Frontiers in Health Informatics
2024; 13: 197
www.ijmi.ir
Open Access

Designing a system to empower startup businesses for evaluating digital health products

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Article Info

Article type:
Research

Article History:
Received: 2024-01-31
Accepted: 2024-02-26
Published: 2024-03-20

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Keywords:
Startup Businesses
Empowerment
Digital Health Products
Evaluation

A B S T R A C T

Introduction: Given the emergence of startup businesses in digital health and the importance of their products for human well-being, there is a critical need for consistent and continuous evaluation of these products. Therefore, producing high-quality and standard products in the health sector helps maintain the competitive market both nationally and internationally. Due to the lack of an evidence-based system that provides comprehensive educational information and an empowerment platform in health fields, this study aimed to design a system for empowering startup businesses to evaluate digital health products.

Material and Methods: This study was conducted in three phases: 1) descriptive, 2) development, and 3) evaluation. In the first phase, data elements and functional and non-functional requirements were identified through a literature review and validation by experts. In the second phase, the system was developed using SQL Server 2019, C# language, and an interface was created using ASP.NET Core in Visual Studio 2022, along with programming languages HTML, CSS, Bootstrap, and Java to design a database. In the evaluation phase, the designed system was assessed based on Nielsen's questionnaire and usability indicators.

Results: Twenty functional and eleven non-functional components were identified for the design of the system, which were confirmed by related experts. The system comprises main modules, including educational resources, empowerment, a network of startups, a discussion forum, experiences, and a library for evaluating digital health products. In the empowerment section, the modules of consultation, webinars, coaching programs, tools, indicators, and evaluation frameworks were developed and implemented. The highest average severity of issues was related to the error prevention section rather than reminders, while the lowest average severity of issues was associated with the consistency and standards principle.

Conclusion: The design of empowerment systems in startup businesses can provide a suitable platform for enhancing evidence-based evaluation for their companies.

Cite this paper as:
Seifi M, Maserat E. Designing a system to empower startup businesses for evaluating digital health products. Front Health Inform. 2024; 13: 197. DOI: 10.30699/fhi.v13i0.586

INTRODUCTION

In the 21st century, not only is the hope for life increasing, but also the number of patients suffering from chronic diseases and the cost of supplying modern treatments are on the rise. The World Health Organization estimates a shortage of 4.3 million health workers worldwide [1]. In the United States, healthcare expenditures account for 17.2% of the gross domestic product (GDP), with an average annual cost of $10,000 per person for healthcare [2]. Developed economies are challenged to ensure the resilience, stability, and quality of healthcare services due to demographic changes, increased life expectancy, the rising prevalence of chronic diseases, and the re-emergence of infectious diseases [3]. The healthcare industry lags behind in adopting emerging technologies compared to other industries [3], and there is evidence supporting cost-effectiveness in healthcare services [2]. These escalating challenges underscore the growing need for effective, measurable, sustainable, and innovative healthcare

services [4-6].

Information and communication technologies (ICT) are perceived as effective tools for the cost-effective, efficient, and quality provision of healthcare system needs and services [4, 7, 8]. Furthermore, digital technologies can facilitate the transition from hospital-centric healthcare models to patient-centric models, improving access to healthcare and contributing to the sustainability of healthcare systems [3]. On the other hand, the rapid advancement of technologies such as the internet and smartphones penetrating into healthcare has motivated the development of digital health technologies, including mobile health and electronic health, which, in addition to overcoming challenges related to spatial distance between healthcare providers and patients, can offer an opportunity for creating personalized insights into community care. Digital health leverages various technologies in the management of healthcare services to enhance patient health [9, 10].

Startups are newly established companies or entrepreneurial ventures currently in the phase of market exploration and development, launched with the objective of pursuing a replicable and scalable business model [11, 12]. To achieve scalability goals, it is imperative to leverage intangible assets such as knowledge and human capital as key drivers [13]. The evaluation of products in the digital health startup domain is crucial. Because, with a more precise and standardized evaluation of these products and startups, a hopeful future with higher-quality products becomes imaginable for them [14]. In addition to the mentioned aspects, evaluation is considered a positive step toward transforming a startup into a knowledge-based company [14]. In the evaluation of health technology, critical attention is dedicated to key components such as effectiveness, safety, cost-effectiveness, pre-marketing, and post-marketing assessments [15], as well as business model frameworks [16]. The distinctive aspect of evaluating startup products lies in not only considering the assessment criteria but also scrutinizing their business indicators [17].

Given the significance of the effectiveness of digital products in the healthcare field, standardized evaluation based on evidence is essential to ensuring product efficacy [18]. However, evaluating digital health products poses many challenges for startups, such as a lack of resources, expertise, and guidance [19]. To navigate these challenges successfully, startups must offer high-quality products that align with key success factors in the digital health domain, encompassing customer needs, regulatory compliance, market size, business model, innovation, and funding [20]. There is a need for an evidence-based system that provides comprehensive education and empowerment in the health sector. This system would enable startups to develop and evaluate their digital health products with greater efficiency and effectiveness. Therefore, this study aimed to design an empowerment system for startups with the goal of evaluating digital health products.

MATERIAL AND METHODS

As illustrated in Fig 1, this study has been conducted in three phases: descriptive, development, and evaluative.

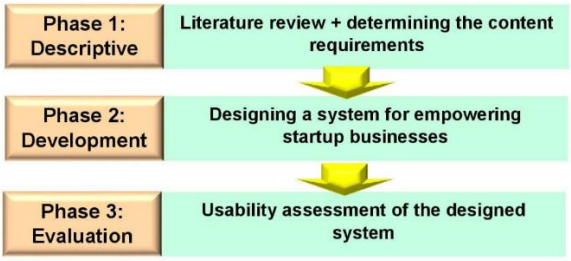

Fig 1: Overview of method's steps

Phase 1: Literature review and content requirements

Databases and search strategy

In this phase, a literature review was conducted to identify papers that focused on the evaluation of digital health product systems. PubMed, ProQuest (dissertation & thesis global databases), scientific information database (SID), IranDoc, and grey literature (i.e., Google scholar) were searched using the appropriate keywords: assessment, evaluation, mHealth, mobile application, digital health product, business model, market*, startup*, and start-up*.

Study selection

Articles were considered for inclusion if they met the following criteria: 1) explored digital health systems, 2) focused on the evaluation of business systems, and 3) targeted startup systems. Papers that did not align with the objectives of our study, were not published in English or Persian, or lacked full-text availability were excluded.

Content requirements

To identify content and essential functional and non-functional requirements from the perspective of related experts, a researcher-designed questionnaire was employed. Initially, the system requirements were determined through a focus group session. Subsequently, the questionnaire items were refined based on the results of the focus group session and the review. To ensure the questionnaire's validity, content validity ratio (CVR) and content validity index (CVI) were calculated for each questionnaire

item and the entire questionnaire, with the participation of 15 related experts, i.e., health information technology (N=2), medical informatics (N=7), and health information management (N=6). For CVI calculation, simplicity, relevance, and clarity were assessed for each item using a 4-point Likert scale (aligned with the criterion, somewhat aligned with the criterion, relatively aligned with the criterion, not aligned with the criterion). Items with a score exceeding 0.79 were considered acceptable in the CVI. For CVR calculation, the necessity component was evaluated using a three-point Likert scale ("essential," "useful but not essential," and "not essential"), with an acceptable value of at least 0.49 for the 15 experts. The questionnaire's reliability was confirmed with a Cronbach's alpha of 0.83.

Phase 2: Development

Based on the results obtained from the initial phase and consultations with relevant experts, the framework or overall plan of the program was designed. Accordingly, the structure and content of the program were developed. Additionally, the system modules were configured and developed. This research is built upon MVC Core technology. To establish the database, SQL Server 2019 software was employed, and the program's logic was created within the ASP.Net Core environment of Visual Studio 2022, using the C# language. The user interface was designed using ASP.Net Core in Visual Studio 2022, along with programming languages such as HTML, CSS, Bootstrap, and Java. Moreover, SSL licensing was utilized to ensure security in web service transactions in this research.

Phase 3: Evaluation

The usability of the system was assessed using the Nielsen's questionnaire [21], which comprises the following items:

1) system status monitoring, 2) system-world realism alignment, 3) user control and freedom, 4) compatibility and standards, 5) error prevention, 6) recognition over recall, 7) flexibility and efficiency of use, 8) aesthetic and minimalist design, 9) aid users in recognizing, diagnosing, and recovering from errors, and 10) help and documentation

For this purpose, fifteen experts in health information technology, medical informatics, and health information management participated in the study. They were requested to assign a severity rating to each issue utilizing Nielsen's severity scale: 1. no problem, 2. cosmetic problem, 3. minor problem, 4. major problem, and 5. usability catastrophe.

RESULTS

Phase 1: Literature review and content requirement

The functional and non-functional requirements of the startup business empowerment system for evaluating digital health products through literature review and experts' knowledge are presented in Table 1. The characteristics of the involved experts are shown in Table 2.

Table 1: Functional and non-functional requirements of the startup business empowerment system for the evaluation of digital health products.

Component	Property	Results		Final status
		CVR	CVI	
Functional Requirements: General Content	Registration and membership	1	1	Accepted
	System dashboard	1	1	Accepted
	Event and news	1	1	Accepted
Functional Requirements: Specialized Content	Evidence- based articles and resources	1	0.86	Accepted
	E-books	1	0.93	Accepted
	Guides, Manuals, and Standards	1	0.93	Accepted
	Multimedia Educational Materials	1	1	Accepted
	Webinars and Training Workshops	1	0.93	Accepted
	Coaching Programs	1	0.93	Accepted
	Evaluation of Digital Health Products	1	1	Accepted
	Digital Health Product Assessment Tools	1	1	Accepted
	Frameworks for Assessing Digital Health Products	1	0.93	Accepted
	Electronic Examinations	1	0.93	Accepted
	Technical Consultation Services	0.93	0.86	Accepted
	Success Stories of Startup Companies	0.86	0.93	Accepted
	Marketing and Technical Research Experience	0.86	0.86	Accepted
	Profiles of Startup Companies	1	0.93	Accepted
	Capability Map of Startup Companies	1	1	Accepted
	Discussion Forum	1	1	Accepted
	Digital Health Product Evaluation Library	1	1	Accepted

Component	Property	Results		Final status
		CVR	CVI	
Non-functional Requirements	Customization of Learning for Users	1	1	Accepted
	Search and Navigation	1	1	Accepted
	Language Considerations	1	1	Accepted
	Interoperability	1	1	Accepted
	Performance	1	1	Accepted
	Usability	1	1	Accepted
	Reliability	1	1	Accepted
	Compatibility	1	1	Accepted
	Security	1	1	Accepted
	Scalability	1	1	Accepted
	Privacy and Security Framework (Access Control, User Tracking)	0.83	0.83	Accepted

Table 2: Characteristics of involved experts (N=15)

Variables		No (%)
Gender	Male	9 (60)
	Female	6 (40)
Field of education	Information Technology Management	2 (13)
	Medical Informatics	7 (46)
	Health Information Management	6 (40)
Job experiences	<5	7 (46)
	6-10	5 (33)
	>10	3 (20)

Phase 2: Design the system

Fig 2 illustrates the use case diagram, representing the interaction between the user and the designed system.

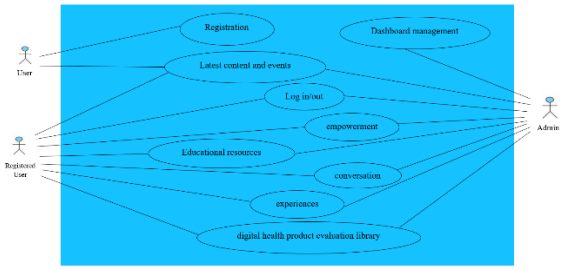

Fig 2: Use case diagram

Fig 3 illustrates the homepage of the startup business empowerment system, which is composed of six menus and their respective sub-menus as outlined below:

1. Educational Resources:
- Evidence-based articles and resources
- Electronic book
- Guidelines and standards
- Educational multimedia
2. Empowerment:
- Technical advice
- Electronic test
- Evaluation of digital health resources
- Digital health product evaluation tools
- Evaluation frameworks for digital health products
- Program of webinars and workshops
- Coaching program
3. Experiences:
- Startup success stories
- Marketing and technical research experience
4. Startup Network:
- Profile of new companies
- Capability map of startup companies
5. Discussion Forum
6. Digital Health Product Evaluation Library

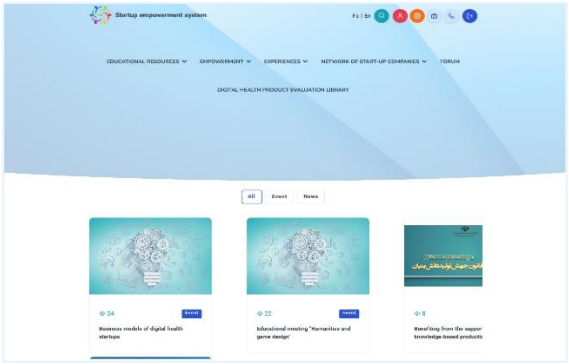

Fig 3: The main page of the New Business Empowerment System

Individuals are required to register to gain exclusive access to the system; however, general content is open to the public. Fig 4 displays the user interface of the system dashboard, specifically designed for system management by the admin. The main dashboard page presents key metrics, including the number of users, posts, views, and comments. Additionally, it offers features such as creating new posts, viewing existing posts, accessing user information, establishing access types for users, editing menus and sub-menus, and sending group emails.

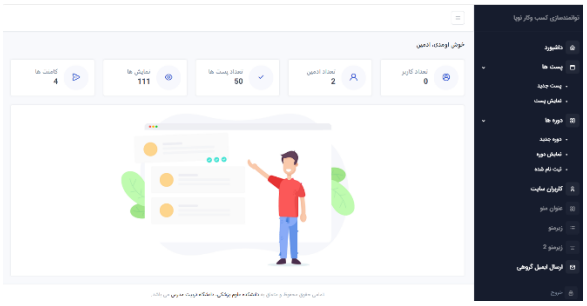

Fig 4: Dashboard of Empowering Start-up Businesses System

The additional features of the designed system include creating and editing personal profiles, returning to previous stages at any step, search functionality, settings, guidance, displaying and printing overall results, and alerts.

Phase 3: Evaluation

In Table 3, the severity of the designed system problems based on Nielsen's criteria is presented.

Table 3: Rating scale for severity level and range of severity categories

Category	Score	Average Severity	Definition
No problem	0	0-0.5	There is no problem
Cosmetic problem	1	0.6-1.5	No modification is needed unless the project has extra time
Minor problem	2	1.6-2.5	Fixing this issue is a low priority.
Major problem	3	2.6-3.5	Correcting it is important, making it a top priority.
Usability catastrophe	4	3.6-4	Fixing the problem is mandatory before product release.

The findings related to the Nielsen questionnaire are displayed in Table 4 In this study, the highest average severity of issues is associated with the "Error Prevention" and "Recognition over Recall" categories, while the lowest average severity of issues is related to the "Consistency and Standards" principle.

DISCUSSION

This study designed a system to empower startup businesses to evaluate digital health products in three phases (Fig 1). The system requirements were derived from the literature and experts' opinions. The system was designed, and validated based on these requirements, and evaluated using the Nielsen's questionnaire. The results showed that the system achieved a high level of accuracy and precision, as well as positive user satisfaction.

Table 4: Findings related to the Nielsen questionnaire

Items	The average severity scores
Viewing System Status: The system should always inform users of what is happening with accurate messages at the right time.	2.1
Consistency with the Real World: The system should communicate with the user in familiar words, phrases, and concepts instead of computer-oriented language.	1.2
User Control and Freedom: Users often make mistakes while interacting with the system and should be able to easily exit the current state by selecting the "Cancel" option without navigating through various pages.	2
Consistency and Standards: Users should not be in doubt about whether words, situations, or actions have the same meanings or not. Common principles should be applied.	0.9
Error Prevention: Error messages should be expressed in simple language and, along with a comprehensive description of the error, suggest helpful solutions. Conditions leading to errors should be eliminated, or errors should be checked, and the possibility of confirming any activity before its completion should be provided for the user.	3
Recognition over Recall: By presenting objects, actions, and options, the cognitive load on users' memory should be minimized. Users should not need to remember system information.	2.3
Flexibility and Efficiency of Use: The use of shortcuts accelerates the interaction for experienced users. The system should be designed to meet the needs of both expert and novice users. Users should be allowed to customize repetitive actions.	1.4
Aesthetic and Minimalist Design: Message boxes should not contain irrelevant and unnecessary information. The use of unnecessary information hinders the visibility of essential information.	1
Assistance to Users in Error Recognition, Identification, and Correction	1.8
Guide and Documentation: The guide should be easily searchable and user-focused, outlining the necessary steps to perform a task without being overly lengthy.	2

This study determined the information requirements and data elements for a system to empower startup businesses to evaluate digital health products in Iran. The essential data requirements and key functional modules for proper performance in information systems are user management, content management, content delivery, and content analysis [22]. These requirements were collected and prioritized using a mixed-methods approach that involved a literature

review, interviews, surveys, and focus groups with various stakeholders [23]. The study also presented a validated set of requirements for the system design based on the feedback from the related experts. The findings of this study are consistent with the previous studies that highlighted the importance of user-centered and participatory approaches for developing information systems [24-26]. However, various studies also identified some specific challenges and opportunities for content management systems in Iran, such as the lack of standardization, the diversity of user needs, the cultural and linguistic differences, and the legal and ethical issues [27-29]. These factors should be considered in the design and implementation of content management systems in Iran and other similar contexts.

The digital revolution in healthcare services has created a global business opportunity for startups specializing in digital innovations. These startups challenge the traditional healthcare service industry by introducing fundamental and sustainable innovations in the agile product development cycle and creatively acquiring resources from their networks [30]. However, the evaluation of information systems plays a vital role in ensuring the quality and effectiveness of these innovations. Unfortunately, many systems are accessible to the public without sufficient scientific efforts in their design, development, and evaluation. Disregarding the specific needs of users can lead to challenging learning experiences and improper system usage, ultimately resulting in the failure to achieve desired goals [31-33]. Moreover, health applications may jeopardize the privacy and security of consumer information [34-36]. Some of these applications lack evidence-based foundations or have low quality and were developed without careful consideration of user characteristics [37]. These challenges in program design and implementation can lead to the provision of incorrect information, consequently leading to inaccurate decision-making and unstable health outcomes [38, 39]. Incorrect medical recommendations provided by these systems can have harmful effects on consumers, as they may result in inappropriate or unnecessary care, leading to complications and other issues [39-41]. Therefore, designing high-quality health systems requires the use of evaluation criteria. It is necessary to establish a standardized and acceptable set of metrics and criteria for evaluating these systems.

Various methods have been proposed for evaluating health systems, each with different processes and capabilities [42-44]. The main goal of health system evaluation is to address existing issues in systems to optimize healthcare services and enhance decision-making at each level of the country's healthcare system [45]. For example, Logan et al. developed a new framework called mHealth index and navigation database (MIND) to evaluate mobile health programs based on various components such as accessibility, privacy and security, clinical aspects, interaction style, and collaboration capabilities [46]. Mathews et al. provided a scoring card in four dimensions: technical, clinical, cost, and usability for evaluating the digital health products of companies and startups [47]. They also emphasized the validation of standards, transparency, and objectivity of business products. In the current study, six evaluation criteria (i.e., satisfaction, interaction, clinical, technical, usability, and marketing) and evaluation frameworks were considered. The empowerment system attempted to incorporate these evaluation criteria into the Digital Health Products Assessment Library. The findings of this study reveal that the empowerment system successfully fulfilled most of the evaluation criteria, garnering positive feedback from experts. The system demonstrated its capability to offer personalized, evidence-based recommendations for enhancing users' health and well-being. It effectively supported users in setting and monitoring their health goals while providing pertinent information and resources. Its user-friendly interface and design facilitated easy interaction, ensuring a seamless experience. Importantly, the system adhered to privacy and security standards, safeguarding user data. With its potential to expand market share and increase revenue for digital health products, the system also held promise for enhancing the overall quality and efficiency of healthcare services.

The system designed in this study contributes to the advancement of digital health applications by providing a novel and innovative solution for empowering startup businesses to evaluate their products. The system addresses some of the challenges and gaps identified in the literature, such as the lack of knowledge, skills, resources, and support for conducting rigorous and credible evaluations of digital health products [48, 49]. The system also promotes the generation and dissemination of real-world evidence for digital health products, which is essential for their adoption and implementation in the health care system [50]. It has the potential to enhance the quality, validity, and impact of digital health products and their evaluations, as well as foster a culture of learning and improvement among the startup community.

The implications of this paper are significant for both researchers and practitioners in the field of digital health. For researchers, the study provides a new perspective and a comprehensive model for evaluating digital health products, which could be further refined and extended to cover other aspects and dimensions of quality and usability. For practitioners, especially start-ups, the study offers a practical and user-friendly tool that can help them assess and improve their products and enhance their

competitiveness and credibility in the market.

CONCLUSION

This study provided a novel and comprehensive system for assessing the quality and usability of digital health products, especially for startup businesses that lack the resources and expertise to conduct formal evaluations. The evaluation results showed that the system met the standards of quality and efficiency, and it supported startups in improving their products and documenting their progress. The system also had the potential to enhance the competitiveness of the digital health market nationally and internationally, as it aligned with the principles of evidence and research and development. The generalizability and scalability of the system may be affected by the diversity and complexity of the digital health products and their evaluation contexts. The system may also require continuous updating and maintenance to keep up with the rapid changes and developments in the digital health field. Future studies could explore the long-term effects and outcomes of the system on startup businesses and their evaluation practices, as well as the feasibility and sustainability of the system in different settings and scenarios.

AUTHOR'S CONTRIBUTION

All authors contributed to the literature review, design, data collection and analysis, drafting the manuscript, read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this study.

FINANCIAL DISCLOSURE

No financial interests related to the material of this manuscript have been declared.

ETHICS APPROVAL

This work was a part of a Master of Science thesis approved by the ethics committee of Tarbiat Modares University (No: IR.MODARES.REC.1402.016).

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