Advances in Consumer Research
ISSN (Print): 0098-9258
ISSN(Online): 3079-1766

Vol. 2, Issue 3 (2025) *https://acr-journal.com/*

A Consumer-Centric Approach to Quality Function Deployment: The House of Quality for E-Consultation Apps in Telemedicine

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Cite this paper as: Dr. Ritika Rathore, Dr. S.S. Jasial, Dr. Rushina Singhi, (2025) A Consumer-Centric Approach to Quality Function Deployment: The House of Quality for E-Consultation Apps in Telemedicine. *Advances in Consumer Research*, 2 (3), 547-557.

KEYWORDS

Quality Function Deployment, Telemedicine, E-Consultation, customer requirements, House of Quality, Consumer research.

ABSTRACT

The Covid- 19 Pandemic has given a boost to telemedicine. To curb the spread of infection, E-consultation apps have emerged through public, private and third-party players. This study aims to find the Voice of Customer (VOC) in Tele-medicine apps and translate them into attributes offered by E-health portals. The study uses House of Quality model to list down the patients' requirements and rank them according to their importance which is obtained through a feedback survey of 300 online consultation's patients during the pandemic period. The technical requirements of the e-health portal are obtained through discussion with 30 healthcare providers and app developers and the relationship is shown through HOQ model. This QFD model would help E-health sector to modify their product offerings according to customer requirements and enhance patients' satisfaction index. The academicians can use the model for referencing of QFD in health care sector

1. INTRODUCTION

Virtual consultations as a part of telemedicine have been in practice since 2000s primarily by medical professionals for case discussions and referral of patients from remote locations. WHO defined Telemedicine as "*the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities.*"(Board Of Governors, 2020). Using telecommunications technologies to transfer information and services related to medicine is known as telemedicine. (Perednia & Allen, 1995). But today in the ongoing pandemic, all healthcare specialties have been forced to adjust and change for providing continual care to patients while

maintaining social distancing (Kichloo et al., 2020). The healthcare system worldwide has been facing the dilemma of how to provide services not just to covid infected patients but also to other patients suffering from trauma, acute illnesses or chronic illness while protecting the doctors, nurses and other healthcare providers (Bashshur et al., 2020). Telemedicine or E- consultations has been useful in current pandemic situation by allowing slightly unwell people to receive the necessary supportive care while restraining their exposure to other ill patients (Portnoy et al., 2020). The huge shift towards telemedicine shows it as an operative tool for following social distancing in clinical or other settings. The use of E-consultations has seen increase by both health care professionals, as marked by rising instances of sending e- prescription documents to patients, and young patients without any chronic diseases who were infrequent users but due to pandemic have had to use this method to contact healthcare professional. (Solans et al., 2021).

Digital Healthcare

The digital health market in India is anticipated to increase from $3.83 billion in 2022 to $18.34 billion in 2030, registering a growth rate of 21.6% from 2022 to 2030. There have been initiatives to increase government spending on healthcare and broaden insurance coverage.

Remote delivery of healthcare services and information is made possible by the use of digital tools and communication platforms in the field of digital healthcareIndia's market for digital health is growing swiftly and has the potential to improve patient access to care and increase the effectiveness of the healthcare system. In India, digital health is expanding in a number of sectors, including telemedicine, electronic health records (EHRs), and medical devices.

Both the public and private healthcare have advocated for the use of telemedicine and virtual OPD service during the current pandemic through different portals like E-Sanjeevani, ORS Patient portal, Apollo Tele consultation or through private practitioners registered with m-health/e-health apps like Practo, Ekacare etc. Virtual OPD is a technology that connects patients with available doctors for online consultations and allows doctors to email printable subscriptions to patients. Its goal is to create an atmosphere where patients who require doctor assistance at home can consult doctors, share photographs, communicate with doctors, tell them about their problems, and debate solutions. This facility enables people in remote areas of the state to seek advice of health experts.

(Ahn et al., 2014) analyzed patients' preferences and perceptions towards the different attributes of telemedicine services, focusing mainly on device and service types, and draw inferences about service design and dissemination strategies in modern era. A number of research on telemedicine, or video consultations, have been conducted in various locations across the world. Telemedicine articles usually emphasize the need for more study regarding safety, efficacy, and cost effectiveness. (Mair & Whitten, 2000). In present scenario, the world requires an efficient medium to maintain social distancing. And healthcare has always been a service where the presence of patients is mandatory to get medical assistance. But the use of telemedicine has provided an alternative to access the medical care virtually using technology.

Huge number of inferior quality health apps has flooded the healthcare sector since there are no fixed standards for their development and valuation. Start-ups with limited research and development resources employing people with non-medical backgrounds have been developing these e-health portals creating contradictory views on technology development versus evidence-based medicine principles. Traditional healthcare centers with larger financial resources, such as pharmaceutical companies, have acknowledged that they need to embrace digital health, but are having difficulty doing so due to the contrasts in medication research and digital tool development. Moreover, they need to offer the attributes that cater to the needs of customer requirements and provide them an edge over their competitors. With a plethora of such apps and portals coming up, it is important to deduce exact customer requirements in e- consultation portal and match them with the technical descriptors for the best product offering in telemedicine.

This paper purposes to explore the customer requirements of the present state E- consultation services and then to decide the relevant portfolio to be offered in the virtual consultation portals. By adopting QFD (Quality Function Deployment), this study proposes a new approach to develop a customer-oriented E- consultation system.

The quality function deployment (QFD) is commonly used since it aids in determining the customer's voice and translating it into technical requirements that must be met in the product or service design to ensure customer satisfaction. Yogi Akao created the QFD model in 1966, and it was widely utilised in Japan from 1960 to 1970. It was later employed by Mitsubishi's Kobe shipyard in Japan (1972). House of Quality is one of the tools of QFD that helps to translate customer requirements to technical properties. (Camgoz-Akdag & Beldek, 2020). QFD as a planning and problem-solving tool has been developed to confirm quality in new or improved products and services.(Altuntas & Kansu, 2020). Quality Function Deployment benefits by focusing 100% on the customer thereby increasing the likelihood of getting customer satisfaction. It helps in improving communication within the team. It provides a greater chance that the product will do well in the market. QFD Model has been used extensively in product design features in manufacturing industry and lately it has found applications in service industry as well. (Karanjekar et al., 2021) applied a comprehensive QFD model for technical academic institutions to assess stakeholders' requirements. Their translation into service features, important processes, and eventually key activities are offered to management as recommendations for making appropriate decisions and actions. The basic enactment tool in QFD application during product/service design, development and manufacturing is provided by HOQ (Hauser and Clausing, 1988). In the healthcare sector, QFD methodology is scarcely used. (Radharamanan & Godoy, 1996) used Quality Function

Deployment for improving quality in healthcare service delivery system. (N et al., 1999) presented a customized QFD for designing of computer network service for occupational therapists. (Moores, 2006) used QFD methodology for exploring "radiation safety management" in healthcare. Furthermore, fuzzy logic based QFD is also used in health-care settings. For example, (Lee et al., 2015) used fuzzy QFD to analyze the healthcare service requirement in Singapore. (Dijkstra & Bij, 2002) used a refined model of QFD for health-care applications taking two case studies in Dutch health-care organizations. (Gremyr & Raharjo, 2013) highlighted the antecedents of applying Quality Function deployment and applied QFD in the cardiology clinic to decrease the time spent on medication by more than 20 percent. (Ahmed et al., 2006) developed quality healthcare software to be used in hospital Information System using QFD. Similarly (Simons & Verhagen, 2008) applied "value sensitive design" and QFD to healthcare ICT. (Dehe & Bamford, 2017) makes a real contribution through empirical observation of QFD modelling and provided evidence of its enactment inside the intricate and developing healthcare infrastructure. (Núñez & Ruiz de Adana, 2019) used QFD model to identify patient requirements in a hemodialysis unit. (Süleyman Barutçu, 2019) used QFD methodology to develop m-health apps from the perspective of doctors, advocating technical features of m-health accessible through smart phones. He emphasized on healthcare practitioners' requirements of tracking digital medical records and sharing them effectively.

In this study, QFD is based on arraying patients' wants (WHATs) in Telemedicine app technical attributes offerings (HOWs). After this, e-consultation app developers, health ministry, technology firms, Hospitals and healthcare providers could work in tandem to direct design and development of e-consultations through telemedicine app(S Barutçu, 2019).

Research Gap

QFD application in the Telemedicine field of healthcare with the perspective of customers' requirement was not found. There exists a gap between the stakeholder's requirements (patients and healthcare providers) with regard to the e-consultation services provided by the various telemedicine portals. The main stakeholder i.e., patients require a good consultation experience in virtual mode with a positive outcome in terms of diagnosis and future directives. Therefore, it becomes imperative for the telemedicine app developers to provide service offerings for maximum customer satisfaction.

Research objectives

1. To identify the patients' requirements for e-consultations through telemedicine app;

2. To translate these requirements to technical attributes to be added to enhance service delivery of telemedicine;

3. To generate a HOQ model for application of QFD in telemedicine to make an affordable and innovative offering as required by all stakeholders

2. MATERIAL AND METHODS

Purpose of the study: To study the satisfaction of the consumer of online consultations for better understanding of the necessary requirements of the patient using Telemedicine portals.

Objectives of the study: To Conduct a survey of patients to identify basic demands and rank them according to the patient's needs, write technical specifications based on discussions with doctors and app developers to assure the realization of the stated needs, and construct a House of Quality based on the data obtained. (Nikolaeva et al., 2020)

Define Customer Requirements

The first stage in implementing Quality Function Deployment (QFD) is to identify consumers' needs, which focuses on defining, clarifying, and identifying client requests. The house of quality (HOQ) model is driven by the needs of the customers. It lays the groundwork for ensuring that the process is tailored to the demands of the clients. (C. M. LeRouge et al., 2015) provided patient perspective on telemedicine quality and developed a service quality model. The quality characteristics of this model has been used and validated through a survey. A sample of 300 patients who took e- consultation from a polyclinic physician during the period of pandemic were contacted and feedback cum survey form was administered to find out the factors affecting customers' satisfaction. The demand quality was listed under five main headings mainly, Technology aspect; System Quality Aspect; Interaction aspect; Support and Services Aspect and Security Aspect (C. LeRouge et al., 2002) which were further subdivided into more realistic and easier to understand indicators. (Javanparast et al., 2021) [Table 1] lists the voice of customer or "WHATS" of the e-consultation service through Telemedicine.

2.1 Determine weight of customer requirements

Importance to these customer requirements is assigned by calculating the mean of the importance given by respondents in the survey form. The assigned weights in the range of 1 to 5 which are calculated by the mean values on the Likert scale data collected from the research survey conducted. [Table 1]

TABLE 1 – WEIGHTED CUSTOMER REQUIREMENTS

	First Grade Indicator	Second Grade Indicators	Weight	Description
A1	Technology aspect	**A11** Video and Audio Clarity	4	Image Resolution and Synchronization in audio and video
		A12 Uninterrupted Connection	5	
		A13 Ease of Use	4	Intuitive and friendly interface
		A14 Peripheral Sophistication	3	Can perform a range of medical tasks like Pulse, BP monitoring etc.
		A15 Interoperability	3	Real time transmission of input and output
A2	System Quality Aspect	**A21** Reliability	4	Consistent function
		A22 Usefulness	5	Functioning of system as intended
		A23 Performance	5	Satisfaction of both parties
		A24 Affordability	3	System usage & consultation cost
		A25 Ergonomic Design	3	Ease of maneuverability & compatibility
A3	Interaction Aspect	**A31** Doctor's tele-presence	5	Communication, Courtesy, Empathy
		A32 Content of communication	5	Diagnosis & Clear Future Directives
		A33 Responsiveness	4	Quick response and timely service
		A34 Assurance	4	Competence, Knowledge & Credibility of Doctor
		A35 Telemedicine orientation	4	Doctors & patients are comfortable in using telemedicine
A4	Support-Services Aspect	**A41** Availability of prescription	5	Printable & legible prescription after consultation
		A42 Billing Collection	4	Ease of making payments and getting receipts
		A43 Appointment scheduling	5	Ease of making first appointment & follow-ups
		A44 Diagnostic and Pharmacy	3	Availability of lab testing and pharmacy solutions
		A45 Grievance Redressal	3	Solutions to issues pertaining to payment, consultation etc.
A5	Security Aspect	**A51** Data /Information Security	2	Data Privacy
		A52 Network Security	2	Safe connection
		A53 Healthcare Standards	1	Follow healthcare protocols
		A54 IT Protocols	1	Follow all IT standards

2.2 Define Technical Attributes

Formulating technical attributes to fulfill customers' demands is the second stage of QFD's House of Quality Diagram. In this step, the patients' requirements from telemedicine app are looked at and corresponding technical quality characteristic is arrived at to achieve patients' demand. In this study, the technical requirements were arrived at through interviews with healthcare providers and App developers and through secondary literature mainly (Ndlovu et al., 2021), (Alharbi et al., 2021), (Weber et al., 2021) and (Van Velthoven et al., 2018). 30 doctors of different specialties were interviewed for this purpose and their inputs were recorded to develop technical requirements. For digital know-how, inputs were taken from app developers who helped in framing the attributes with IT background. The basic set was categorized as System/Portal Design;

Technology Design; Interpersonal Skills; Information Management System and Security and Compliance features. These were further extrapolated to technical attributes as listed in Table 2.

	First Grade Indicator	Second Grade Indicators
B1	Technology Design	**B11** Codec Support
		B12 Real Time Communication
		B13 User-friendly Interface
		B14 Device pairing for remote monitoring
		B15 A seamless interface between all health information system
B2	System Design	**B21** Software/app accessible through laptop /tablet/ smartphone
		B22 E-consultation features
		B23 Pilot Run and feedback
		B24 Optimal pricing for usage
		B25 App Design suited for all age groups
B3	Enhanced Interaction features	**B31** Documented SOPs to be followed by Doctor and Patient with regards to their tele-presence
		B32 Diagnosis and future directives
		B33 Interpersonal Skills
		B34 Due diligence while adding Doctors and patients
		B35 Training/Demo Session
B4	Information Management System	**B41** Electronic Patient Record and maintaining Digital Trail
		B42 Digital Payment Solutions
		B43 Appointment booking system and follow-ups
		B44 Diagnostics and Pharmacy Solutions
		B45 Customer Support
B5	Security and Compliance	**B51** End to End Encryption Protocol
		B52 Firewall and cyber security
		B53 Ethical Medical Practices Code compliance
		B54 HIPAA Compliance

TABLE 2- TECHNICAL REQUIREMENTS

2.3 Relationship Matrix

The fourth step in constructing House of Quality Diagram is to build the relationship matrix [Figure 1]. This matrix depicts a connection between the Customer/patients' demands from a telemedicine portal and the Technical Characteristics offered by e-consultation providing apps through symbols which represents a strong relationship (value given "9", shown by 'ʘ'), moderate relationship (value given is "3", shown by 'O'), and a weak relationship (value given is "1" shown by '▲'). Based on the given values, relative importance of every technical attribute is calculated using the formula for each column as

$$\frac{Product\ of\ relationship\ value\ and\ weights\ assigned\ to\ customer\ requirements\ X\ 100}{\sum Product\ of\ relationship\ value\ and\ weights\ assigned\ to\ customer\ requirements}$$

			HOWS																								
			Technology Design					System Design					Enhanced Interaction Features					Information Management System					Security and Compliance				
WHATS		Importance Weights	Codec Support	Real Time Communication	User-friendly Interface	Device pairing for remote	A seamless interface	Software/app accessible	E-consultation features	Pilot Run and feedback	Optimal pricing for usage	App Design suited for all	Documented SOPs to be	Diagnosis and future	Interpersonal Skills	Due diligence while adding	Training/Demo Session	Electronic Patient Record and maintaining	Digital Payment Solutions	Appointment booking system	Diagnostics and Pharmacy	Customer Support	End to End Encryption	Firewall and cyber security	Ethical Medical Practices Code	HIPAA Compliance
Technology aspect	Video and Audio Clarity	4	9	9					3	1																	
	Uninterrupted Connection	5	3	9			1		9																		
	Ease of Use	4			9			9				1					3					3					
	Peripheral Sophistication	3	3	1	3	9																3					
	Interoperability	3	9	3		3	9						3														
System Quality Aspect	Reliability	4						9		3				3		1	1						3				
	Usefulness	5			3			3	9		1	3	3	9				9	1	1	3						
	Performance	5	1	3	9					1		3	9	9	3	1	3	9		3	1	1					
	Affordability	3				1		3			9										1						
	Ergonomic Design	3			3			3		3		9					1										
Interaction/Use Aspect	Doctor's tele-presence	5											9		9	3											
	Content of communication	5		1									3	9	9	9		9									
	Responsiveness	4		3			3						3	3	9	1	1	9	1	3		3					
	Assurance	4												3	9	9						1	1		3		
	Telemedicine orientation	4			1					1			3	1	3		9					3					
Support-Services Aspect	Availability of prescription	5												1				9							3		
	Billing Collection	4																	9								
	Appointment scheduling	5			3			3										3		9							
	Diagnostic and Pharmacy	3	3															3			9						
	Grievance Redressal	3																				9					
Security Aspect	Data /Information	2														1							9	3		3	
	Network Security	2																					3	9		3	
	Healthcare Standards	1											9	9	3	3		3							9		
	IT Protocols	1	3																	3			3	3		9	
	Importance		104	125	133	39	44	120	102	34	32	61	162	189	192	114	74	243	45	80	50	81	43	27	36	21	
	Relative Importance Weights		4.83	5.81	6.18	1.81	2.05	5.58	4.74	1.58	1.49	2.84	7.53	8.79	8.93	5.30	3.44	11.30	2.09	3.72	2.32	3.77	2.00	1.26	1.67	0.98	
	Significance Level		4.83	5.81	6.18	1.81	2.05	5.58	4.74	1.58	1.49	2.84	7.53	8.79	8.93	5.30	3.44	11.30	2.09	3.72	2.32	3.77	2.00	1.26	1.67	0.98	

Figure 1 - Relationship Matrix

2.4 Correlation Matrix of Technical Attributes

This matrix analyzes technical requirements and sees how each one affects the other, whether they work together (strong positive relation shown by '++'; positive relation by '+') or have design conflicts (negative relation shown by '-'and strong negative relation by '▼').

2.5 Technical Attributes and Targets

This step's purpose is to identify the most critical issues and address them in order to provide the highest degree of customer satisfaction. The significance level of these technical attributes is shown in Figure 2.

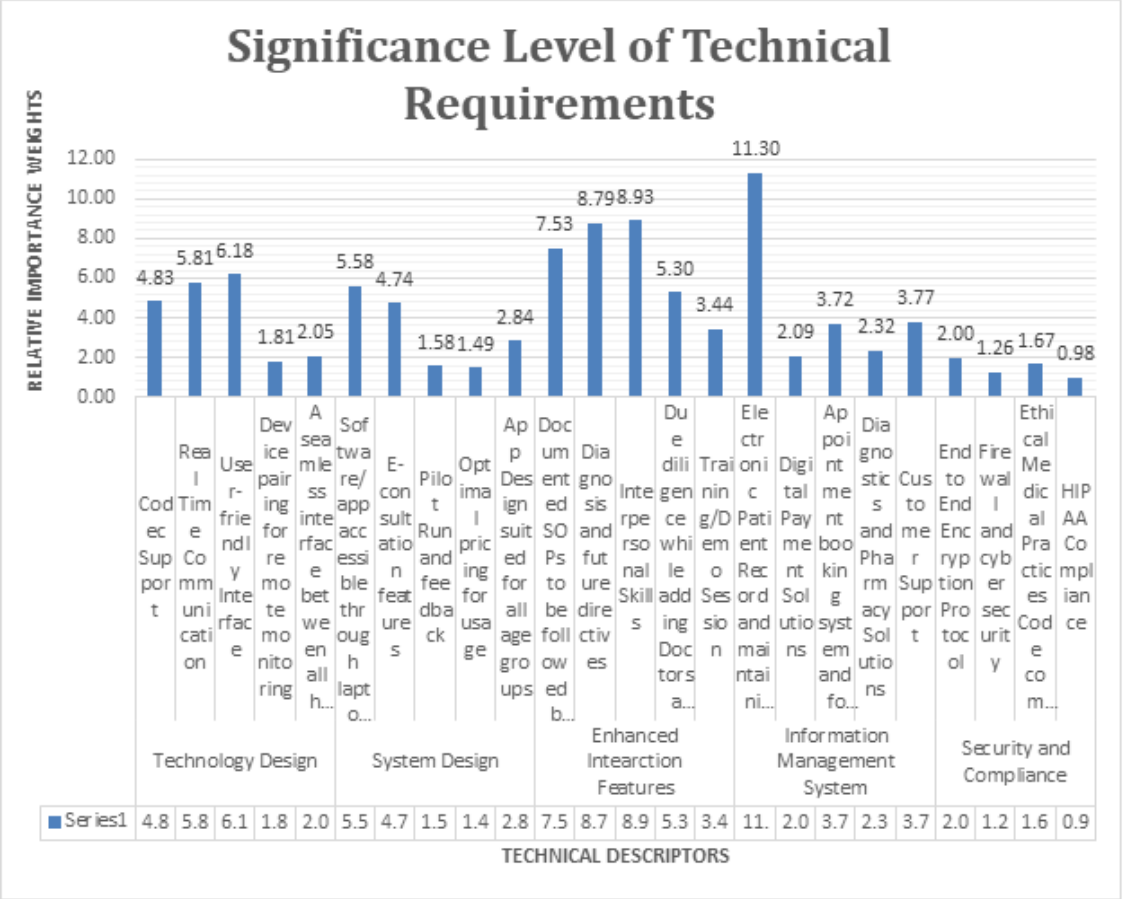

Figure 2 - Significance Level of Technical Attributes

2.6 House of Quality (HoQ)

The matrix of "House of Quality" depicts the relationship among the customer (patients opting for telemedicine) requirements and Technical Service Attributes provided by E-health Apps. It is a basic Product Planning or concept matrix developed. [Figure 3]

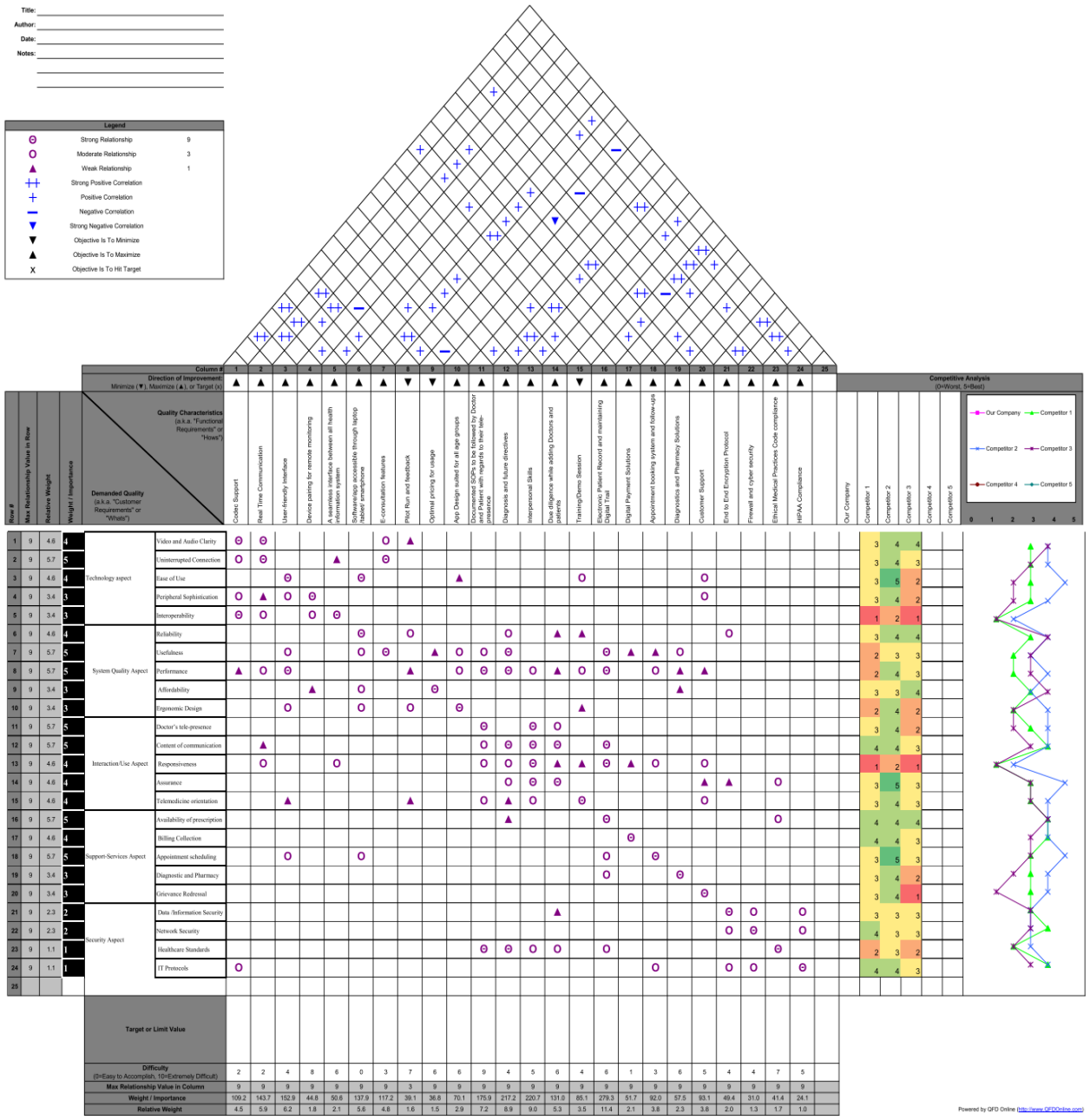

Figure 3- House of Quality

3. RESULT

The expectations of patients undertaken E- consultation were identified and related to the technical attributes of the e-consultation app through a qualitative approach. The following results were obtained:

- Voice of customer for e-consultation according to its importance is obtained through survey. [Table1] It was observed that the Interaction aspect which covers style of communication in terms of tele presence of health care provider, content of communication, responsiveness, assurance and tele-orientation of doctor which are service quality attributes in general OPD setting holds true for Virtual OPD setting as well. Secondly, Service support system in terms of e-prescriptions, diagnostic and pharmacy solutions are also important quality factors. Apart from that, data security issue is not in forefront of patients' minds until specifically asked. But they need seamless network connection to enhance quality of communication and give importance to e- prescriptions and follow-ups.
- The technical requirements [Table 2] encompass the area of digital offerings like System and Technology

design, Enhanced Interaction Features, Information Management System and Security and Compliance. Their relative importance is analyzed. [Figure 1]

- House of Quality model is formed. [Figure 3]. The relationship between the patient's requirements and the technical attributes are represented in its center. The results of the comparative evaluation, referring to the patient's assessment of the quality of e-consultation apps is integrated into matrix. The correlation matrix of technical attributes becomes the roof of the traditional House of Quality model.

4. DISCUSSION

Statement of principal findings

This research attempted to clarify the ambiguity of patient perceptions so that they may be used as valuable information in Telemedicine analysis and translated into technically competent product offerings. The QFD model developed in this study would help E-health sector of the country to modify their product offerings according to customer requirements and enhance patients' satisfaction index.

Strengths and limitations

It is one of the first studies to use Quality Function deployment (QFD) tool in the area of telemedicine and develop a customer-oriented E- consultation system.

The patients' contacted for feedback survey on the use of e-consultation services were mainly covid-19 patients. Data thus obtained is skewed towards online consultation of a specific illness and may change with respect to other illnesses. The technical attributes were obtained through literature survey which is still in nascent stage; interview with healthcare providers who themselves are not digitally proficient; amateur app developers who are unable to comprehend the healthcare protocols and standards; and through brainstorming of authors. These are not tested through a case study and hence are not validated.

Interpretation within the context of the wider literature

The E-consultation portals have primarily two stakeholders viz. patients and doctors. This study focused on 'whats' from patient perspective only. The future work in this area would be to develop QFD for e-consultation portals with doctor's perspective and later on combine both stakeholder's requirements. Taking healthcare provider perspective would help categorize benefits of telemedicine in specific illnesses and would help focus technical product offerings in a specific direction rather than generic offerings which would lead to increase in patient satisfaction.

Implications for policy, practice and research

The research and conclusion will help understand where hospital management should focus their attention in the coming years. Even after the pandemic is over, E-consultations through Virtual OPD and telemedicine would help triage the symptoms and offer referrals for serious cases. Therefore, the study has tremendous scope in the future while covering customer requirements of various demographics and technical characteristics to suit specific purpose of telemedicine. The academicians can use the model for referencing usage of QFD in services sector.

5. CONCLUSION

We conclude that the methodology of QFD analysis for a digital medical consultation is a method of systematizing consumer requirements and examining their basic needs that patients expect to meet through telemedicine by receiving quality medical care, and the quality criteria in turn, they are developed by a team of experts (medical workers) and app developers, which gives the maximum effect of the interaction of the patient and medical personnel. The hospital management needs to hire a digital curator to adopt the most important technical attributes that can be achieved within their capability and approach and he should work in conjunction with the healthcare service provider

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