Adoption and Implementation of Health Information System in Limited Resource Setting: A Survey on User Experience Perspective

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ABSTRACT---- ***Understanding the situation is essential to bring sustainable health information system. It helps to get the detail of the context, methods of communication, and tools experienced that will ensure the sustainability and the success rate of information system. In principle, information system projects involve users and collaborate with stakeholders throughout the design process such as requirement gathering, requirement specification, implementation and design, testing, training and so on. Most of information system projects in developing countries face a difficulty of getting appropriate user requirement and engagement This results in degrading the success rate and create fragile information system. An assessment review of the Ethiopian Health Information System (EHIS) noted that only 52% of the components (such as infrastructure, information policy, data sources and so on) were present and the health information system struggles with poor data management, system resources, dissemination and use of information system. However, inadequateness and the fragility of the system mainly arise from lack of appropriate user involvement and requirement. User experience design has been known to create an influence and increase level of participation in the process, but not fully explored in the fragile system and low resource setting scenario. The story of health information in low resource setting is examined. User experience design and participatory design model is proposed as a solution to outline critical issues and mode of communication to increase the success rate of health information system adoption and implementation.***

Keywords---- Health Informatics, User Experience Design, Fragile System, Participatory Design, Health Information System, Health System Adoption and Implementation

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1. INTRODUCTION

Information system simplifies and facilitates the interaction of activities. It supports the coordination and interaction of hardware, software, data, people and process to collect, analyze, store and disseminate useful data or information (Bourgeois, D. T., 2014).

Nowadays, organizations in the developed world are using information systems in a very efficient manner compared to those organizations found in developing countries. Organizations in developing countries are not using information system in its fullest potential due to cost, weak infrastructure, poor data management and system resources and so on The main reason is that the step that they follow during the development of information system neglects the participation of end users. It's important to explore the information system cases in developing countries to reduce the chasm between the design ('designer') actuality gaps by considering the country context and hard-soft copy gaps (Ric`hard Heeks, 2002).

Active participation and involvement of end users in the process of software development are crucial for efficient and successful computer information system (Abelein, U., & Paech, B. (2013, 12)). User experience participatory design emerged to advocate the active involvement of end users in the need assessment, design and decision making process so as to improve and ensure elicitation of stakeholders need, usability and success rate of projects (Simonsen, J., & Robertson, 2013).The strategy to apply participatory design is to see, move and again see. In the design, we need to identify when the participant is better to answer, what type of user should be included in the participation, how to measure participation, and how do they influence to ensure the success rate of the design ((Goldstein, H., 1985), (Bratteteig, T., & Wagner, I, 2012)). By doing this, we assure the importance of participatory design in decision making through creating choices, selecting among them, concertizing choices, and evaluating the choices and the design result to ensure the sustainability of the project (Bratteteig, T., & Wagner, I. , 2014). Bratteteig, T., & Wagner, I. have recommended different methods of participation to share the decision process and power. However, if the system is fragile, it's difficult to make sustainable decisions. Some of the information systems that have been developed are fragile

and its fragility can arise from the technological artifact (hardware and software), but also it can arise from the methods, models, and structures used in the development and management of Information Systems ((Gorgeon, A., 2015), (Hole, K. J., 2016)). The success and failure of an information system arise not only from the shallow consideration of IT artifact, but also limited exploration of public sector organizational context (Dwivedi, Y. K et al, 2014).

The fragility of the existing information system in low resource setting starts from requirement specification to implementation and testing. The development of health information system projectaces a number of problems such as a) stakeholder changes their mind frequently during the course of action, b) the end users are not willing to speak up, c) conflicting priorities of stakeholder, d) inability to identify their needs clearly and so on. The collaboration of university and industry linkage is not as expected. For instance, Ethiopia has a collaborative PhD program in Information System which was started in 2008 , but have scarcity of resources and more than 20 universities throughout the country provide computing undergraduate training and some universities start graduate trainings recently (Negash, S, 2012). However, poor univerisityindustry linkage set-up, lack of resources and infrastructure in the organization, cultural constraints, and deficiencies in the law and infrastructural and low standards of social performance are the major constraints that affect the success of an information system project (Simonsen, J., & Robertson, 2013).

We are interested to examine the constraints that hinder health information system adoption and implementation through user experience design and participatory point of view and propose a model that would be helpful to facilitate the sustainable growth of software industry in low resource settings.

2. RELATED WORK

The penetration of health information is very low in developing countries due to cost, infrastructure, and lack of comfort among health workers with electronic medical records (Akanbi et al, 2012). A cross sectional study of three Ethiopian hospitals reveals 54.1% of health professionals were ready to use health information system platform and points out increasing awareness, knowledge and skills of the professional are very important (Bruk et al, 2014). Though the progress of health usage is promising, there is still a challenge in balancing ownership and technical support in the implementation of health management information system (Feysia et al, 2012). It requires proper engagement and involvement of health professionals to facilitate the adoption and design of health management information system.

Health information systems program participatory design within the HISP network has made great efforts to fill the gaps. It has more than 15 years proven story in developing countries like South Africa, Cuba, India, Mozambique, Sierra Leone, Kenya and so on. The HISP network tried to build DHIS (District Health information System) using participatory design (PD)to provide generic and flexible country based data warehouse to address the local and national needs. The DHIS platform used for "data collection, validation, analysis and presentation of aggregate statistical data, tailored to supporting integrated health information management activities". The platform has made an improvement from the MS Access platform (V1) to web based open source Java framework (V2) (Simonsen, J., & Robertson, 2013), (DHIS, 2016).

A review on the experience of practicing traditional PD on HISP starts in South Africa and then continues to expand in Cuba, India and Mozambique. The expansion of PD appeared on the network of actions through universities, ministries of health, international agencies and implementing agencies like HISP South Africa and HISP India by assessing the limitation of the traditional approach ((Simonsen, J., & Robertson, 2013), (DHIS, 2016)). It was moved from stand-alone (e.g. Sierra Leone) to networked applications (e.g. Kenya) within health systems to provide as free and open source software.

Experiential and experimental analyses are the two popular methods of knowing something. The HISP experience proved active participation of different users which was very critical for the success of information system projects. The recent practice and adoption of PD inclines towards learning from real word instead of experimental approaches. A mobile assistive healthcare-related intervention ensures that it's impossible to create effective health care technologies without active user engagement (Hakobyan et al, 2015). Actively participatory observation was the recommended strategies for proper engagement and user participation because it's crucial to involve end users in the mobile healthcare designing process. However, critiquing the existing application is not recommended due to the fixation of the design, but creative and innovative design came from no smartphone experience (Davidson et al, 2013).

User experience participatory design does not only bring unlimited benefit for the success of information system projects, but also it's effective for scarce resource utilization. The design of health information system for rural health practitioners, disadvantaged women and rural Ethiopian community using cultural participation practice was an exemplary practice ((Lustria et al, 2010), (Amanuel Zewge et al, 2015)). However, most of the research was challenged and limited to incorporate mutual learning and cultural barriers in the design process.

3. METHODOLOGY

A review and case study report was made to explore the status of health information system in low resource setting like Ethiopia and propose a model for user experience participation to alleviate from fragile state. We conducted a literature review and case analysis to understand the current status of health information system in developing countries. The aim of reviewing literatures, documents and case analysis was to understand the situation and interaction of information systems in real life context (Klein et al, 1999). Exploratory data analysis like histogram was used to analyze the percentage evaluation scores and components of HMIS. Reviewing documents helped to understand the information system development and its interaction with different level of users. Understanding the level of user participation helped to understand the situation and how the decision was made. Different comparisons were performed to examine the connection between different end user participation and the success of an information system. At the end, we analyzed user experience of PD with respect to the context and experience of developing countries to address the gaps, propose participatory a model to recover from fragile system, outline critical issues and mode of communication. The proposed model helps to promote active user participation and prepare a strategic participation plan that are crucial to reduce the design reality gap and to get the voice of the end user.

4. RESULT AND DISCUSSION

User experience participatory design is ideal to bring active communication and participation between responsible bodies. It needs active involvement of several groups of stakeholders, end users, and senior management. Conducting holistic comparative evaluations of information system projects help to understand the relevance of user experience participatory design. Besides, it's good to write the success and failure stories in public organization and commercial sector with multicultural scenario to address the impact, efficiency, and effectiveness of health information system platform.

The health information system seems very fragile in developing countries like Ethiopia. Some of the information systems were not efficient, and failed to cope with the need of the user after utilizing a lot of resources. Figure 1 indicates the percentage evaluation scores and the components. The review on health information system indicates that the system struggle with poor data management, system resources, dissemination and use of information system even if the indicator and information products are adequate ((Federal Ministry of Health, 1999), (The Health Workforce in Ethiopia, 2012)).

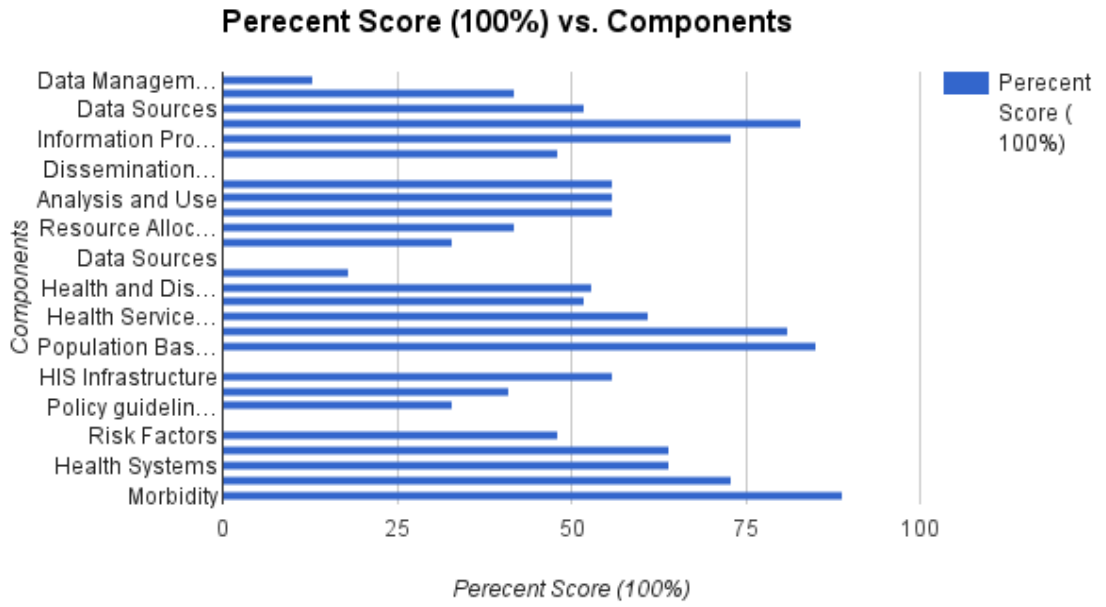

Figure 1: Evaluation Scores and Components of HMIS [21]

Figure 2 depicts the component review clustered result into not functional, present not adequate, adequate, not adequate and highly adequate. It illustrates the overall count result of health information system components and the capacity of the system to generate, analyze, disseminate and use of health information. It also depicts active user involvement and participation. The assessment review confirms 52% of the components were present, but not adequate. For instance, the review noted that census and population based surveys are adequate. However, the survey and implementation of routine health information system were inadequate. This is may be because of the capacity of the ministry of health and need further investigation.

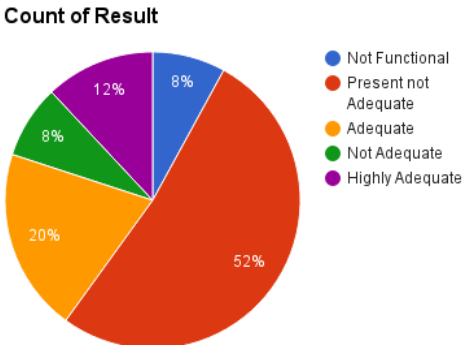

Figure 2: Overall Ethiopian HMIS Component Review Result [21,22]

HMIS assessment on Southern Nations and Nationalities Peoples' Region SNNPR also noted that the health post didn't use the HMIS properly (Belay, H. et al, 2014). To overcome the challenge, conducting HMIS training for the health post will bring better implementation aspects and helps to create better follow up mechanisms, program advocation, and controlling mechanism. Still, it requires active user engagement and participation to implement and deploy in full scale.

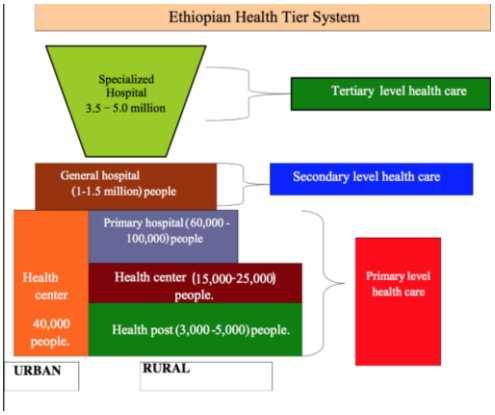

Figure 3: Structure of Ethiopian Health System (FDRE MoE, 2010)

Level of participation in PD or practicing PD highly depends on the structure of the system. In South Africa, PD tried to practice the Scandinavian tradition for political empowerment and practical learning through hands on participation to ensure equitable health service delivery and empowerment of communities. The result indicates each level needs a freedom to define its own standards based on the national guidelines to automate the paper based system. Similarly, to be effective in automating Ethiopia's health information system, understanding the structure is very crucial. Figure 3 above presents the structure of the Ethiopian health system; the system is classified into primary, secondary and tertiary level health care. The tertiary health care mainly includes specialized hospitals to serve 3.5-5.0 million people. Option 1-1.5 million people will get service from general hospitals (secondary level health care).The primary level health care service is classified into urban and rural. The health center in urban serves up to 40,000 people whereas the rural people gets service from health posts (serve 3,000-5,000 people), health centers (15,000-25,000 people), and primary hospitals (60,000-100,000 people).

The experience of PD in Cuba (Matanzas and Sanctí Spíritus pilot project) shows that building strong parallel national structure is important to automate paper based systems. The local and province database application design prototype helps to make the data analysis and management easier. The Ethiopian health system follows its own hierarchical structural system from Federal to Kebele level (federal→regional→zonal→woreda→kebele). Besides, it's important to include horizontal activities of all stakeholders operating at that particular level. Incorporating PD helps to consider the local priorities along with all national priorities and benefits to engage stakeholders at all levels.

The experience of South Africa and Cuba shows that the success of information system highly depends on the structure of the system. Understanding the structure will increase the success rate of information system, but the PD experience of Indian assures the success of participatory design highly depend on the greater level of top (political) support. It struggles to combine the bottom system learning with the top level and difficult to build health information system through different health facilities to satisfy their needs without the top level political support.

The experience from South Africa and Cuba helps to improve the strategic implementation of PD in Mozambique (through learning by doing approach to enhance sense of empowerment and pivot table based were provided to promote flexible local reports), and Sierra Leone (through participatory prototyping strategy involving all levels of users). It's

important to participate different level of users since the health system is uncoordinated and difficult to provide relevant information. However, the practice of participatory design in Kenya was advanced and illustrated using cloud based infrastructure by incorporating users and new features such as feedback and chat.

To summarize the experience, the success of PD in South Africa, the health information system platform was installed on each computer through CDs physically while Keyna used cloud based infrastructure. The lesson of participatory design confirmed design needs to be broad and their context matters. It depends on time, space, and culture. However, the system design requires broader education and training. The PD experience of Cuba and India couldn't scale beyond the health system. PD in south Africa, Cuba and India targets on exercising the right thing in post apartheid local empowerment by reinforcing the importance of politics, albeit with the difference of politics, legacies of soviet statistics based planning, and the British bureaucracy need to get permission not to empower the users respectively.

In all, the conventional approaches for HMIS implementation mainly depends on top-down approach. Once getting the top level management permission, deployment of the designed system starts and training will be provided hierarchically for different levels of users which leads towards the creation of the fragile system. To alleviate the problem, we propose a user experience participatory design model and communication channel based on four pillars such as community, health system (includes health post, health sector, primary hospitals, general and territory hospitals), top level management and policy makers (regional and federal health office, ministry of health) and information system developers.

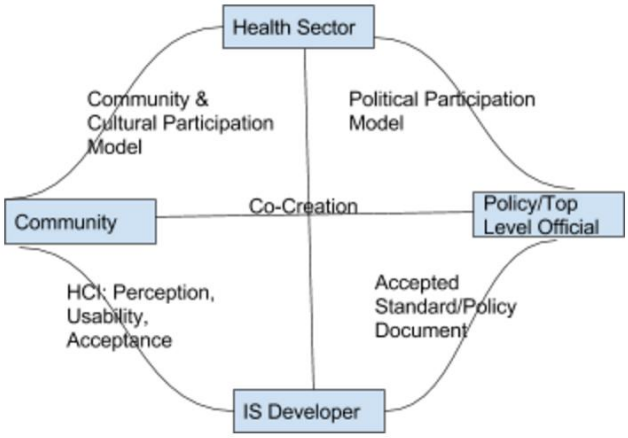

Figure 4: Proposed Model for HMIS User experience PD to alleviate Fragile System

Figure 4 displays dimension of participation pillars that include the community, health sector, higher official, and information system developer. Empowering community, cultural and political participatory design, and participation are very crucial to engage and facilitate the success of an information system. Following the community participation model, proper and timely interaction within and between the pillars will increase the success rate.

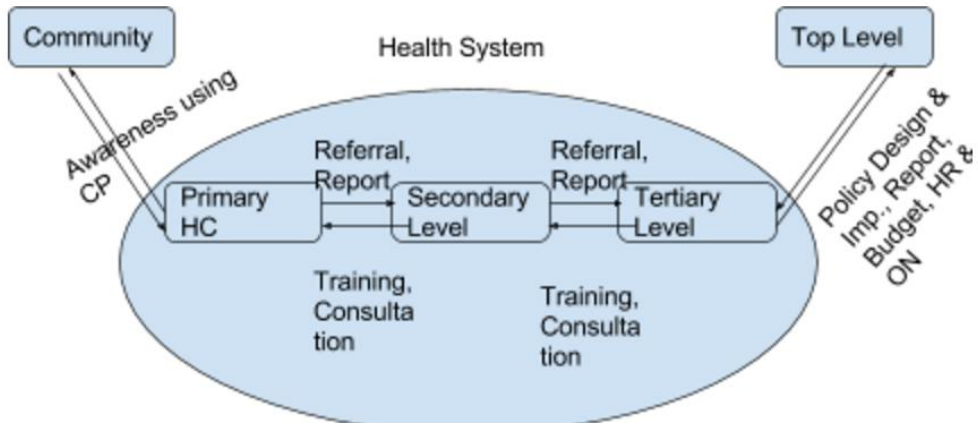

Figure 5: PD Model of Communication

. For instance, in Ethiopia there are different types of local community participation models such as cooperative work ("Debo", a trend to accomplish activities with a motto of together we can do everything, "Wenfel" call it Give and Take), social grouping (such as "Idir" a model for helping each other, coffee ceremony – a typical tradition to discuss and share ideas with relatives), and so on (Zewge, A et al, 2015). The information system to be implemented needs to consider the accepted standard, usability and the perception of end users.

The most important thing is defining mode of participation, communication channel, and need to contextualize accordingly. Figure 5 above depicts the direct interaction of the health system with the community, and the top level management officials as well as interaction within the health system. Community cultural participation method empowers the community and strengthens the health system to provide proper care, service and awareness, but it's very crucial to follow the political participation model and guidelines in order to achieve the desired output.

5. CONCLUSION AND RECOMMENDATION

The success of information systems highly depends on a proper understanding of the existing system structure, engagement of all stakeholders from top to bottom, and requires top level political commitment. Involving and engaging all different levels of user creates a sense of empowerment, and is decisive to understand the context such as patterns of value, behavior, belief, and language of a culture shared by a group of people. Creating flexible system and participating different level of users enhances the sense of empowerment and the success rate of information system. For instance, Mozambique's flexible reporting system and Sierra Leone's user engagement and empowerment strategies are noted examples. Following cultural participation, cooperation or social grouping model boosts the success rate. However, ethnographic investigation is required to bring innovative strategies and validate our proposed model in a real world environment as well as estimating the time and cost of participation.

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