaning that if a researcher emphasizes on devising one of them, then it will increase the benefit of another item. However, “–” shows a negative correlation between two items, i.e., if a researcher improves one of them, then it will deteriorate the other. In other words, negative correlations imply bottlenecks or contradictions of components and restrict deploying the translation.

After confirming the correlation matrix with contradictions from these negative correlations, we use TRIZ to transfer these contradictions into the appropriate parameters among the 39 Engineering Parameters (Altshuller, 1984). We then divide these parameters into “Improving factors” and “Worsening factors”. We abstract the original problem into the form of TRIZ’s solution process and check the 39×39 Contradiction Table to find the principle numbers. According to the definition of 40 Inventive Principles, we can identify some possible developments and ideals.

3.6 Recognizing the main points of development

In the final stage, we consider both the important ratings of HOQs and also the possible ideas from TRIZ. According to the output information from QFD, high priorities of the development can be suggested.

4. Case study

We illustrate a case of conceptual design for a mobile healthcare device as follows.

Step 1: Identify three HOQ items

The abundant information by questionnaires, in-depth interviews, and scenario analysis help construct the three-stage QFD. HOQ1, HOQ2, and HOQ3 present the deployment of product, components, and cost, respectively.

Step 2: Calculate the priorities of the left-side items

After ensuring all the items of the three houses, we calculate the priorities of the left-side item. We use ANP in HOQ1 and HOQ2 and arithmetic mean in HOQ3. There are 11 demands under customers’ requirements to form an ANP network of the left-side items for HOQ1.

As mentioned in Phase 2 of Section 3.2.1, we ask three experts to make comparisons among criteria and check their consistency. Because of space limitation, we only show the left-side items’ unweighted supermatrix of HOQ1 in Table 1. We then compute its weighted supermatirx and the limiting supermatrix. Table 2 lists the items of the numbers designated. Table 3 presents the limiting priorities of the left-side

	Customers’ Requirements	1-1	1-2	1-3	1-4	1-5	1-6	1-7	1-8	1-9	1-10	1-11
Customers’ Requirements	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1-1	0.04009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1-2	0.02075	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1-3	0.10643	0.0987	0.1200	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1-4	0.16711	0.30808	0.39385	0.27615	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

items of HOQ1 and HOQ2.

Table 1. The limiting supermatrix of the left-side items in HOQ1

1-5	0.11493	0.18146	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1-6	0.0669	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1-7	0.0283	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1-8	0.05272	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1-9	0.29803	0.41176	0.48614	0.72385	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1-10	0.05126	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1-11	0.05347	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 2. The items of the designated numbers

1-1	Software functions	1-7	Appearance
1-2	Hardware functions	1-8	Portability
1-3	User-friendly	1-9	Accuracy
1-4	Efficiency	1-10	Reasonable price
1-5	Privacy	1-11	After-sales service
1-6	Customization		

Table 3. The priorities of the left-side items of HOQ1 and HOQ2

Left-side items of HOQ1	**Priority**	**Left-side items of HOQ2**	**Priority**
Software functions	0.04009	Diet control	0.01433
Hardware functions	0.02075	Dose interval remind	0.11509
User-friendly	0.10643	Exercise condition recorder	0.06232
Efficiency	0.15711	Quality of sleep check	0.01892
Privacy	0.11493	Regularly physical examination	0.01958
Customization	0.0669	OPD reservation	0.10414
Appearance	0.0283	GPS for medical facilities	0.03342
Portability	0.05272	IC card	0.04408
Accuracy	0.29803	Align to hospital	0.18264
Reasonable price	0.05126	Emergency support system	0.0882
After-sales service	0.05347	Privacy authorization function	0.1791
		Disassemble small detection device	0.01768
		Telemedicine service	0.12355

Product Functions / Customers' Requirements	Diet control	Dose interval remind	Exercise condition recorder	Quality of sleep check	Regularly physical examination	OPD reservation	GPS for medical facilities	IC card	Align to hospital	Emergency support system	Privacy authorization function	Disassemble small detection device	Telemedicine service

Steps 3 & 4: Acquire the what-how relationship and obtain the important ratings of HOWs

Tables 4, 5 and 6 show the relationship matrix of what-how in HOQ1, HOQ2 and HOQ3, respectively.

Software functions	0.0401	□	□	□	○	○		□		○	○	○	○	○
Hardware functions	0.0208	△		□	□		○	□		□	○	□		○
User-friendly	0.1064	□	□	□	□				□	○	○	□		
Efficiency	0.1671			□			□	□		□	□	□		
Privacy	0.1149	□	○		△	□	○		○	○	□	○		
Customization	0.067	○	□		□	○	□	□		○	○	○	○	○
Appearance	0.028		△		△		△		△		□		△	
Portability	0.0527	□		○	△		□	□	○		○		□	□
Accuracy	0.2980	○	○	○	○	□		○		○	○	○	□	
Reasonable price	0.0513					□	△	△	△	□		□	□	△
After-sales service	0.0535	△	△	□	□	△		□	△	□		□		○
Importance		3.7826	3.9187	4.32	3.9817	2.409	2.1609	3.8164	1.9612	4.3774	6.195	4.893	2.1972	1.8403

Table 4. Information of HOQ1

Table 5. Information of HOQ2

Components / Product Functions		Micro-Electro-Mechanical Systems	Wireless sensor network	USB 3.0	Bluetooth 4.0	Global positioning system	Professional medical support system	Cloud computing	Central processing unit	Open Services Gateway Initiative	Infrared thermal imaging temperature measure	Picture archiving and communication system	Quick Response Code	Wireless charging technology	Iris recognition system	Design of size and weight	Design of material and style
Diet control	0.0143	□	□	□	△	△	○		□				○			□	
Dose interval remind	0.1151	△	○	△	□				○				○				
Exercise condition recorder	0.0623	○	○	△	△		○		○		□	□	○			○	△
Quality of sleep check	0.0189	○	○	△	△				○		□		○				
Regularly physical examination	0.0165	△		△		△			○	△			○				
OPD reservation	0.1041						○		○			□	○				
GPS for medical facilities	0.0334	○			○	○		□	○	□			△				
IC card	0.0441	△	□	○	△		○		○				△			○	○
Align to hospital	0.1826	△	□	△	△		○	△	○	△		□					
Emergency support system	0.0882	○	○	△	△	○		□	○	△	○		□	□	□	□	△
Privacy authorization function	0.1791	△	△	△	△		○		○						○		
Disassemble small detection device	0.0177	○	○	□	○				○		□			○		○	○
Telemedicine service	0.1236	○	△	△	○	○	○	□	○			□					
Importance		3.6772	3.7456	1.2792	2.5067	2.2374	6.3916	0.9182	8.9140	0.3876	1.0906	1.4180	3.3240	0.4237	1.8766	1.4244	0.7064

Table 6. Information of HOQ3

Costs		Mechanical Cost	Design Cost	Test Cost	Material Cost	Project Management Cost
Micro-Electro-Mechanical Systems	0.9375	□	○	○		

Wireless sensor network	0.625	□		□	○	□
USB 3.0	0.625		□		○	
Bluetooth 4.0	0.6875		□	○		
Global positioning system	0.6875				○	
Professional medical support system	0.75	□	□	○		□
Cloud computing	0.5625	□	□	○		□
Central processing unit	0.625				○	
Open Services Gateway Initiative	0.625	□	□	□	□	□
Infrared thermal imaging temperature measure	0.5625	□	○	□		□
Picture archiving and communication system	0.625	□	○	□		□
Quick Response Code	0.6875			○	□	□
Wireless charging technology	0.5		○		□	
Iris recognition system	0.5625		○	□		
Design of size and weight	0.5		Δ	Δ	○	
Design of material and style	0.5625		○	Δ		
Importance		14.0625	44	42.6875	33	13.3125

Step 5: Eliminate the contradiction of components

In this stage we emphasize the component items of HOQ2 only. The contradictions in the correlation matrix of HOQ2 are shown in Figure 3 and described in Table 7.

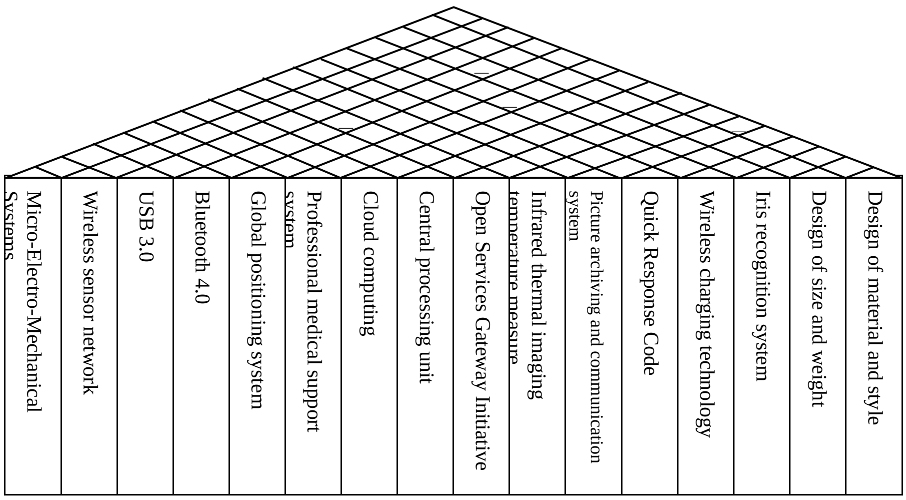

Figure 3. Correlation matrix of HOQ2

Negative Correlation		**Description**
Central processing unit	Wireless charging technology	If we want to improve CPU speed, it will increase the need of electricity.

Professional medical support system	Central processing unit	If the support system operates multi-processing, it will decrease CPU speed.
Wireless charging technology	Design of size and weight	If we need larger capacity to contain more electricity, then the need will result in heavier weight an larger volume of the device.
Professional medical support system	Wireless charging technology	If the support system operates multi-processing, it will increase the need of electricity.

Table 7. Description of the negative correlation

According to the TRIZ process of generating ideas, we transfer these components into the appropriate parameters and separate them into "improving parameter" and "worsening parameter" in order to check the 39×39 Contradiction Table and find the suitable Intensive Principles. Table 8 collates the information, including the four contradictions, the transferred engineering parameters, and the final result of the inventive principles of TRIZ.

Table 8. Collation of the contradictions

No.	Improving Parameters / Worsening Parameters	Engineering Parameters	Inventive Principles	
1	Central processing unit	39. Productivity	35. Parameter change	10. Prior action
	Wireless charging technology	19. Use energy by moving object	38. Enrich	19. Periodic action
2	Professional medical support system	36. Device complexity	12. Remove tension	26. Copy
	Central processing unit	39. Productivity	17. Another dimension	
3	Wireless charging technology	21. Power	8. Counterweight	38. Enrich
	Design of size and weight	01. Weight of moving object	36. Phase transition	31. Hole
4	Professional medical support system	36. Device complexity	27. Cheap disposable	2. Take out
	Wireless charging technology	19. Use energy by moving object	28. Mechanics substitution	29. Fluid

In the conceptual design stage we need the innovative idea to help designers find the creative points and think about the possibility of development. Thus, we choose the appropriate principles and consider these principles in order to offer future development directions.

I. Central processing unit VS wireless charging technology
- 10. Prior action: Solar power energy

Using solar energy to store more power is the prior action to prevent it from being exhausted.

II. Professional medical support system VS central processing unit
- 12. Remove Tension: Multi-core CPU

In order to use the device effectively, we use a multi-core CPU to deal with the multiple tasks.

III. Wireless charging technology VS design of size and weight
- 31. Hole: Porous media

Use porous media to reduce the weight of the electricity charging device.

IV. Professional medical support system VS wireless charging technology
- 27. Cheap Disposable: Disposable battery
- 2. Take out: Disassemble battery

We can afterwards design a disassemble battery system so that users will be able to charge several batteries independently or consider disposable batteries to maintain sufficient power of electricity.

Step 6: Point out the main developments

According to the importance of the three-stage HOQs and the TRIZ, we recognize the main developments and several creative ideas that indicate a future design direction. This information provides some major characteristics of the future device and also shows the future needs of the healthcare industry.

I. Top three important product functions: (i) Compatibility of medical system, (ii) Emergency helping function, and (iii) Privacy authorization function.

II. Top three essential components: (i) Central processing unit, (ii) Professional medical support system, and (iii) Wireless sensor network.

III. Top three major costs: (i) Test cost, (ii) Design cost, and (iii) Material cost.

To help readers catch the sense of the device, Figure 4 shows a draft of the future mobile healthcare device. In the front side, users have to verify their identification through iris recognition, and then they can start to use this device. In the back side, a blood glucose meter, blood pressure meter, and exercise condition detection are able to be dismantled according to the users' requirements. The functions of heartbeat detection and infrared thermal temperature measure detect the users' body condition. If the situation is abnormal, then the device gives a notice to its users. Moreover, if it is a serious condition, then the device provides a button for notifying a hospital and his/her emergency contact person.

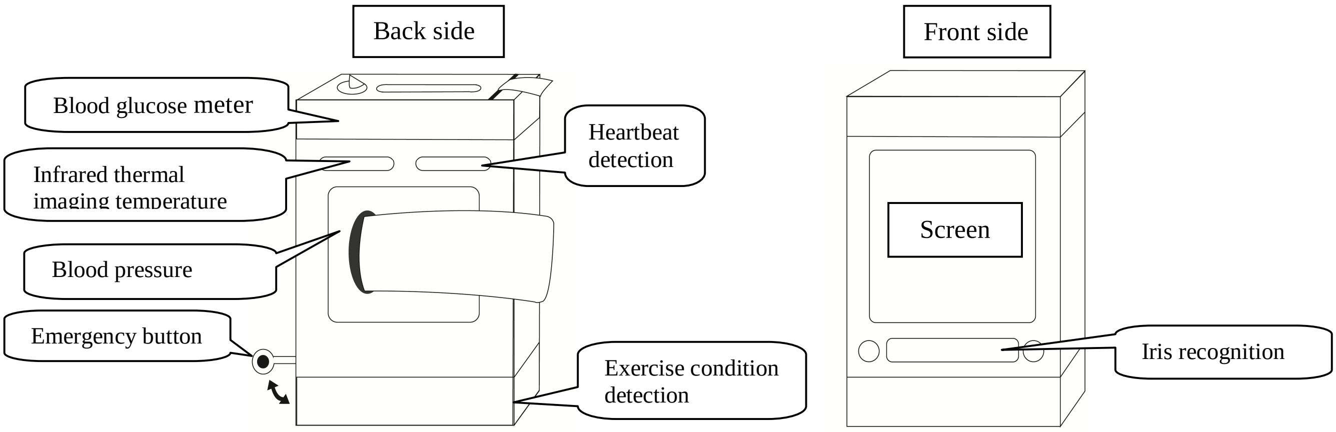

Figure 4. Draft of the mobile healthcare device

5. Conclusions

This research presents an effective model for new product design by integrating a three-stage QFD, ANP, and TRIZ to reduce the time of development, ensure customers' requirements in the specifications, and guarantee cost savings. The proposed process for designing a future mobile healthcare device points out some important features and also considers the needs of customers. This is a future direction for the healthcare industry. The analysis shows that the important functions are its compatibility with medical systems, an emergency helping function, and a privacy authorization function; the essential technical specifications are central processing unit, professional medical support system, and wireless sensor network; test cost, design cost, and material cost should be emphasized more in the cost consideration. There are also some creative ideas that can be a direction for future development in the healthcare industry.

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