Journal of Health Informatics in Africa

12th Health Informatics in Africa Conference (HELINA 2019)
Peer-reviewed and selected under the responsibility of the Scientific Programme Committee

Assessing Users Involvement in Analysis and Design Tasks of Electronic Health Information Systems: Experiences, Challenges, and Suggestions to Optimise Involvement

Christine Kalumera Akello[a], Francis Fuller Bbosa[b], Josephine Nabukenya[b*]

[a]Gulu University, Gulu, Uganda
[b]School of Computing & Informatics Technology, Makerere University, Kampala, Uganda

Background: User requirements play a vital role in the development of usable EHIS. For developers to design better quality, relevant and safer EHIS that meet user needs, they are required to actively engage stakeholders especially in the analysis and design tasks of its development life cycle. This is because they provide context appropriate solutions based on their needs. However, in most cases developers ignore health stakeholders' input especially during these tasks due to varying perspectives and expectations, complexity, high cost, and variability in time to complete the tasks. This has resulted into various challenges including difficulty in capturing and interpreting user requirements in an effective and efficient manner, poorly designed and unusable systems, unsatisfied user needs, and high maintenance costs. This study thus aimed at assessing users' involvement in the analysis and design tasks when developing EHIS with a view to understand their experiences, challenges, and suggestions to optimise their involvement.
Methods: We employed a cross-sectional survey to investigate and describe the level of user involvement and challenges faced in the analysis and design tasks of the EHIS development process. A total of 36 health practitioners from 13 Key health institutions located in Uganda were selected as respondents.
Results: The study revealed that majority of the respondents was involved in EHIS development, with a few involved at analysis and design tasks. Increased costs associated with data collection, followed by lack of consensus in clarifying, articulating and defining user requirements were recorded as the biggest challenges faced by users at requirements gathering, analysis and system design tasks. Regards suggestions to optimising users' involvement in EHIS development tasks, the study reported that users were very much interested in being involved at all tasks of EHIS development, and consultation of users was paramount in order to incorporate all their needs in EHIS.
Conclusions: The results from the study demonstrate the value of user involvement at the analysis and design tasks of EHIS development cycle. User involvement offers benefits in form of reduction in costs, improved productivity due to users easily arriving at a common consensus and positive growth in user attitudes. The researchers intend to incorporate suggestions that emerged from this study to conduct long-term evaluations of existing EHIS and investigate how users' involvement changes over time.

Keywords: Keyword: Human Centred Design/User Centred Design, User involvement, User stories Analysis and Design

*Corresponding author: josephine@cit.ac.ug, Makerere University, School of Computing and Informatics Technology, P.O. Box 7062, Kampala, Uganda
 J Health Inform Afr. 2019;6(2):1-10. DOI: 10.12856/JHIA-2019-v6-i2-221

1 Introduction

In recent years, many countries have adopted Electronic Health Information Systems (EHIS) with the aim of replacing existing paper-based patient records with electronic information systems to enable better integration, sharing of information, and smoother collaboration amongst different healthcare providers [1]. EHIS have been critically acclaimed for their ability to increase legibility, reduce medical errors, shrink costs and boost the quality of healthcare [2]. An Electronic Health Information System refers to a digital collection of patient information or a computer managed health information system [3] that is designed to improve the quality of healthcare, efficiency, diagnosis, and treatment as well as safety of patients [4], through processing data and knowledge in the health sector environment [2]. It encompasses a wide range of products and services designed to collect, store, exchange and use patient data throughout the clinical practice of medicine for communication and decision-making; examples include; electronic medical records, electronic health records, clinical decision support, computerised physician order entry, administrative, laboratory and radiology health information systems [5].

EHIS development process goes through different iterative tasks of the System Development Life Cycle (SDLC). The first three tasks (user stories collection/requirements gathering, analysis and design) involve identifying and interpreting user requirements in a much more clearer and understandable form [6]. Gathering system requirements and interpreting these requirements, requires one to take into consideration many things including; user needs, user perspectives, available resources, and the budget. This is because if requirements are wrongly specified or interpreted in an ambiguous, incorrect or not complete format from the start, then the developed system is at risk of not working to the expectation of the targeted user. Active user engagement and ownership is very vital for the success of many designed EHIS and tech-enabled projects; this is because they provide context-appropriate solutions based on their needs [7], which leads to better quality, relevant and safer devices that meet users' needs [4] foster ownership [8] successful implementation and quality of the product [4]. However, there still exists a huge disparity between the way developers and stakeholders of the designed health information systems artefacts regard user involvement.

In information systems discipline, the notion of *user involvement* is generally described as the participation of potential users or representatives in the system development process [9]. It is largely related to user perception of system usefulness, which tends to create a sense of ownership and more positive attitude towards computer systems [10] [11]. In most cases developers ignore stakeholders' input, especially during the analysis and design tasks [4] , due to complexity, high cost and variability in time to complete tasks [12] [13]. To a large extent this has contributed towards miscommunication, misunderstanding as well as conflicts between users and the development teams, difficulty in translating user stories into design specifications and time wastage [14] [15]. Consequently, many developers design systems that lack clarity on who the users of the system are, what they need or how their needs differ [16]. As such, many of these poorly designed systems are abandoned by the target users because of their ineffectiveness in meeting user needs [12], limited interoperability [17], and also have other challenges including; 80% of high maintenance costs [18], errors, that could cause patient harm and death [19] [20]. This partly explains why only 61% of the designed systems meet the requirements specifications of the users, and 63% of the design projects surpass their estimated budgets [21].

To avoid such pitfalls, [22] suggests that developers should employ the Human Centred Design (HCD) approach also known as User Centred Design (UCD) approach. *User/Human Centred Design* (UCD/HCD) is an interactive approach to system development that involves studying, understanding and considering user perspectives in all the design tasks and iteratively developing products that works for the intended end users [10] [23] [24]. Additionally, the World Health Organisation (WHO) strongly encourages use of HCD/UCD approach when designing EHIS (UNICEF Designing Digital Interventions for Lasting Impact). This is because this approach follows global principles for digital development (digitalprinciples.org). Among these principles is "design with the user" and "be collaborative" [25] [26] as described in the WHO *collaborative requirements development methodology*. According to [24], *users* can be divided into three broad, categories; these include primary users (person(s) who will regularly use the artefact), secondary user (person(s) who will only occasionally use the artefact), and tertiary user (person(s) who will be affected by the use of the artefact). Examples of users in the health systems include; patients, former patients, care takers, medical device users, advisors, participants, consultants, co-producers, healthcare professionals, community leaders, general public, ultimate end users and

organizations with health interest or a specific disease [27] [28] and the power they have over the proposed system range from vendors, policy makers, professionals, to data entry personnel [29].

Following the UCD/HCD approach, during *user stories collection/requirements gathering* phase, users define the system in more detail with regard to its inputs, processes, outputs, and interfaces. Users specify requirements including; key system functionalities, identify the kind of test to be performed, define test procedures or use cases to be used in testing, and traceability back to the requirements [30], to a level of detail sufficient for systems design to proceed. In the *Analysis* phase, users ask themselves three major questions; how does the current system work, what do the users want, and what recommended solutions can work for these users [31]. The phase is therefore important in determining what business needs exist, as well as how they can be met, who will be responsible for individual pieces of the project, and what sort of timeline should be expected. The core activity at this phase is to understand the requirements of the users of the product and to come up with a design that is easily acceptable to the users [32]. While in the *design phase*, end users discuss and determine their specific business information needs for the proposed system [33] as well as consider the essential components, structure, processing and procedures for the system to accomplish its objectives. The necessary specifications, features and operations that will satisfy the functional requirements of the proposed system are identified.

In using the UCD/HCD approach, several *benefits* are advanced to the users. For instance, EHIS developed using this approach, appeals to a wide array of customers, because before proceeding to another phase, all user groups have to be satisfied with the requirements made [34]. Furthermore, user involvement helps designers to manage users' expectations of a new product. When users have been involved in the design of a product, they know from an early stage what to expect from a product and they feel that their ideas and suggestions have been taken into account during the process [10]. This leads to higher customer satisfaction, smoother integration of the product into the environment and a sense of ownership for the final product [35]. User involvement helps the system developers to get fast and easy methodologies of designing and validating the system functionality. System developers can assess and certify data from the secondary sources to identify users' requirements, and thus apply a more appropriate methodology [10].

Notwithstanding the above benefits for users' involvement in the UCD/HCD approach, the users still face various challenges. One of the major challenges of the UCD/HCD is that users with negative attitudes will resist the implementation of the new system or changes in existing system. Others may pose unrealistic expectations from the system [36]. Some users may not wish to participate or get involved in the project while others may not have the right attitude to the workplace thereby causing behavioural problems and ultimately causing delays in the project delivery timelines [37]. Involving users in the development of information systems always requires more time for proper engagement, extra work and also attracts additional costs because of the larger resulting project teams [38]. Effective incorporation of user participation in the design process is also among the challenges. Determination of which voices will be heard and how the users' preferences will be reflected in the design is a values-based decision and is rarely easy [39]. Along with the issue of who gets to participate comes the issue of how to recruit users who will represent the potential target user groups appropriately when those groups are very large or very diverse. When user participation is limited to only a certain stage, the users' role will end up being that of information providers rather than co-designers of the project. [4], asserts that the highest participation rate of users in the four-stage development of the HIS was related to the implementation phase and the lowest participation rate was related to analysis. The study further reveals that established teamwork from end-users and the support of top managers from HIS development as the most important factors in increasing user participation. This calls for the need to focus on the other three stages of EHIS designing, that is, requirements gathering, analysis and design. Further still, [12] also observed that there is limited appreciation of users' input in healthcare system development. Their findings indicate that 60% of the users believed that designers and developers of the system ignore their views and 22% asserted that their recommendations were not applied when modifying the system. This explains the low level of participation of users in the design and evaluation stages. The study recommended that communication between the end users and developers should be improved and better methods for healthcare IT development should be devised. Lastly, a study on user involvement in the co-design of self-care support systems for heart failure patients by [40], revealed that there is a difference between users who work in an organizational setting and users who are patients. Patients as users provide comprehensive ideas that can be used to improve care of other patients in future. However, there is need to explore co-design with the

users, so as to approve the ideas that patients have apparent during their encounter with the system, as well as find a balance between a situation understanding of users and the developers.

Given the above benefits and notwithstanding the various challenges faced by the users involved in the UCD/HCD approach in designing EHIS, currently in Uganda's health sector, various users are not involved in the first three tasks of the EHIS development process. To this end, this research sought to establish the magnitude of users' involvement in the user stories collection/requirements gathering, analysis and design tasks when developing EHIS with a view to understand their experiences and the challenges that impede their involvement, as well as to propose suggestions to optimise their involvement

2 Materials and methods

The Cross-sectional survey was used for data collection because it was found to be more suitable in describing the current level of user involvement in the user stories analysis and design tasks of EHIS development, as well as establishing the challenges that impeded users from being adequately involved in these tasks. *Cross-sectional survey* is a method that is used to collect data at a particular point in time [42] [41].Particulary we used the survey questionaires to investigate the level of user involvement in the EHIS development process.

Questionnaire design: All the three authors participated in designing the questionnaire. The design of the questions was based on the review of literature on the challenges of user involvement in analysis and design tasks [37] [21]. Both close-ended and open-ended questions were developed. The questions had two major sections. Section A required the respondents to provide information on the organisation, its location, title of respondent at the organisation, size of organisation. Section B mainly focused on user experience on the different EHIS used in their organisation, how it was acquired, whether the design of the EHIS or not, how they were involved at the different tasks, the challenges they faced in using the systems while not involved in its development. The respondents were also asked to suggest ways in which they would like to be involved in the user stories analysis and design tasks, how they would like to be involved in EHIS development and in what tasks they would like to be involved mostly. A pre-test was first done on the questionaires to verify if they accurately reflected the area of interest, and thereafter questions were futher simplified to make it easily understandable and acceptable to the target respondents.

Sample size: Uganda was used as our case study to better understand the problem under study. A total of 36 health-practitioners were purposively selected from 13 key health institutions located in the Northern and Central regions of the country, that is, Gulu and Kampala, respectively. The limited number of health institutions using EHIS in Uganda, coupled with time and cost constraints informed the rationale for purposive sampling. The roles of the respondents ranged from biostatistician, counsellors, data clerks, health information systems specialist, lab technicians, clinicians, nurses, quality control officers, to monitoring and evaluation officers.

Inclusion Criteria: This study was restricted to medical practitioners' who either used the EHIS on a daily basis or were in charge of developing or monitoring the EHIS.

Data collection: A self-administered questionnaire was sent to respondents. A 95% response rate was achieved. The questionnaire gathered background information about their places of work, their experience while using EHIS as well as their involvement in the EHIS development process.

Data analysis: The raw data transcribed on hard copy questionnaires was entered into Microsoft Excel templates. From Microsoft Excel, data cleaning was undertaken to validate and verify all the collected data. All outliers or missing information were dropped from the final dataset and used for analysis. The raw data was exported to Stata 14 for analysis. Descriptive statistics were then generated using Stata to come up with the summary tables and graphs.

3 Results

3.1 Background characteristics of respondents' institutions

The researchers collected information about the background characteristics of the respondents' institutions. Respondents from AcholiRhites, Gulu Regional Referral hospital and Infectious Diseases Institute accounted for 25%, 22.2% and 19.4% of the respondents, respectively. In terms of size of the organisation, at least 72% of the respondents were from health organisations that employed at least 50 people. Most (38.89%) of the respondents were data clerks. The nurses and HIS Specialists at 19.44% and 13.89% followed the data clerks, respectively. The most commonly EHIS used by respondents' organisations were Open EMRS (44%), Integrated Clinical Enterprise Application (ICEA)(19%)-an in-house developed system at Infectious Diseases Institute, DHIS2 (19%), HMIS (3%), MTRACT (14%). Furthermore, respondents were asked how their respective institutions acquired the EHIS. 44.44% of the respondents mentioned that they were designed in house; the vendors' designed 13.89% and 41.67% mentioned other sources.

3.2 Extent to which the users were involved in the EHIS development

Respondents' were asked to state the magnitude of their involvement in the development of EHIS at their respective institutions. Overall, 47% of the respondents were never involved in EHIS development. Among those that were involved, majority of respondents were involved at the implementation task (52%) with only 31%, 22% and 22% being involved at the requirements gathering, analysis and design tasks of the EHIS development cycle respectively. For those that were involved, the breakdown of the tasks at which they were involved is illustrated in figure 1.

Figure 1 below shows that the majority of respondents (52.78%) participated in the implementation task of the EHIS development whereas the least participation rate was recorded at the analysis and design tasks. This agrees with the findings of [4], who revealed that the highest and lowest participation rate of users in the four-stage development of the EHIS was the implementation and analysis stages respectively. [4] attributes this low level of involvement in the analysis and design tasks to the complexity, high cost and variability of time to complete the tasks.

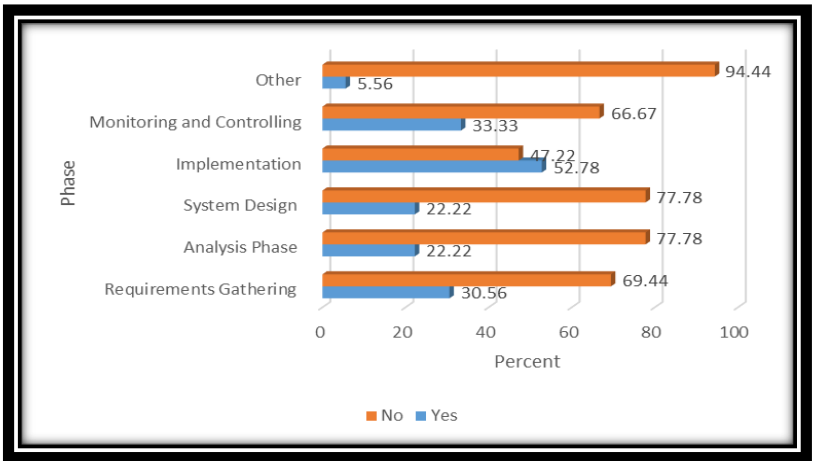

Figure 1. Respondents involvement in the EHIS by Task

3.3 Challenges faced by Users when not involved in the EHIS development at various phases/tasks

The researchers asked respondents about the challenges they faced when not involved in the EHIS development process. Figure 2 below shows that increased costs was recorded as the biggest challenge

faced by users at the requirements gathering, analysis and system design tasks at 67%, 44% and 56% respectively. Increased costs referred to the process of data collection in that it requires a lot of resources and a lot of time wasted in transcribing, coding and analysing the narrative of different stakeholders. This was followed by lack of consensus in capturing, clarifying, articulating and defining user requirements due to the communication gap between the users and developers at 54%, 38% and 38% respectively. This results in inadequate initial analysis of user requirements [43].

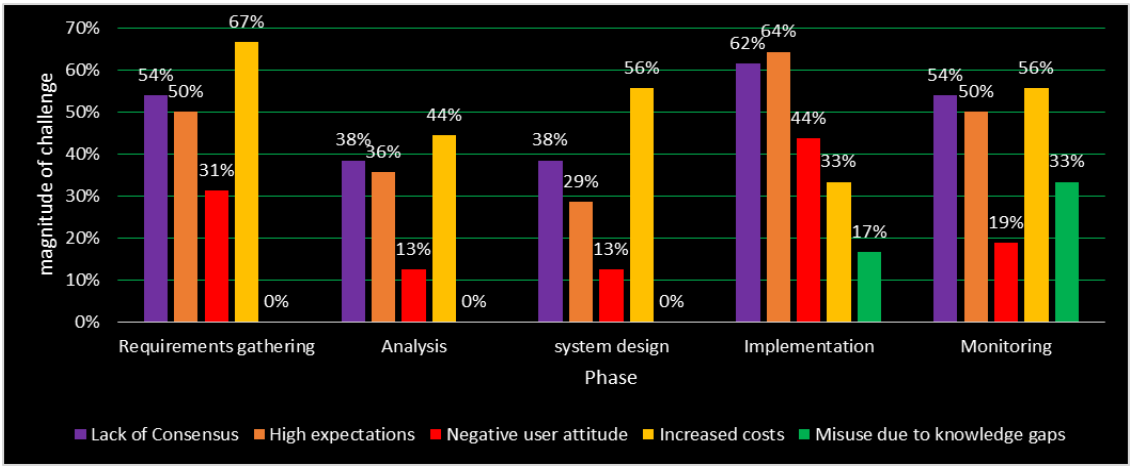

Figure 2. Breakdown of challenges encountered at various tasks of the EHIS development cycle

The above findings are emphasized by several scholars such as [10] who asserts that user involvement helps designers to manage users' expectations of a new product; and [37] who revealed that some users may not have the right attitude to the workplace thereby causing behavioural problems and ultimately causing delays in the project delivery timelines.

3.4 Suggestions to address the challenges and how users wanted to be involved in future EHIS project development

Respondents were asked to make suggestions for addressing challenges faced when not involved in the EHIS development process and how they would like to be involved in future EHIS development projects. The biggest percentage mentioned that they would like the users to be involved at all tasks of the EHIS development, that is, from the initial stage to the final stage (27.78%); these were closely followed by those that mentioned that consultation of users is paramount so as to incorporate all their needs in the EHIS (22.22%). Figure 3 below shows the respondents suggestions.

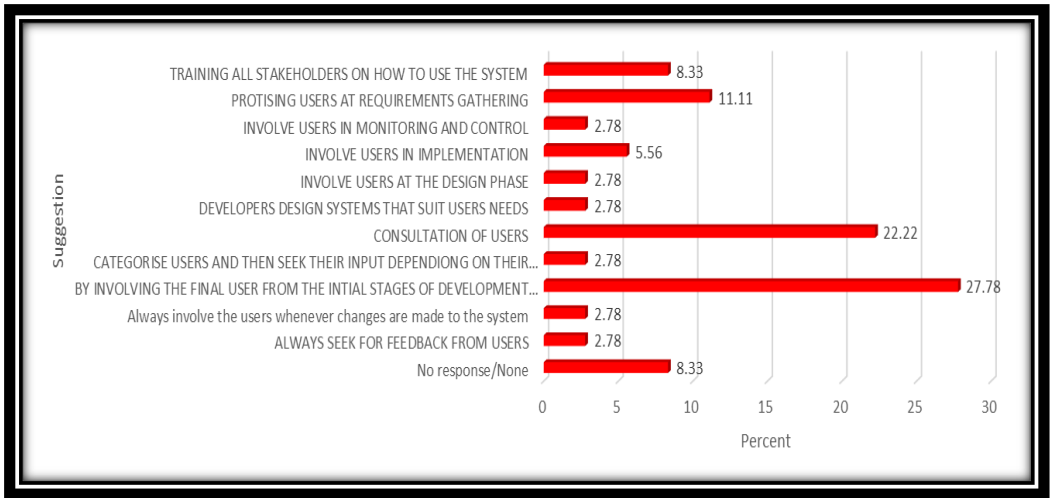

Figure 3. Suggestions to address the challenges in figure above

Furthermore, respondents were asked at what stage of EHIS development they would like to be involved in. Findings revealed that most users (80.56%) would prefer to be involved at the requirements gathering task. This is emphasized by [43] [6] [21], who reveal that system requirements gathering is one of the most ignored tasks by system developers. The fact that the design task attracted the least number of user preference for involvement at 41.67%, is further a testimony to findings from [21] study, which show that unsatisfactory initial analysis of the user requirements by the developers explains why only 61% of systems designed meet the requirements specification of the users.

4 Discussion

From the results above, we observe that the analysis and design tasks are very vital for transcribing user stories into actual system requirements to satisfy user needs. The fact that user involvement in the analysis and design tasks was very low (22.2%), compared to implementation tasks (52.7%), confirms the assertions made by [4] [13], that developers ignore user inputs and design systems that lack clarity on who the users of the system are or how their needs differ [16]. This finding prompted the researchers to question where developers obtain requirements used for designing EHIS systems.

On the issue of challenges faced, 44% of the respondents mentioned that, they were unsatisfied with the current EHIS systems, because they negatively affected their efficiency and effectiveness in work tasks [12]. For example, they wasted a lot of time in trying to access and understand the system functionalities, hence they preferred to use alternative means to achieve their work tasks. Our finding concurs with explanations made by [44] that inadequate initial analysis of user requirements, makes developers design systems that do not cater for user needs [16]. This explains why only 61% of the designed systems meet the requirements specification of the users [21], and why target users abandon 63% of such systems [12].

Further more, based on our findings, there seemed to be an interesting linkage between user involvement in the different EHIS development process and the challenges faced when users are not fully involved in these tasks. The respondents felt that their ideas should be included in all the tasks of EHIS process development, because besides being well acquainted with the business process operation of these health facilities, they were the actual users of these systems. However to their dismay, only small portions of their ideas were actually included in the EHIS design. As such their limited involvement in these tasks led to challenges such as lack of consensus, high expectations of the product, poor/negative user attitude, increased costs and misuse due to knowledge gaps towards the poorly designed EHIS [12].

To address the above challenges, respondents presented the following suggestions; their views should always be considered in all tasks of EHIS process development, feedback from users on the performance of current system, should be considered before designing new ones, prioritise user requirements and provide more training to enlighten them on how to use systems, where they were not involved in the

process development, so that they can optimise its use. This study aims to incorporate these suggestions to investigate how user involvement can be optimised in the analysis and design tasks in the development of EHIS, to design better quality, relevant and safer devices that meet users' needs to improve efficiency and effectiveness in the delivery of services as well as to avoid future errors that could cause patient harm and death [4] [7] [8].

5 Conclusion

In this paper the authors investigated the extent to which users were involved in the analysis and design tasks of the electronic health information systems development process and challenges associated with not involving them. Results show that only 22% of users were involved at the analysis and design tasks. Additionally, the biggest challenges faced at these tasks were increased costs, lack of consensus and high expectations. These were recorded at 44% and 56%; 38%; as well as 29% and 36% respectively. To address the above drawbacks, the researchers intend to incorporate the suggestions that emerged from this study to conduct long-term evaluations of existing EHIS and investigate how users' involvement changes over time. In conclusion, despite evaluating a pilot study, the authors feel that the results provide strong justification for the concept of optimising users' involvement at the analysis and design tasks in the development of electronic health information systems following the UCD/HCD approach.

Acknowledgements

We acknowledge the support from African Development Bank (ADB-HEST project in Gulu University) and Makerere University.

References

[1] Kaipio J. Usability in Healthcare: Overcoming the mismatch between information systems and clinical work. Dissertation. Alto University; 2011
[2] Ngafeeson, Madison N. Healthcare information systems opportunities and challenges. In Encyclopedia of Information Science and Technology, Third Edition, pp. 3387-3395. IGI Global, 2015.
[3] Zhang J, .Human-centered computing in health information systems: Part 2: Evaluation. Journal of Biomedical Informatics. 2005; 38(3), 173–175.
[4] Rahimi B, Safdari R, Jebraeily M. Development of hospital information systems: User participation and factors affecting it. Acta Informatica Medica. 2014 Dec; 22(6):398-401.
[5] Wardlaw JC. *Introducing User-Centred Design: A Longitudinal Study of a Healthcare Informatics Organisation* (Doctoral dissertation, UCL (University College London)). 2016.
[6] Parveen N, Beg R, Khan MH. Integrating security and usability at requirement specification process: International Journal of Computer Trends and Technology. 2014 Apr;10(5):236-40.
[7] USAID (2018). Feed the future. The US government's global hunger and food security initiative.https://www.ictworks.org/wp-content/uploads/2018/04/Programming-Toolkit-Digital-Tools-for-Agriculture.pdf from: http://www.comminit.com/usaid/content/digital-tools-usaid-agricultural-programming-toolkit.%20acssed%20on%2011/21/2018 acessed on 11/21/2018 at 4:38pm
[8] Saliba V, Legido-Quigley H, Hallik R, Aaviksoo A, Car J, McKee M. Telemedicine across borders: a systematic review of factors that hinder or support implementation. International journal of medical informatics. 2012 Dec 1;81(12):793-809. https://www.ncbi.nlm.nih.gov/pubmed/22975018
[9] Barki, H., & Hartwick, J. (1989). Rethinking the concept of user involvement.*MIS Quarterly* Vol. 13, No. 1 (Mar., 1989), pp. 53-63. https://www.jstor.org/stable/248700?seq=1#page_scan_tab_contents
[10] Sun Z. User involvement in system development process. In Proceedings of the 2nd International Conference on Computer Science and Electronics Engineering 2013 Mar 3. Atlantis Press.
[11] Bano M, Zowghi D. User involvement in software development and system success: a systematic literature review. In Proceedings of the 17th International Conference on Evaluation and Assessment in Software Engineering 2013 Apr 14 (pp. 125-130). ACM.
[12] Martikainen S, Viitanen J, Korpela M, Lääveri T. Physicians' experiences of participation in healthcare IT development in Finland: willing but not able. International journal of medical informatics. 2012 Feb 1;81(2):98-113. https://doi.org/10.1016/j.ijmedinf.2011.08.014

[13] Gustafson Jr DH, Maus A, Judkins J, Dinauer S, Isham A, Johnson R, Landucci G, Atwood AK. Using the NIATx model to implement user-centered design of technology for older adults. JMIR human factors. 2016;3(1):e2.
[14] Ratwani RM, Savage E, Will A, Arnold R, Khairat S, Miller K, Fairbanks RJ, Hodgkins M, Hettinger AZ. A usability and safety analysis of electronic health records: a multi-center study. Journal of the American Medical Informatics Association. 2018 Jul 2;25(9):1197-201.
[15] Dwivedi MS, Upadhyay MS, Tripathi MA. A working framework for the user-centered design approach and a survey of the available methods. International Journal of Scientific and Research Publications. 2012
[16] Money AG, Barnett J, Kuljis J, Craven MP, Martin JL, Young T. The role of the user within the medical device design and development process: medical device manufacturers' perspectives. BMC medical informatics and decision making. 2011 Dec;11(1):15. https://doi.org/10.1186/1472-6947-11-15
[17] Furukawa MF, King J, Patel V, Hsiao CJ, Adler-Milstein J, Jha AK. Despite substantial progress in EHR adoption, health information exchange and patient engagement remain low in office settings. Health Affairs. 2014 Aug 7;33(9):1672-9.https://doi.org/10.1377/hlthaff.2014.0445
[18] McCurdie T, Taneva S, Casselman M, Yeung M, McDaniel C, Ho W, Cafazzo J. mHealth consumer apps: the case for user-centered design. Biomedical instrumentation & technology. 2012 ;46(s2):49-56.
[19] Thilo FJ, Hürlimann B, Hahn S, Bilger S, Schols JM, Halfens RJ. Involvement of older people in the development of fall detection systems: a scoping review. BMC geriatrics. 2016 Dec;16(1):42.
[20] Elkin PL. Human factors engineering in HI: so what? who cares? and what's in it for you?. Healthcare informatics research. 2012 Dec 1;18(4):237-41. https://doi.org/10.4258/hir.2012.18.4.237
[21] Teixeira L, Ferreira C, Santos BS. User-centered requirements engineering in health information systems: A study in the hemophilia field. Computer methods and programs in biomedicine. 2012 ;106(3):160-74.
[22] Schnall R, Mosley JP, Iribarren SJ, Bakken S, Carballo-Diéguez A, Brown III W. Comparison of a user-centered design, self-management app to existing mHealth apps for persons living with HIV. JMIR mHealth and uHealth. 2015;3(3):e91. DOI:10.2196/mhealth.4882
[23] Ghazali M, Ariffin NA, Omar R. User centered design practices in healthcare: A systematic review. In 2014 3rd International Conference on User Science and Engineering (i-USEr) 2014 Sep 2 (pp. 91-96).
[24] Marty PF, Kazmer MM. Involving users in the co-construction of digital knowledge in libraries, archives, and museums. Johns Hopkins University Press; 2011.
[25] UNICEF. (2018). Designing Digital Interventions for Lasting Impact. Retrieved from https://www.unicef.org/innovation/sites/unicef.org.innovation/files/2018-11/unicef_digitalhealthinterventions_final2018.pdf
[26] Waugaman A. From principle to practice: implementing the principles for digital development. Proceedings of the Principles for Digital Development Working Group. 2016:4.
[27] Ghulam Sarwar Shah S, Robinson I. User involvement in healthcare technology development and assessment: structured literature review. International Journal of Health Care Quality Assurance. 2006 Oct 1;19(6):500-15. https://www.ncbi.nlm.nih.gov/pubmed/17100220
[28] Lindenmeyer A, Hearnshaw H, Sturt J, Ormerod R, Aitchison G. Assessment of the benefits of user involvement in health research from the Warwick Diabetes Care Research User Group: a qualitative case study. Health Expectations. 2007 Sep;10 (3):268-77. https://doi.org/10.1111/j.1369-7625.2007.00451.x
[29] Beaumont R. Developing Information Systems: Getting the users involved. From https://www.floppybunny.org/robin/web/virtualclassroom/chap12/s4/des2Retrieved November 29, 2018,
[30] System Development Life Cycle Framework Guide. 2006 http://library.state.or.us/repository/2009/200906081134261/index.pdf
[31] Balaji S, Murugaiyan MS. Waterfall vs. V-Model vs. Agile: A comparative study on SDLC. International Journal of Information Technology and Business Management. 2012 Jun 29;2(1):26-30.
[32] Durrani MY, Ali A, Majid H, Farid S. Importance Of Requirement Gathering And User Involvement in Designing A Software Product: A Case Study Of A Small Scale Project. Science International. 2016 Jan 1;28(1).
[33] Ralph P, Wand Y. A proposal for a formal definition of the design concept. In Design requirements engineering: A ten-year perspective 2009 (pp. 103-136). Springer, Berlin, Heidelberg.
[34] Kautonen H, Nieminen M. Conceptualising benefits of user-centred design for digital library services. Liber Quarterly. 2018 Apr 23;28(1). https://www.liberquarterly.eu/articles/10.18352/lq.10231/
[35] Yvonne R, Helen S. Interaction design: beyond human computer interaction). New York. John Wiley & Sons, Inc. https://arl.human.cornell.edu/879Readings/Interaction%20Design%20-%20Beyond%20Human-Computer%20Interaction.pdf
[36] Palanisamy R. Empirically testing the relationships between user involvement, information waste, and mis success. Journal of Services Research. 2001 Apr 1;1(1).

[37] Wagner EL, Newell S. Exploring the importance of participation in the post-implementation period of an ES project: a neglected area. Journal of the Association for Information Systems. 2007;8(10):32.
[38] Vadapalli A, Mone MA. Information technology project outcomes: user participation structures and the impact of organization behavior and human resource management issues. Journal of engineering and technology management. 2000 1;17(2):127-51. https://doi.org/10.1016/S0923-4748(00)00018-7
[39] Baek EO, Cagiltay K, Boling E, Frick T. User-centered design and development. Handbook of research on educational communications and technology. 2008;1:660-8.
[40] Aidemark J, Askenäs L, Nygårdh A, Strömberg A. User involvement in the co-design of self-care support systems for heart failure patients. Procedia Computer Science. 2015 Jan 1;64:118-24.
[41] Jesson J. Cross-sectional studies in prescribing research. Journal of clinical pharmacy and therapeutics. 2001 Dec 31;26(6):397-403.
[42] Neil J.Salkind. Exploring Research, 6th Edition, Pearson International Edition. 2006
[43] Abugabah AJ, Alfarraj O. Issues to consider in designing health care information systems: A user-centred design approach. Electronic Journal of Health Informatics. 2015 May 8; 9(1):8.