Development of Resilient Health Information Infrastructure in Complex, Dynamic and Resource Constrained Health Care Context

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DEVELOPMENT OF RESILIENT HEALTH INFORMATION INFRASTRUCTURE IN COMPLEX, DYNAMIC AND RESOURCE CONSTRAINED HEALTH CARE CONTEXT

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Abstract

This research concerns the standardization strategy and organizational resilience behavior and action while designing and implementing HIS in low resource country context. Considerable IS research have been conducted to understand HIS standardization strategy and organizational resilience independently. This paper employed holistic approach, drawing up on organizational resilient and standardization literature based on interpretive case study approach, explores the process of electronic health management information system(eHMIS) design, implementation in low resource country to understand the interplay between organizational resilience and standardization strategy. The major research question guiding this study is how e-HMIS design and implementation process addressed the continuous change of health care in resource constrained context with a focus on resilience and standardization strategy.

Key word: Implementation, e-HMIS, HIS, Resilient, Standardization, Information infrastructure

1. Introduction

Health Information System (HIS) is considered as a strategy to address the health care delivery problem through equitable health resource allocation and setting priority [34]. HIS is conceptualized differently in various IS research, a patient level data is often termed as electronic medical record(EMR); a system that handles aggregated data based on every day care provision is termed as HMIS and there are also other systems such as HRMS, Financial system, Drug and logistics system. This study concerns the health management information system (HMIS) which collects and aggregates routine data from health facility level and sends to the next higher level woreda, zonal, regional and MOH on periodic basis like on weekly, monthly, semi-annually and annual basis. Managers at various administration levels used this aggregated data for resource allocation and planning purposes. Managers at various administration levels are supposed to use this data for resource allocation and planning purposes.

Despite lack of technology, technical knowledge and skill, low economy and lack of information infrastructure in resource constrained countries, huge IT investment has been made in health care industry to reap the fruits of ICT [5]. Such IT investment in low resource countries is often supported by donor agencies [34] which is susceptible for sustainable failure. However, IT investment in healthcare industry in general and in developing countries in particular does not yield the expected results [2, 6, 3, 15, 25, 58-60]. The inherent complexity and changing nature of health care is considered as a reason for viable results of IT investment in the sector in addition to various contextual challenges such as political, technological, social, resource etc..

Such inherent complexity and the continuous change of health sector challenged the developed countries HIS development and implementation efforts to produce many fragmented system which in turn require them huge investment to make it interoperable. Developing countries should take lessons from developed countries to prevent from overcrowded with multiple fragmented systems while also addressing the changing need of the sector due to the fact that e-health initiatives are still at infancy stage in developing countries.

The strategies, decision and actions taken during design and implementation will have significant impact to influence the development and evolution of [21, 18] HIS. Contemporary research is swinging in top-down and bottom-up approach to design and implement HIS in such dynamic and diversified context [38]. Some criticized the formal traditional top down approach due to the fact the approach hinders innovation in such changing world where as others justified the importance of top down approach to maintain communication and coordination amongst heterogeneous health sectors actors with considerable resource [21]. Furthermore, scholars in developing countries favor top-down approach due to the fact that many developing countries followed strict hierarchical system. However such hierarchical approach is highly criticized as it constrains innovation and generativity to address the emerging needs. Balancing standard and generativity in HIS design and implementation is the current challenge of IS research.
Contemporary research disclosed that successful HIS should constituent both stability and flexibility features to create interoperable system and also to address emergent future needs. Accordingly, IT initiatives now a days have adopted architectural and central IT governance approach in many IS design and implementation endeavor to address both stability and flexibility

[21]. Recent research result extends the architectural and central IT governance approach by identifying stable and unstable system elements (ibid). For stable system elements, top-down approach has been suggested where as for unstable elements bottom up strategy. Although literatures depict how to balance generativity and stability conceptually, there are few empirical research carried out in developed countries to explicate the issue [20, 41]. Research depicts how standard enables generativity through negotiation without constraining communication and coordination[20,21]. Such kind of empirical research is crucial to understand how to maintain a balance between standardization and generativity.

In line with these studies, drawing from organizational resilience, generativity and standardization literature, this paper seeks to contribute for this discourse by surfacing the e-HMIS implementation process in resource constrained setting. The results of the research surface key activities, strategies and decisions taken during implementation process which enable or constrain the establishment of resilient health information infrastructure. A system which has both stability and generativity feature in this paper is considered as resilient HIS.

The overall objective of this study is understanding the relationship between standardization and genrativity in e-HMIS development and implementation in Ethiopia. To realize this objective, I formulated the following major and specific research questions. :- How e-HMIS implementation process manages the continuous change of the health care context while maintaining coordination and communication? The study guided by interpretative case study using the concept of strategy and organizational resilience.

The next section is organized as follows. Section 4 discusses the theoretical foundation which is followed by research methodology in section 3. Section 5 presents the research setting followed by Analysis and discussions of the study in section 6. Finally conclusion will be presented in section 7.

2. Theoretical Foundation

HIS requires stability and homogeneity to enable coordination and communication amongst heterogeneous health stakeholders, health programs. HIS also need variability and evolveability feature to meet the anticipated and unanticipated future needs of the sector. However, excessive variability results fragmented systems. Similarly, excessive stability can render an irreversible system[26] which is a challenge for addressing emergent needs of the industry respectively. Thus, maintaining a balance between stability and evolvability while designing and implementing HIS is a central challenge to HIS infrastructure.

2.1. Standardization Strategy

Standardization strategy is ways for developing new standards and how actors play a role, interact and change through the process of standardization. In this study eHMIS is considered as standard and strategy followed to develop and implement eHMIS. There are two major types of

standardization process, top down and bottom up, in developing and implementing new standard[26]. The top-down standardization process is a formal standardization process which is characterized as stable, specification driven and often guided by standardization committee(ibid…). It is also widely used in various sectors mainly in telecommunication and engineering field. The top down standardization has four sequential stages as definition, development, implementation, diffusion and use.

On the other hand the bottom up standardization process follows evolutionary or experimental standardization approach [26]. Internet development and use is categorized under this evolutionary model which has the stages of proposed model as development, draft model which is testing and full or standard which is acceptance[1]. The existing standardization system which was initiated and used in 19th century is not appropriate to meet the complex demands of the 21st century [48]. The twenty one century standardization requires flexible standard that meets the current need. The trends of standard changes from stable to flexible due to the global process [11].

Pollock and his collegues [42] suggested generfication model which focuses on developing general software to address the interest of more users as much as possible. However this model is challenged as it requires more local appropriation[4]. Other researchers claimed flexible standards for complex technological system in such more dynamic world that changes over time[9, 26, 49]. Van den Ende et al [49] argue that the more flexible standard is easy to adopt and more successful. Hanseth and his colleagues [26] explicate how standard can be changed easily, if it is simple and used it for many actors if it incorporates all stakeholders' interest. The simplicity emancipates from the standard definition, if the standardization process follows the top down approach, that will ended up with complex standard which is less flexible, where as if it is bottom up, it is more flexible as it is seen in internet development and use [26]. Braa and his colleagues [9] also suggest ' flexible standards strategy' for health care based on their action research done in a number of developing and middle income countries in Africa and Asia.

The recent research result has also identified three standardization strategies in relation to service innovation based on a 20 year longitudinal research in Norwegian health care development and use[21]. The identified strategies are Anticipatory, Integrated solution and Flexible Generification. The anticipatory standardization strategy characterized by top-down and specification driven is considered as the official and dominant strategy. Anticipatory standardization strategy can develop many standardization strategies which might not be feasible to implement. The remaining two, integerated solution and flexible generification strategies, are an emergent strategies [40] based on their empirical material. The integerated solution focus was on user requirements and functionality which is 'user-driven 'rather than specification driven. Thus this standardization process includes more active user involvement and designing integrated solution which satisfy the users' requirements. However, in spite of the effectiveness of the integerated solutions, it was time taking and a slow process. The third strategy is flexible generification which has focused more on developing working solutions based on users' practices and needs based on input-output legitimacy. The researchers found that flexible generification is suitable for successful HIS implementation in such turbulent area of health sector. They suggested standards to be more generic at the same time simple and flexible to adapt the changing needs of the sector [21]. Accordingly, contemporary research disclosed that

successful HIS should constituent both stability and flexibility features to address the emergent future needs. IT initiatives now a days have adopted architectural and central IT governance approach in many IS design and implementation endeavor to address both stability and flexibility [21]. Recent research result extends the architectural and central IT governance approach by identifying stable and unstable system elements (ibid). For stable system elements, top-down approach has been suggested where as for unstable elements bottom up strategy.

In line with these studies, this study seeks to explore the strategies, activities; decisions that have taken during the e-HMIS implementation process to reveal its role for maintaining the balance of generitivity and standardization. In addition to the standardization strategy, literatures now a days due more attention for organizational resilient for successful HIS implementation in such changing environment [15] .

2.2. Organizational Resilience

Literatures now a days due more attention for organizational resilient for successful HIS implementation in such changing environment [15]. HIS resilience consists both the stability and evolveability features [50].

The organizational resilience rooted from psychology [13] at individual level and later extensively used at organizational level [45]. Organizational resilience is suitable to explore how actors act in the process of IT implementation. According to the literatures, resilience refers to the capability of individuals, groups, or organizations to adapt quickly to changes in their environments [23, 45]. Literatures provide different definition for the organizational resilience, this study considers resilience as a process capability in overcoming barriers to change and in developing multiple sources of competitive advantages [44]. This approach has three advantages first, resilience is related to the process of change. Second, resilience is multi-faceted, rather than single quality. Thus, organizations may possess some resilient capabilities and not others. Third, in a process perspective, resilience becomes a capability that may be related to both successful and unsuccessful adoption behaviors. On one hand, resilient organizations may able to adopt an innovation and quickly recover from the interruption and return to serving its mission. On the other hand a resilient organization may able to absorb or reject an innovation without any significant change.

The concept of resilience can be used to explore how initial adopted system abandoned after certain period of time through a process point of view. In addition to this, the concept can also be used to explore the human agency adoption practice how specific and complex interactions between different levels of adoption behavior including individuals, groups and organizational unit [30].

The resilience framework can be characterized by time periods, types of systems, types of events, required system actions, and qualities that must be preserved for the system to be considered resilient[36]. In this study eight years is the time period of eHMIS implementation, the system is eHMIS, actors action is considered as needed system action, sustainable eHMIS use for data collection, reporting, analysis and use for local action is considered as qualities that must be preserved to be resilient.
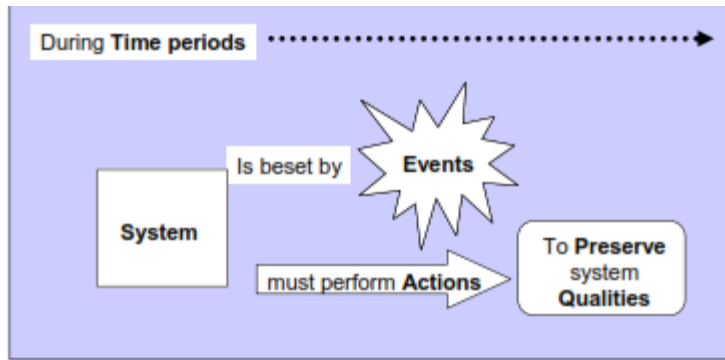
Figure 1. Framework Elements

A knowledge of how standardization strategy influence or impede health workers, programs and public health care settings behavior and actions towards change is a vital knowledge to devise appropriate strategy that can develop organizational resilience that is capable of addressing such changes. This study seeks to investigate the relationship between standard strategy and organizational resilience. The overall objective of this study is how standard strategy influence or enhance organizational resilience and its impact on eHMIS implementation. To realize this objective, I formulated the research question as How the standardization strategy facilitates or embeds organizational resilience within public health care settings?

3. Interpretive Case Study Research Methodology

The research is designed as a single case study with multiple sites involved. In this research, the case is defined as the DHIS implementation in public health care settings and allows examining relationships at different levels of analysis within the DHIS implementation context; national level, regional health bureau, zone health office, wereda health office, and health facility level. The approach will allow me to investigate the case at hand in depth to provide a rich understanding of the case. Case study research can be positivist, interpretive, or critical, depending upon the underlying philosophical assumptions of the researcher. This study will adopt interpretive approach to investigate the DHIS implementation as the study tries to understand the technical, social, cultural, organizational situations of the HIS implementation in relation health care context that various from health facility to health facility, administration level to level etc.

Interpretative understand phenomena through the meanings and interpretations that people assign to them and their understandings of the social and organizational context [52]. It thus has the potential to produce deep insights into the processes of IS development and implementation and how these influence and are influenced by the context[52].

A case study is suitable in answering questions of 'how' and 'why'[52]. It also addresses contextual and complex conditions and not just isolated variables, and rely on multiple sources of evidence [53]. Thus, case study is well suited to study the development, implementation, and use of the introduction of IT in organizational contexts [10].

The research will be designed as a single case study with multiple sites involved.

3.1.   Data Collection Method

The study conducted through an in-depth review of secondary data including the organizations' strategy documents and different rules, guidelines, registers pertinent to health service delivery and resource allocation, and official reports from the different health facilities. In addition, the majority of primary data will be collected through semi-structured interviews with key informants (such as health workers, IT technicians, persons dealing with statistics, health managers and planners), and the observation of work practices surrounding the collection, processing, use and transmission of data. Thus gathered data will be triangulated with these data collection methods.

Seventeen informants have been interviewed from the public health hierarchy(national, regional, sub city and health facility). All interviews have been conducted using recorder as well as taking notes. There are some interviewee has been interviewed twice so as to clarify and in need of additional data after transcription. Thus gathered data will be triangulated with each other. Interview took from 40 up to 60 minutes.

Table 1. Details of Informants

Sn	Specialization	Organization	No of Respondents	No of interviews
1	HMIS Head	FMOH	1	1
2	HMIS staff	FMOH	2	2
4	HMIS head	AAHB	1	1
5	Support staff	Yeka Subcity	3	5
6	Data clerks/ HIT	Health facilities	3	3
7	Health professionals	Health facility	3	3
	Total		15	20

3.2. Modes of Analysis: Hermeneutics

Hermeneutics approach is selected for the study at hand. Hermeneutics is primarily concerned with the meaning of a text or text-analogue (oral or written text). The basic question in hermeneutics is: what is the meaning of this text?[43]. Taylor says that:"Interpretation, in the sense relevant to hermeneutics, is an attempt to make clear, to make sense of an object of study. This object must, therefore, be a text, or a text-analogue, which in some way is confused, incomplete, cloudy, seemingly contradictory in one way or another, unclear. The interpretation

aims to bring to light an underlying coherence or sense" [48]. Hermeneutic clarifies the different views of the organizations stakeholders which are often incomplete, cloudy and contradictory. The major objective of hermeneutic analysis is to make sense of the whole and the relationship between people, the organization and information technology. Accordingly, hermeneutics approach is followed to interpret, describe and analyze the data.

4. E-HMIS implementation

Like any other developing countries, the introduction of ICT in Ethiopia health care setting has been facilitated by donor agencies and NGos. HIS implementation was first introduced in Ethiopia by different NGOs in different health programs in cooperation with regional health bureaus [31]. However, such varies efforts created redundancies and duplication of effort in health programs and even with in regions. Thus, in 2006, FMOH criticized such dispersed regional efforts that created fragmented systems for the country and launched HMIS reform at national level in cooperation with its partners (donors and NGOs). Comprehensive and standardized national HMIS for evidence based planning and management of health services was designed and implemented at national level [19]. The MOH partners, Tulane University and John Snow, developed and implemented two different software in different regions of the country, Tulane developed and implemented Electronic Health Management Information System (E-HMIS) in all regions except SNNPR where John snow implemented another software which does the same process data collection, process, analysis and reporting. These two systems have been in use in their respective regions till December, 2017. Having two systems with in a country created a challenge to generate a country level health report. MOH took considerable investment to integrate the reported data with two different systems at national level. Furthermore, the continuous change of health care which requires change in system, system failures required being at each site for maintenance and to incorporate changes made in the system. Such handling software maintenance and incorporate changes made in the system consumed a huge investment. Due to these problems, starting from 2015, MOH have sought solutions to address these problems. This paper focuses on e-HMIS which was working for about five years in all regions of Ethiopia till December 30, 2017.

The study will uncover the whole process of eHMIS implementation from software selection, customization, training, use and support. The study includes how the software was selected and designed, how the training and support was organized, and finally the use which includes how data is gathered first from the health facilities (clinics, health centers, and district hospitals), captured in the software, flows to the wereda, zone, the regional and the national levels. Thus, the study requires multi-level analysis which enabled an understanding of the various vertical and horizontal flows of information, resources, rules, plans, and support.

TUTAPE (Tulane University's Technical Assistance Program for Ethiopia) developed Electronic Health Management Information System Software in partnership with CDC and the Fedeeral Ministry of Health Ethiopia (FMOH) [19] using c-sharp, and sql technologies for application and database respectively. Developers used the designed standard data collection tools such as talley sheets, registers, indicators and various reports as an input to design and develop eHMIS. The system was first tested in Addis Ababa, later in eastern shoa zone of Oromia, and Tigray regions. At these testing stages, different system problems and bugs such as summation

problem, report missing, and variable missing were identified for software maintenance. The software development took more than a year to deploy at sites. The software was revised three times through out its five years life time due to new users' requirement, missed indicators, reports, summation problems and so on. All these revisions required the presence of implementer at each physical point to incorporate or install the revised system.

A five day eHMIS training was given in cascading format in 21 health science colleges which were equipped with necessary equipment such as computer, projector. First, a five day master training of trainers was given for forty trainees which was conducted in Adama. Trainees from Federal Ministry of health, all regional health bureaus, and implementing partners participated in the master of training of trainees. These master of TOT provided the EHMIS training to zonal or sub city level TOT who were expected to provide training and for zonal level users. Ultimately, end user training was given for trainees comprised of health facilities who are actually use the system for data entry, and reporting

The initial training given for master of TOT did not enable trainers at the level providing support to end users. Thus most of the support requests were forwarded to upper level region till national level FMOH that brought a great workload on Tulane staff and also took significant period of time to get on time support. As a result, Tulane prepared and provided a 20 days troubleshooting and maintenance training for all regional and sub city HIT staff that highly minimized the support requests came to Tulane and FMOH. However, trainers did not have access to source code to continue learning about systems such as how to modify, insert new requirement including adding and modifying data element, indicator.

FMOH purchased 4000 computers, some servers to make the sites ready for system installation and use. The system was cloned in all 4,000 computers at Ministry of health and distributed to all sites including regions, zones, wereda/sub city, and health facilities found within country. However, maintenance and reinstallation required at sites due to database failure, system revision due to minor mistakes for instance missing indicators, data element and also new requirements need software installation. Thus installation consumed huge amount of time, and finance particularly when they made system revision. eHMIS had made three revision.

5. Analysis and Discussion

The analysis have been made as mentioned earlier first by interpreting the data gathered by using hermeneutics approach to come up with concepts generated from the data and establish pattern and finally map it with the standard strategy and organizational resilience concepts.

5.1. Top-down eHMIS strategy

The case description as shown in section 5.1 has revealed how top down approach or centralized approach was followed for all eHMIS initiation, development, implementation and use. The top-down standardization process is a formal standardization process which is guided by standardization committee [21]. The HMIS steering committee chaired by FMOH, selected system developer organizations through some criteria. The top down standardization approach

has been characterized as stable, and specification driven[21]. Similarly in this case, the standard data collection tools and reports, indicators were given as a specification to develop eHMIS. The centralizing approach except providing the same specification to guide the system development, it did not give a room for system developer organizations to discuss about how to develop the system. As a result both partners ended up with two different eHMIS systems with huge investment which has predominantly the same function. These two eHMIS became un-compatible at national level to prepare a national level report. Thus FMOH invested additional time, effort and finance to develop a system that can integrate and analyze a national level data and generate report. Furthermore, in order to change a single data element, data set or organizational unit, it required to change on source code which is not accessible to public organizations as well as it requires high tech knowledge and skill. Standard's simplicity depends on the approach to defining a standard, if it is top-down it is less flexible where as if it is bottom up, it is more flexible [65]. As eHMIS development followed top down approach it requires high tech knowledge and skill for system change. The top down approach which has its roots of the 19th century is not appropriate to meet the demands of the 21st century which is complex and more dynamic [49]. Similarly, eHMIS was not cope-up with highly dynamic situations of the health sector as it was stated above in the case study section 5.2.1. Thus the strategy did not allow them to modify the system with existing limited system knowledge and skill. This research finding is similar to [21] anticipatory standardization strategy which is not feasible to implement or take considerable time. Researchers suggested standards to be more generic at the same time simple and flexible to adapt the changing needs of the sector [21, 11, 9]. Thus HIS managers, designers and implementers should consider the flexibility and simplicity of the standard for successful HIS design and implementation in such changing environment.

Regarding training, training was also organized at central level without making ground level assessment. This centralized training by focusing more on training specification includes training content, duration, number of trainees, training place and fund) missed key HMIS and HIT trainees in the first round master of TOT which slowed down the implementation of eHMIS. System installation and support was also organized at region level which required the presence of Tulane staff at all sites which also taken considerable time due to the vastness of the sites and the large number of support requests.

Although actors at sub city and region level had involved in many implementation activities such as conducting training, installing the software and providing support to end users, their role was limited to accompanying Tulane staff and facilitating this activity rather than discharging the activity by their own. This was mainly because system related knowledge, skills, set up files and the source code was under the control of the Tulane university. In general, the system development and implementation was primarily dominated by FMOH and Tulane University where as the public actors at region, sub city and health facility were just facilitating the implementation process. Standard's simplicity depends on the approach to defining a standard, if it is top-down it is less flexible where as if it is bottom up, it is more flexible [26].

5.2. Stakeholders Resilience towards eHMIS

Resilience refers to the capability of individuals, groups, or organizations to adapt quickly to changes in their environments [13, 23, 36, 45]. Resilient organizations may able to adopt an innovation and quickly recover from the interruption and return to serving its mission. On the other hand a resilient organization may able to absorb or reject an innovation without any significant change. In the case at hand, FMOH, regional health bureau, Tulane University and other partner organizations including CDC, ITECH have shown considerable organizational resilient to thrive technical and organizational problem faced during implementation and to continue implementing and using the system. For instance they hired new staff to strengthen HMIS at lower levels, bought UPS, install antivirus and used various technical measures to safe the system from failure, organize extensive trouble shooting training to build lower level HIT capacity. Direction had been given to send monthly data only in eHMIS. All these actions were taken by the organizations to continue implementing and using the system. However, some of the resilient behavior was not adequate and some required significant investment, and others ended up with limiting eHMIS use to merely for data entry and reporting which missed the main goal of eHMIS which is using data for local action.

Despite all actors enthusiasm and resilient behavior towards eHMIS implementation and use, their resilient behavior was not extended eHMIS use from data entry reporting to the level of data use at all stage, enable to use local capacity for extending, modifying system and even to handle some support, rather it continued to rely on system developer organization for the day to day support issues and system changes.

5.3. The Interplay between eHMIS strategy and Organizational Resilient

Regardless of all public level actors enthusiasm and resilient actions towards the system as mentioned in section 6.2, the centralized strategy did not extend further the created resilient action to facilitate the development and implementation of sustainable eHMIS. The administrative institutions considerable resilient action had not been extended from purchasing hardware, developing a software, organizing and conducting training and issuing rules not to the level owning system knowledge and skill, owning system source code and using eHMIS data for local action.

The top down approach did not provide suitable platform to foster learning with in public health institutions rather it centralized high level system knowledge, skill and system under the control of system developer organization. Neither the cascading training nor extensive troubleshooting training focused on limited system knowledge and skill did not allow learning and sharing deep level system knowledge and skill from system developers to public health institutions. As a result, HIT staff at various administration offices had invested unnecessary time, money and effort in surfing external resources to use such centralized knowledge and skill as it is mentioned in case description section. Second, it took considerable time to get technical support. Third, the top – down approach did not allow public HMIS and HIT staff to access the source code of the system which should have facilitated owning deep level system knowledge and skill to own system support as well as to handle system change as result the public HIT and HMIS staff

heavily relied on system developer organization knowledge and skill mainly for system change. Moreover, FMOH had invested other considerable amount of money to develop and integrated data analysis tool at national level due to absence of access to source code. This finding is also in congruence with in congruence with Hanseth and Bygstad which showed how the traditional, top-down IS strategy can came up with multiple standardization, yet it was difficult to implement and slow [21]. Issuing rules not to accept paper based monthly report though enhanced the end users' eHMIS use only to the level of data entry and reporting, yet it missed the major objective of eHMIS which is using data for local action. This finding is similar to Hanseth & Bygstad [21] stated as the top-down approach merely automates the existing paper based system to computer system which is merely reduced time, not change the way HMIS was organized and use.

As described above in this analysis section, the top – down approach enabled all actors to be resilient at certain level yet not facilitated the exhibited resilient action. These resilient actions taken by all actors had also brought negative consequences. First, it required huge investment. Second it limited eHMIS to merely for data entry and reporting. Third public HIT and HMIS staff system knowledge and skill was not in a position of owning system support and modification activity rather they had been heavily relying on system developer organizations staff. Fourth the public organizations at any level did not have access to system code till the termination of eHMIS. Lastly, it missed the main objective of eHMIS development and implementation which is using generated data for local action. This finding is similar Cho and his colleagues [15] results stated "while resilience facilitated swift and successful adoption, it also created tensions that endangered further diffusion and the long-term sustainability of the tele-health innovation"[15]. Furthermore, the strategy did not extended or foster the exhibited resilient behavior and action.

Thus, the above mentioned situations (frequent support requirement and its investment, the dynamic nature of the health care which required system revision and installation to each site, absence of system ownership to make modification, absence of the required system knowledge and skills at public HIT and HMIS staff) challenged FMOH to continue its resilient behavior towards eHMIS, rather switched to look for other better alternative. Thus despite, considerable resilient behavior was seen at all end users and public health administration offices and also partner organizations for effective implementation of eHMIS, FMOH by considering the consequences of eHMIS implementation decided to replace eHMIS with DHIS-2 which is an open source web based software.

The case analysis has vividly depicted how the top down eHMIS development and implementation strategy facilitated to develop organizational resilience with all stakeholders at certain level where as at the same time limited the organizational resilience action. This limited organization resilience action might deteriorate the developed organizational resilience through time. This interplay between eHMIS strategy and organizational resilience has shown its considerable impact on the development and implementation of sustainable eHMIS system. For instance the centralized cascading training resulted for missing key trainees, inadequate training and increases implementation cost where as the organizational resilient action of the actors 'trouble shooting and maintenance training' which was derived from the reality exhibited in institutions facilitated learning and minimizing implementation cost and time at certain level. Furthermore, the top down approach issued guideline to use merely eHMIS for data reporting though it enhanced users eHMIS use by showing resilient action by using sub city computer for

data entry and reporting yet this resilient action limited the purpose of eHMIS merely to data entry and reporting. The top down strategy adopted in the case at hand case even if it created resilient action yet it was unable to facilitate the resilient action by availing more conducive environment.   Thus appropriate strategy should be devised that not only to develop organizational resilient behavior and action but also fostering the organizational resilient actions by providing suitable environment.   This case slightly indicated the bottom-up approach might help in developing organizational resilience and also facilitating further the organizational resilience.

6. Conclusion

The standardization strategy and resilience concept is used to understand and depict the interplay between IS implementation strategy and organizational resilience in shaping the development and implementation of eHMIS. The study identified how top-down or centralized HIS standardization strategy at the beginning created organizational resilience behavior and actions at all levels. However, the created organizational resilience behavior was not reinforced by providing system level ownership and the required system knowledge and skill.   The developer organization who monopolizes the system ownership, resource and knowledge and skills did not enable them to address the users' frequent and emergent needs. It took them considerable time and resource to fix minor users' problem at lower levels. Consequently, the created organizational behavior became limited to generate the required organizational resilience behavior and actions mainly at lower levels to address the emerged users' need. Lately sub-city focused deep level training minimized the frequent users' support and helped to continue using the system.   However, the negative consequences of organizational resilience and top-down strategy which requires huge running cost and time also deteriorated the upper level resilience towards the system that leads to terminate the use of eHMIS.

Thus the study by relating organizational resilience and standardization strategy depicted how their interplay shape the eHMIS design, implementation and use. The study depicts how top-down strategy is unable to create sustainable organizational resilience behavior and action to address the emerged needs of the users. Thus the research suggested for implementers to employ appropriate strategy which emphasizes both in creating and sustaining organizational resilience behavior and action that can address the emergent needs of the users. In this case, sub city(wereda) level focused strategy produced viable results in sustaining the organizational resilience   behavior   and   action   which   can   address   the   emergent   needs   of   users.

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