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mHealth apps design using quality function deployment

Structured Abstract:
Purpose: Our aim was to: (i) draw health managers', clinicians', entrepreneurs' and mobile apps designers' attention towards new mobile health applications (mHealth apps); (ii) define mHealth apps design characteristics intended for doctors; and (iii) highlight how mHealth apps can be designed using Quality Function Deployment/House of Quality (QFD/HOQ) techniques from doctors' perspectives.
Design/methodology/approach: Data were collected through a survey and in-depth interviews with doctors to understand their needs and attitudes towards mHealth apps. Analytic Hierarchy Process (AHP), Quality Function Deployment (QFD) and House of Quality (HOQ) methods were used to analyse data.
Findings: Doctors agreed that mHealth apps provide them with the tools to improve their service and to become more efficient. Once the twelve doctors' wants were collected, they were prioritized according to their significance and used for mHealth apps development. Eight technical characteristics that cater to doctors' expectations were sorted. We suggest that mHealth app designers need to provide design requirements recommended by health personnel for a higher satisfaction level.
Originality/value: Healthcare managers are focusing on increasing their efficiency, patient satisfaction, and care quality, and decreasing costs. For these purposes, mHealth revolution and mHealth apps have high potential for improving doctor effectiveness and healthcare quality. This study is among the first to: define Turkish doctors' wants from mHealth apps; elaborate the app's technical characteristics; and to increase design quality, which is implied in improving app design. mHealth revolution and mHealth apps can improve doctors' effectiveness and healthcare quality. Our research makes a significant contribution to define doctors' wants from mHealth apps, to elaborate their technical characteristics, and to increase mHealth apps design quality using Quality Function Deployment (QFD).

Keywords: mHealth Revolution, mHealth Applications, House of Quality, Quality Function Deployment.

Article Classification: Research

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Introduction

Advances in Internet, mobile communication, smartphones, and mobile apps have revolutionised many areas, and have an emotional, commercial and communicative effect on everything from lifestyles to businesses. Besides mobile marketing, shopping, commerce, entertainment and advertising, we mobile apps can affect healthcare.

An 'm' precedes words related to the mobile communications industry, like 'e' is related to the Internet; thus 'mHealth' is preferred to 'mobile health'. mHealth can be defined as collecting and using health data through mobile technologies such as smartphones, tablets, or personal digital assistants and health related information for patients and for doctors who monitor their patients from outside the hospital. Consequently, mHealth apps provide doctors with greater mobility, which helps those in different areas to care for their hospitalized patients

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even while on the move; i.e., doctors can retrieve critical information about their patients with SMS/MMS/Apps messages without making phone calls to nurses or assistants in the hospital.

The mHealth industry is complicated. Health managers, Global System for Mobile Communications (GSM) operators, smartphone manufactures, science and software engineers, and mobile app developers need to work together. They also have to adapt to circumstances that frequently change. mHealth apps do not just retrieve content from hospital information systems; i.e., sending Short Message Service (SMS)/Multimedia Messaging Service (MMS), they receive instant information about patients, compare results, etc. Therefore, mHealth apps developers need to realize that doctors need certain key information to provide a more efficient, punctual health service via instant messages. App quality depends on how well it addresses doctors' wants and needs; hence, understanding clinician's expectations is an important issue. Quality Function Deployment (QFD) is a powerful technique for developing products, services, processes, software, and finally mHealth apps. Our study mainly tries to gain an insight into how QFD is applied to design mHealth apps from doctors' perspectives and to develop different mHealth apps design guidelines through QFD. This article is divided into several parts: (i) literature reviews on the mobile revolution, mHealth apps, QFD use, House of Quality (HOQ), methods; and (ii) applying QFD in mHealth app design. Interviews and surveys among doctors determined what they demand from mHealth apps design.

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Mobile technology and mHealth Revolution

Hospital administrators are under pressure to: increase patient satisfaction; boost efficiency and service quality and decrease their costs. Consequently, they are investing in advanced information and communications technologies and in mHealth apps that are designed to achieve these aims. After their launch in 2007, smartphones have been transformed and improved. Smartphones or tablets loaded with mHealth apps will connect hospital systems anywhere, and mHealth apps will offer abundant potential for improving coordination among patients and clinicians, and their healthcare institutions. Although mHealth, an informatics sub discipline, exploits mobile communications devices for health and wellness activities, Fox *et al.,* (2017) used the mHealth domain as the context for an interdisciplinary learning experience for professionals.

mHealth is defined by the World Health Organization as health practice supported by mobile smart phones and other wireless devices (mHealth, 2011). Singh and Landman (2018) described mHealth as a system that uses mobile and wireless communication technologies to improve healthcare quality and efficiency, outcomes and research. Istepanian and Lacal (2004) described mHealth as a wireless medium involving mobile telecommunications and multimedia technologies and its integration with mobile healthcare delivery systems. Kaplan (2006) highlighted how smartphones can be used successfully to support healthcare services, sustain telemedicine and remote healthcare in developing nations.

mHealth is a complex industry where it can be difficult to develop sustainable business models; since mobile communications generate more than five billion contacts between users, patients, healthcare staff, health system administrators, and firms in health commodity supply chains (Qiang *et al.,* 2011). If mHealth apps are designed from doctor and patient perspectives, then smartphones can be transformed into effective healthcare platforms. Tracking disease symptoms can be completed without effort, logged, and electronically shared with healthcare practitioners. Meanwhile, gathering diagnostic data like blood pressure and heart rate can be automated. Furthermore, doctors, healthcare staff and pharmacists could use data to offer the best healthcare services (Speidel and Sridharan, 2014). Improving people's wellbeing around the globe can be achieved using mHealth apps, as it is a fresh, up and coming, dynamic field (Qiang *et al.,* 2011). However, doctor and patient usage are different. Razmak *et al.,* (2017)

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describes four indicators to determine how e-health communication systems and technologies are used.

mHealth apps industry

The mHealth industry is growing rapidly, and the mHealth app is a popular term to describe it. There are many reports and studies about mHealth that are designed to improve patient satisfaction and healthcare efficiency. The latest smartphones are increasingly viewed as hand-operated computers rather than phones (Wilhide *et al.,* 2016; Boulos *et al.,* 2011). Additionally, smartphones offer facilities that computers cannot, such as automatically retrieving and sending SMS/MMS/Apps messages. Accordingly, the mHealth app user count is increasing, and mHealth app revenues rise yearly (Statistics and Facts about mHealth, 2018).

Improving people's health outcomes over the long term can be accomplished using mHealth apps. The apps can help improve healthcare quality and shift the emphasis to preventing disease. mHealth apps csn reduce medical errors, avoid expensive interventions, and broaden access to care (Qiang *et al.,* 2011; Hamel *et al.,* 2014). mHealth technologies can improve post-operative care, and patients are willing to use this technology (Abelson *et al.,* 2017). Thus, mHealth apps provide multiple benefits to healthcare staff and patients through improving access to all healthcare information regardless of location.

Mosa *et al.,* (2012) categorized the app's main purposes, to: (i) provide healthcare professionals with information on disease diagnosis and drug referrals; (ii) search medical literature and clinical communications; (iii) access hospital information systems, client applications, medical training sites; (iv) find general healthcare information; (v) provide educational resources to medical or nursing students; and (vi) help patients with chronic illness and other conditions to focus on disease management.

Boulos *et al.,* (2011) analysed health and healthcare apps, which provided direction to both patients and healthcare staff in various scenarios; e.g., health, fitness and lifestyle education and management, ambient assisted living apps, and public surveillance. Also, they discussed barriers to adopting mHealth apps. Wilhide *et al.,* (2016) explained mobile technology's new capabilities, which helps to drive important aspects of chronic disease and to provide warnings and gather information about disease outbreaks. Wilhide *et al.,* (2016) analysed the 'waterfall' framework for developing mHealth app designs for seven chronic disease states and for three different product types. Bry *et al.,* (2017) explained special mHealth apps for anxiety disorders and thought that researchers should explore strategies to boost the quality mHealth inventions' visibility and availability. Possibly because mHealth apps are designed in academia and supported in experimental trials, they are slow to spread in the mHealth marketplace.

The challenges to developing mHealth apps involve several complex and diverse problems. First, each hospital has its own information system. Thus, mHealth apps should be customized and designed for specific hospitals. Second, patient information should be kept secure and confidential. Although there are some challenges and regulations for mHealth app design (Qiang *et al.,* 2011; Zhang *et al.,* 2014), Hamel *et al.,* (2014) clarified why mHealth apps should be designed with Food and Drug Administration's (FDA) approval in the USA. The FDA is the organization responsible for certifying that medical devices are harmless and effective, so FDA approval can protect public health and boost user confidence in the mHealth industry including products and apps.

Although there are many mHealth apps, only 15% are marketed to doctors, which include Epocrates, PEPID, UpToDate, Doximity, Read by QxMD, NEJM This Week and Isabel (The Top 7 Medical Apps for Doctors, 2017). In most studies, mHealth apps are analysed from patient and smartphone user perspectives (Hamel *et al.,* 2014). Consequently, mHealth apps have become increasingly significant to both patients and doctors and determining the mHealth

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apps' key drivers is increasingly appealing to academic researchers, mHealth app designers and healthcare staff.

Quality function deployment

Quality Function Deployment (QFD) is a tool used to understand users' wants, while helping designers invent new and efficient mHealth apps. One critical step in any new development process, including product, service and software development, is to understand user/buyer/customer wants before the product, service and software are produced, designed or developed, which indicates that actively seeking and understanding what customers really want is one goal that needs to be accomplished. The QFD approach provides a structured framework for concurrent engineering that indicates client's desires through all product, service, or software development phases. Quality Function Deployment converts spoken and unspoken customer requirements into the firm's internal language (Klien, 1990; Govers, 1996; Barutçu, 2006; Zheng and Pulli, 2007).

In 1966, Yoji Akao developed the QFD method as a good planning tool for the Japanese manufacturing industry. He developed a quality assurance method that converts customer satisfaction into a product (Akao, 1990). Prior quality control methods were primarily aimed at fixing problems during or after production. Since 1966, QFD has been used worldwide in many industries to: (i) seek spoken and unspoken customer wants and needs; (ii) uncover true customer needs and positive quality that wows the customer; (iii) translate these into design characteristics and deliverable actions; and (iv) build and deliver quality products or services by focusing various business functions toward achieving customer satisfaction (What is QFD? 2018). Akao (1990) defined QFD as a method and technique used for developing a design quality plan aimed at satisfying the consumer and then translating consumer requirements into design requirements and major quality assurance points to be used throughout the production phase. Raynor (1994) defined QFD as a quality-based method for increasing customer satisfaction and product/service value by translating the customer's voice into design specifications and implementation instructions. The QFD method's success depends on workers' ability to carry out instructions and give customers what they pay for. Herzwurm *et al.,* (2003) indicated that QFD provided an efficient but more informal communication between users and developers. Zheng and Pulli (2007) applied QFD to mobile service development to increase satisfaction from mobile learning services.

House of Quality

House of Quality (HOQ) provides a basic implementation tool for managing QFD throughout product or service design, development, and manufacturing (Hauser and Clausing, 1988). The HOQ cornerstone is determining customer requirements, wants and needs, which is difficult because it requires obtaining and expressing what the customer wants and not what we think or what users expect (Govers, 2001). The customer requirements (WHATs) are translated into design characteristics (HOWs), based on surveys and interviews with customers.

Figure 1 here

There are seven steps in HOQ analysis: (i) gather doctors' needs and wants (WHATs); (ii) calculate doctor needs' relative importance; (iii) generate mHealth apps design requirements (HOWs); (iv) identify competitors or rivals and conduct customer competitive analysis; (v) determine the relationship between HOWs and WHATs; (vi) identify HOWs' vs. WHATs' relative importance; and (vii) compose design targets. In this study, HOQ is based on deploying customer wants (WHATs) in mHealth app design terms (HOWs). Besides mHealth app designers, government agencies, health ministry, technology firms, GSM operators and

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healthcare providers can work together to guide their development and deployment (Qiang *et al.,* 2011).

Methodology

Our aim was to apply QFD/HOQ to mHealth apps development consistent with doctors' expectations. The Quality Function Deployment method helps app designers to recognize doctor expectations from mHealth apps, while designing and defining their requirements to meet their wishes. Data were collected through in-depth interviews and surveys. Our target group were 30 hospital doctors working. The convenience sampling method was used. In the interviews, five doctors were questioned to determine their positive and negative attitudes towards mHealth apps and to obtain their wants (WHATs list). Two stated that it was badly perceived if doctors turn their faces away from patients while examining them. For the survey, 30 questionnaires were distributed to doctors that were later returned and analyzed. There were 12 questions for prioritizing their wants. Analytic Hierarchy Process (AHP) and HOQ were used to analyze survey data.

QFD and HOQ in mHealth apps design

The 'WHATs' list was obtained from doctors' interviews, and twelve design requirements were composed. The first stage identified and formalized these wants regarding mHealth apps to be designed ('WHATs' list). How important is 'sending order request to labs (CW2)' when compared to 'getting test/assay results for diagnostic purposes (CW2)'? The Analytic Hierarchy Process was used to compute each want's importance and to prioritize them. In the questionnaire, there were 12 wants, and doctors were asked to compare their wants (12*12matrix) using a five-point itemized rating scale from 5-extremely important to to 1, least important. While associating the comparative importance of doctor wants in AHP, '1' indicates equally important, '3' indicates that CWi is more important than CWj, '5' indicates that CWi is more important than CWj, and 1/5 and 1/3 indicate reciprocals when their relative importance is reversed.

Table I here

The first respondent's answers to the questionnaire was analysed according to a pair-wise comparison. Scores are revealed in Table I; e.g., according to the first respondent, sending order request to labs (CW2) was more important than instant communication with other doctors (CW8), sending referrals to nurses/assistants (CW7) is far more important than sending order request to labs (CW1). Getting test/assay results (CW3) and enabling doctors to remotely monitor patients (CW10) were equally important. Table II illustrates a normalised comparison matrix and total weighting factors (TWF). Matrix intersections, CWi:j, highlights the CWi's importance compared to the CWj; e.g., CW1:1 and CW1:2 values were calculated as follows; CW1:1= 1/26,39=0,038, and CW1:2=0,2/19,46=0,010. These calculations are made for every cell in Table I to calculate the relative importance of each doctor's expectations. The results for 30 respondents' weighting when the AHP process ended are shown in the last column in Table II.

Table II here

Total Weighting Factors in the mHealth apps for 30 doctors' wants in the AHP Matrix were calculated. Doctors' most significant wants were determined. In Table III, doctors' prioritizations and weightings are revealed; e.g., 'receiving a SMS)/MMS/Apps message

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automatically if the assay results are below average is the most important', and 'instant communication with other doctors' is the least important.

Table III here

The next step in the HOQ model was identifying mHealth app design characteristics 'HOWs', which respond to doctors' expectations. For this purpose, a list to sort technical characteristics was ordered as: (i) automatically retrieving and sending (SMS/MMS/Apps) messages (ii) NFC (Near Filled Communication System) for gathering patients' health information from their mobile device; (iii) voice recording and writing systems for patients' notes; (iv) voice response and routing system like SIRI designed by Apple Inc.; (v) simple mHealth apps screen design; (vi) high capacity and fast connection to health institutions/hospital information systems; (vii) an easy add/remove for personnel lists, for fast SMS/Apps messages; and (viii) a good calendar system for managing daily/weekly/monthly work.

As a final point, the HOQ for mHealth apps design that involves 12 doctors' wants (WHATs) and eight mHealth apps design characteristics 'HOWs' are determined. After defining the mHealth app design characteristics, the correlation matrix for 'HOWs' is analysed. The correlation matrix is used to identify features requiring collateral improvement. This matrix helps mHealth apps designers to decide which HOWs and to what extent they are correlated. This stage in the HOQ process contains a pair-wise comparison of different design requirements. A roof-shaped half-matrix is determined, allowing mHealth apps design characteristics to be identified, synergies (+) and opposites (−). In other words, in the matrix (+) indicates positive correlation (-) indicates negative correlation; e.g., there is positive correlation between 'receiving an (SMS/MMS/Apps) message automatically for the critical test/assay results and 'speed connecting health institutions/hospital information systems'. However, there is negative correlation between 'less complexity and user-friendly design' and 'easy add/remove personnel lists for fast SMS/Apps messages'.

Relationships between WHATs and HOWs are determined using the next step in the HOQ model: evaluating to what extent HOWs could technically relate to WHATs. To indicate the strength between HOWs and WHATs, a three-level rating scale is used [very weak relationship (1 or Θ), medium relationship (5 or O) and very strong relationship (9 or ▲)]; e.g., there is strong relationship between 'managing patient scheduling/appointments' and 'good calendar system for managing daily/weekly/monthly tasks', 'easy add/remove personnel lists for fast SMS/Apps messages' and 'less complexity and user-friendly design', and a very weak relationship between 'sending referrals to nurses/assistants' and 'voice response and routing system like SIRI designed by Apple Inc.'. The existing relationship in mHealth app design features in the HOQ model (Figure 2).

Figure 2 here

Evaluating mHealth app design rivals is important to improve mHealth apps' competitiveness. However, in the literature no completed mHealth apps has been designed as a benchmark for comparison. Some health intuitions/hospital staff just offer partial services on SMS or WhatsApp platforms. Calculating absolute and relative mHealth apps efficiency uses the following formulations: 'Absolute importance = matrix weight * doctor's expectation importance degree' and 'Relative importance = (absolute importance\total importance) *100'.

The most important mHealth apps design is based on relative importance (column weights), which 'retrieve and automatically send (SMS/MMS/Apps) messages for information', 'high capacity and fast connection to health institutions/hospital information systems' and 'easy add/remove personnel lists for fast SMS/MMS/Apps messages'.

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After determining relative importance and ranking mHealth app design requirements (HOWs), design targets must be considered. It helps to identify in which direction each HOWs should be improved to increase doctors' satisfaction. There are three ways to improve: '+' increasing, '-' decreasing, and '0' no effect. From the HOQ chart in Figure 2, all design requirements can and should be clearly extracted for developing mHealth apps. The most important design requirement is retrieving and automatically sending information (SMS/MMS/Apps Messages), and the least important design requirement is NFC (Near Filled Communication System) for gathering patients' health information on their mobile device. All relationships, analysis and evaluations for mHealth apps design HOQ are illustrated in Figure 2.

Conclusions and recommendations

mHealth technology has the potential to improve personal healthcare service quality and doctor effectiveness since they can facilitate remote care virtually anywhere, mHealth apps will develop into significant tools. However, as far as the related literature is concerned, there seems to be few mHealth apps developed for doctors. Therefore, developing mHealth apps from doctors' perspectives can be used for clinical decision support and for timely health monitoring, which enables doctors to send treatments using mHealth apps rather than relying on face-to-face interactions with nurses and patients. These are important for improving doctor as well as patient satisfaction through mHealth apps. However, there are also obstacles and challenges in using mHealth apps. The main obstacles are the small mobile device screens, high development cost, and some doctors' low technological skills, who are unable to recognize and understand the benefits provided by mHealth apps for health institutions. Owing to the differences in intended use, mHealth apps are subject to a wide ranging requirement in healthcare institutions. mHealth apps designers can minimize these challenges by customizing wants or by developing special mHealth apps for each health institution.

In this study, mHealth apps design for providing essential health information about patients for doctors are revealed. According to our QFD/HOQ analysis, the first five mHealth apps design characteristics that doctors wish mHealth apps should include are: (i) receiving a (SMS/MMS/Apps) message automatically if the test/assay results are below average values; (ii) receiving reminder (SMS/MMS/Apps) messages for daily duties; (iii) getting test/assay results; (iv) sending order request to labs; and (v) sending referrals to nurses/assistants. Message (SMS/MMS/Apps) design characteristics during emergencies and as reminders for daily duties are considered highly satisfactory, and they are more important than other wants to increase doctor satisfaction. The most important design requirements for mHealth apps are: (i) retrieving and sending information automatically (SMS/MMS/Apps Messages); (ii) high capacity and fast connection to health institutions/hospital information systems; (iii) easy add/remove personnel lists for fast SMS/MMS/Apps messages; (iv) a voice response and routing system like SIRI designed by Apple Inc.; and (v) simple mHealth apps screen design. Therefore, mHealth app designers and health institution managers should pay attention to these wants and design requirements. Further studies should include larger samples over wider regions; i.e., our study is limited to one location and is unable to cover wider ranging doctors' wants and wishes; i.e., our analysis should be repeated with a larger sample and include doctors in different cities and countries so that survey results can be generalised.

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Table I: Initial AHP Matrix: doctor's wants

CWi/CWj	*CW1*	*CW2*	*CW3*	*CW4*	*CW5*	*CW6*	*CW7*	*CW8*	*CW9*	*CW10*	*CW11*	*CW12*
CW1	1	1/5	1/3	3	1/5	3	1/5	5	3	1/3	5	1/3
CW2	5	1	1/3	5	1/5	5	1/5	3	3	1/3	5	1
CW3	3	3	1	3	1/5	5	1/5	3	3	1	5	1/5
CW4	1/3	1/5	1/3	1	1/5	3	1/5	3	3	3	5	1/5
CW5	5	5	5	5	1	5	1/5	5	5	1/5	5	5
CW6	1/3	1/5	1/5	1/3	1/5	1	1/5	5	5	1/3	3	1/5
CW7	5	5	5	5	5	5	1	5	3	5	3	1/3
CW8	1/5	1/3	1/3	1/3	1/5	1/5	1/5	1	3	3	5	1/5
CW9	1/3	1/3	1/3	1/5	1/5	1/5	1/3	1/3	1	1/5	3	1/5
CW10	3	3	1	1/3	5	1/3	5	1/3	5	1	5	1/5
CW11	1/5	1/5	1/5	1/5	1/5	1/3	1/3	1/5	1/3	1/5	1	1/5
CW12	3	1	5	5	1/5	5	3	5	5	5	5	1
CWT	26,39	19,46	19,05	28,39	12,8	33,06	11,06	35,86	39,33	19,59	50	9,06

Table II: Normalized comparison matrix and total weighting factors (TWF)

	CW1	*CW2*	*CW3*	*CW4*	*CW5*	*CW6*	*CW7*	*CW8*	*CW9*	*CW10*	*CW11*	*CW12*	*Total*	*...*	*TWF*
CW1	0,038	0,010	0,017	0,106	0,016	0,091	0,018	0,139	0,076	0,017	0,100	0,036	0,665	…	15,648
CW2	0,189	0,051	0,017	0,176	0,016	0,151	0,018	0,084	0,076	0,017	0,100	0,110	1,006	…	20,386
CW3	0,114	0,154	0,052	0,106	0,016	0,151	0,018	0,084	0,076	0,051	0,100	0,022	0,944	…	20,854
CW4	0,013	0,010	0,017	0,035	0,016	0,091	0,018	0,084	0,076	0,153	0,100	0,022	0,635	…	12,765
CW5	0,189	0,257	0,262	0,176	0,078	0,151	0,018	0,139	0,127	0,010	0,100	0,552	2,061	…	22,353
CW6	0,013	0,010	0,010	0,012	0,016	0,030	0,018	0,139	0,127	0,017	0,060	0,022	0,474	…	8,845
CW7	0,189	0,257	0,262	0,176	0,391	0,151	0,090	0,139	0,076	0,255	0,060	0,036	2,085	…	18,721
CW8	0,008	0,017	0,017	0,012	0,016	0,006	0,018	0,028	0,076	0,153	0,100	0,022	0,473	…	7,475
CW9	0,013	0,017	0,017	0,007	0,016	0,006	0,030	0,009	0,025	0,010	0,060	0,022	0,232	…	13,478
CW10	0,114	0,154	0,052	0,012	0,391	0,010	0,452	0,009	0,127	0,051	0,100	0,022	1,494	…	12,245
CW11	0,008	0,010	0,010	0,007	0,016	0,010	0,030	0,006	0,008	0,010	0,020	0,022	0,157	…	11,457
CW12	0,114	0,051	0,262	0,176	0,016	0,151	0,271	0,139	0,127	0,255	0,100	0,110	1,774	…	25,122

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Table III. What doctor want from mHealth apps

	(WHATs List)	Total	Relative Importance	%
CW1	Accessing detailed previous treatments and medical records	15,648	0,08264	8,26
CW2	Sending order requests to labs	20,386	0,10766	10,77
CW3	Getting test/assay results for diagnosis	20,854	0,11014	11,01
CW4	Writing down patients' notes during consultations	12,765	0,06742	6,74
CW5	Receiving reminder (SMS/MMS/Apps) messages for daily duties	22,353	0,11805	11,81
CW6	Accessing patient's clinical data from other hospitals	8,845	0,04671	4,67
CW7	Sending referrals to nurses/assistants	18,721	0,09887	9,89
CW8	Instant communication with other doctors	7,475	0,03948	3,95
CW9	Managing patient scheduling/appointments	13,478	0,07118	7,12
CW10	Enabling doctors to remotely monitor patients	12,245	0,06467	6,47
CW11	User friendly and simple design	11,457	0,06051	6,05
CW12	Receiving (SMS/MMS/Apps) messages automatically for the critica test/assay results	25,122	0,13268	13,27
	Total	189,349	1	100,00

Figure 1: Steps to creating a HOQ for mHealth apps design

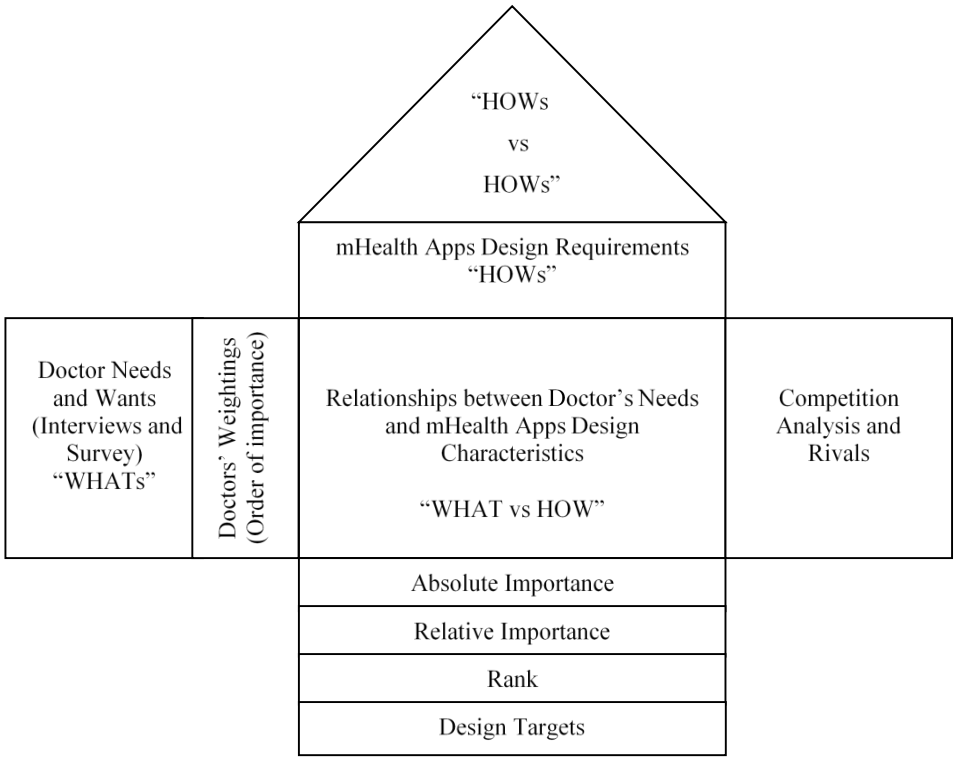

Figure 2: HOQ for mHealth apps design

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Doctors' Wants "(WHATs)" / mHealth App Design Requirements "HOWs"	Customer Weightings	Retrieving and sending (SMS/MMS/Apps) messages	NFC for gathering patients' health information	Voice recording and writing systems for patients' notes	Voice response and routing system like SIRI designed by Apple INC.	Simply mHealth apps screen design	Speed connecting health intuition/hospital information systems	Easy add/remove personnel lists for fast SMS/MMS/Apps messages	Good calendar system for managing daily/weekly/monthly works	No Rivals (0 25 50 75 100)
Accessing detailed previous treatments records	8,26	▲	▲		O	Θ	O	Θ		
Sending order request to labs	10,77	▲		O	O	Θ	O			
Getting test/assay results for diagnosis	11,01	▲				O	O			
Writing down patients' notes during consultations	6,74	Θ		▲	Θ	O	Θ	O		
Receiving an reminder message for daily duties	11,81	▲			Θ		O		O	
Accessing patient clinical data from other hospitals	4,67	O	▲		O	O	O			
Sending referrals to nurses/assistants	9,89	▲		▲	O	O	O	▲		
Instant communication with other doctors	3,95	O		O	O		O	▲		
Managing patient scheduling/appointment	7,12		O	Θ	Θ	O	O	▲	▲	
Enabling doctors to remotely monitor patients	6,47				Θ		Θ			
Less complexity and user friendly design	6,05					▲			▲	
Receiving (SMS/MMS/Apps) messages for the critical test/assay results	13,27	▲			O		O	▲		
Absolute Importance		634,93	151,97	230,39	286,19	270,63	416,96	350,03	177,58	
Relative Importance		26,80	6,41	9,72	12,08	11,42	17,60	14,77	7,49	
Rank		1	8	6	4	5	2	3	7	
Design Targets		+	+	+	+	+	+	+	+	

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