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THE DEVELOPMENT OF A HOSPITAL SECURE MESSAGING AND COMMUNICATION PLATFORM: A CONCEPTUALIZATION

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Abstract

Pagers and phone conversations have been the stalwarts of hospital communication. With good reason, they are simple, reliable and relatively inexpensive. However, with the increasing complexity of patient care, the need for greater speed and the general inexorable progress of health technology, hospital communication systems appear to be increasingly inefficient, non-secure, and inadequate. It is unsurprising then, that methods other than pagers and phone-calls, are often utilized; be it residents communicating with other residents, nurses seeking consultant feedback, or patients seeking advice from their clinicians. Thus, this study seeks to develop a conceptual framework for the theoretical un-derpinning for a larger study and to answer the key research question: How can ICT (information communication technology) solutions ameliorate the current challenges regarding communication inefficiencies within healthcare? To answer this question, this study has served to develop a theoreti-cal research framework by integrating two socio-technical theories namely Actor-network theory and Activity Theory to investigate the possibility of designing a bespoke ICT solution for a specific context at one of the largest private hospital in Australia.

Keywords: Secure Messaging, Information Communication Technologies, Hospital Communication, Actor-Network Theory, Activity Theory.

1 Introduction

Pagers and phone conversations have been the stalwarts of hospital communication. With good reason, they are simple, reliable and relatively inexpensive. However, with the increasing complexity of pa-tient care, the need for greater speed and the general inexorable progress of health technology, hospital communication systems appear to be increasingly inefficient, non-secure, and inadequate (Coiera 2006; Grisot and Vassilakopoulou 2011).

In a broader context, implementing health information systems have been viewed as a potential solution to addressing issues faced in healthcare service provision, such as process inefficiencies, high healthcare costs, poor access to high quality and safe healthcare, and low patient satisfaction (for example, see Edwards et al., 2008; Lau, 2007). Consequently, there is an impetus towards the use of technology in many areas of healthcare administration and care processes. However, the complexities associated with the coordination, communication and delivery of healthcare at the point of care, pre-sents challenges for the design and implementation of hospital secure messaging and communication system. According to surveys conducted by the American College of Physicians and American EHR Partners (2013), user satisfaction and usability ratings for Health Information

Systems (HISs) decreased between March 2010 and December 2012. During this period, overall user satisfaction de-creased by 12% and users who were "very dissatisfied" increased by 10%. Overriding of the system, duplication of documentation, and a reversion to familiar systems such as paper recording has been reported as work-around strategies used to continue delivery of safe and reliable clinical communica-tion and care in the face of technological solutions that do not meet clinicians' needs (Dowding et al., 2009; Lau et al., 2010; Viitanen et al., 2011).

In the information systems literature, development and sequential implementation of a technology solution have been commonly agreed to be a process of social change involving active and interwoven relationships between the social and technical systems (Alexander & Silvis, 2014; Cho et al., 2008; Hanseth et al., 2004; Iyamu & Sekgweleo, 2013; Tatnall & Gilding, 2005). Particularly in healthcare, end users and the socio-organisational context have been argued to play a crucial role to the success of technology implementation (Meijden et al., 2003; Stevenson et al., 2010; Vimarlund & Timpka, 2002). Among different socio-technical approaches, Actor Network Theory (ANT) (Latour, 2005; Law and Hassard, 1999) and Activity Theory (AT) (Leontiev, 2009) have been adopted to develop a rich understanding into the complexity of the heterogeneous network of multiple social and technical actors and the process of social change associated with technology introduction. Thus, this study draws from these two theories to develop a conceptual framework for the theoretical underpinning of the research study and to answer the key research question: "How can a sociotechnical perspective based integrated theoretical framework help us understand the complexities and challenges regarding communication inefficiencies within healthcare and furthermore, how can this framework aid in the development, implementation and adoption of ICT (information communication technology) based hospital communication solutions"?

2 Study Background

A recent report by the Ponemon Institute examined the financial burden resulting from communication inefficiencies in healthcare (Ponemon Institute, 2014). An average US hospital is estimated to lose $USD1.75 million annually due to poorly implemented communication amongst health staff. Some of the key findings included (Ponemon Institute, 2014):

- The average healthcare provider wastes 45 minutes every day by using substandard communication systems such as pagers.
- During admission of a patient, a significant portion of time is wasted due to inefficient communication, costing $USD 728,000 per year per hospital.
- Secure text messaging has the potential to reclaim 20 minutes per patient in the patient transfer alone.
- The use of two-way secure text messaging has the potential to improve productivity, saving an estimated $USD 918,000.00 per hospital annually.

It is unsurprising then that methods other than pagers and phone-calls, are often utilized – be it residents communicating with other residents, nurses seeking consultant feedback, or patients seeking advice from their clinicians (Wu et al., 2013). These methods include smart phone text and image messaging, email, VOIP voice and video calls, etc. Whilst efficient, these methods are insecure, and with the introduction of new health privacy laws there has been increased scrutiny on the way staff involved in patient care share information about their mutual patients (Wu et al., 2013).

Mobile health platforms (mHealth) offer a promising solution to some of the more important problems facing the current healthcare messaging systems (Harvey & Harvey, 2014). Mobile technologies have become the platform of choice with more than 6 billion mobile subscribers worldwide (Smith, 2012). Integral to mobile health is the use of mobile and wireless devices to improve health outcomes, healthcare services, and health research (Varshney, 2014). The topic of Mobile Health (mHealth)

seeks to capture the dynamics of using mobile devices for various aspects of healthcare delivery such as access to government resources, social networking, interactions between organizations, institutions, individuals as well as all relevant interested parties (Vogel et al., 2013).

Mobile Health has many applications. It can be used to facilitate data collection and to encourage health-care consumers to adopt healthy lifestyles or to self-manage chronic conditions. It can also be used to improve health-care service delivery processes by targeting health-care providers or communication between these providers and their patients. So, for example, mobile technologies can be used to provide clinical management support in settings where there are no specialist clinicians, and they can be used to send patients test results and timely reminders of appointments (Free et al., 2013).

In 2013, Free at al conducted a systematic review to investigate the effectiveness of mobile-health technologies to improve healthcare service delivery. 334 studies and 42 mHealth trials, published between Jan 1990–Sept 2010 were included in the review. The study found that some mHealth interventions designed to improve healthcare service delivery processes are modestly effective, but it also highlighted the need for more trials of these interventions (Free et al., 2013). In terms of mHealth interventions targeting communication between health-care providers as well as communication with patients, the study concluded that SMS appointment reminders have modest benefits. Researchers suggested that such solutions be implemented more broadly to improve all aspects of healthcare communication (Free et al., 2013). However, such a broad application is often challenging, due to concerns regarding the security of smartphone technologies when dealing with personal health information.

Thus, this study attempts to answer the research question: "How can a sociotechnical perspective based integrated theoretical framework help us understand the complexities and challenges regarding communication inefficiencies within healthcare and furthermore, how can this framework aid in the development, implementation and adoption of ICT (information communication technology) based hospital communication solutions"?

To answer this question, this study has developed an integrated theoretical framework for the evaluation of the hospital communication ICT secure messaging solution at a private hospital in Melbourne, by applying two strong theories: Actor-Network theory (ANT) and Activity theory (AT), to make a robust body of knowledge for the proposed solution.

3 Methodology

Based on the criteria given by Yin (2010), the choice of methodology for this research study is a qualitative single-case study. This study is about health information systems implementation and adoption and subsequently, its use. To understand the phenomenon, it is important to understand the processes, interactions between human and non-human actors their perceptions and expectations, which can be best served by a qualitative approach as it can serve better in providing the insights necessary to understand the participant's role in the event and their perceptions of the experience Yin (2010).

The part one of this study is theoretical underpinning of the study. To answer the research question and development of the theoretical framework, several archival records and documents relating to the health information and communication technologies implementation and adoption in healthcare service delivery settings were critically analysed. These documents were of great value in developing an understanding of the need for a hospital communication tool and factors important for the implementation and adoption of hospital communication tool. This analysis assisted in developing the theoretical research framework and in planning the primary data collection strategies for the larger study. A priori themes were developed through a pilot survey and then literature was analysed using thematic analysis and hermeneutic analysis, then we performed a gap analysis. The analysis led us towards the sociotechnical perspective of this study. A comprehensive review of two socio-technical theories namely ANT and AT was conducted, that lead to the development of a conceptual framework for the study that serves to build the theoretical foundations of the study. Phase two of this multimethod study will then serve to test this model and build the artefact.

4 Theoretical foundations of the study

Healthcare systems are complex systems especially when they integrate information technology. The challenge of this study is further complicated by the interaction of different human and nonhuman actors that mainly lead to failed technology based healthcare interventions and implementations. As a result, failure rates are unsurprisingly high, costly and have far reaching impacts (Cresswell et al., 2011). Thus, it becomes necessary and important to evaluate these interventions with theoretically informed techniques to enable a deeper understanding which in turn can facilitate a successful development implementation and adoption of health information technology such as hospital communication application (Cresswell et al., 2011).

We believe that a socio-technical systems perspective can provide the foundations for a better understanding of these systems so that there is a better evaluation and provision of specific solutions to address gaps in their current development, implementation and adoption. Furthermore, it can also enhance our understanding by providing a mechanism to study the relationships between technology organisation, people, social and financial factors that influence the success of hospital communication application development as well as implementation and adoption. We believe that a viable healthcare system can only be improved if these considerations are jointly optimised.

Our goal here is to investigate this in the specific context of a hospital communication application, in a private hospital in Melbourne Australia. The initial analysis and the conceptual framework presented for the application development in hospitals to date shows that the processes underlying the development, implementation and adoption of hospital communication application are inherently socio-technical in nature. A socio-technical approach of study therefore will allow more flexibility in system design and adoption.

We have argued here that this approach will be of benefit to both practitioners for better design and implementation, and researchers for better evaluation. The researchers, however, acknowledge that socio-technical theory as Berg et al., (2003) rightly indicate, does have its shortcomings and suggest that to overcome these one should combine such an analysis with other theories namely, Actor Network Theory and Activity Theory which are now presented.

4.1 Actor-Network Theory (ANT)

Actor-Network Theory (ANT) is a sociological theory developed by French sociologists Bruno Latour and Michel Callon and British sociologist John Law (Latour, 2005; Law, 1999). Its fundamental premise is that technologies and people are linked in an often-complex network. ANT tries to bridge the gap between a socio-technical divide by denying the existence of purely social or technical relations. In doing so, it takes a very radical stance and goes as far as challenging many of the conventional epistemological ideas and rejecting any distinction between subject or object, nature or culture and/or technology and society.

ANT assumes that each entity (such as technologies, organizations and humans) is an actor. Therefore, the actors have the potential to transform and mediate social relationships (Cresswell et al., 2011). ANT further emphasises that entities regardless of their nature, whether human, technologies, activities or process, are not fixed. Thus, they do not have any significance on their own, but rather their significance depends on the nature of their relations with other entities in the network and their role which may change as their relations change (Law, 2006). This means that neither actors nor their relations are static and permanent; they change over time and across social and political contexts (Singleton & Michael, 1993).

Actors are essentially considered heterogeneous in nature, representing negotiations at different levels (e.g. political, social, technical and or economic levels). Further, the degrees of commitment, skills, constraints and prejudice among actors also can vary. Often, these represent a mixture of one or two of social, technical or personal levels (Latour, 2005). At the technical level, the role of technology may be involved to facilitate users by giving them accurate and up-to-date information when it is needed.

For example, in healthcare, the accuracy (effectiveness and efficiency) of the technology would be best determined or disputed by the users (nurses, clinicians, pharmacists and patients). To better understand relationships and how they create meaning and describe the role of different actors (e.g., the patient, GPs, nurses, different diagnostic tests, different medical technologies, different communication channels, standards, protocols and decision and policy makers), ANT suggests we should think in terms of networks of relations or actor-networks (Williams-Jones & Graham, 2003).

In the context of hospital messaging, a new technology actor is to be introduced to an existing socio-technical network to replace an existing actor (communication tool, pager) who has a long term established role in the network. This change is both complex and risky especially in an acute care hospital environment. This has been acknowledged in "healthcare, which is a strongly people-centred sector where technology is dealt with more as an intruder, as a spy to the healthcare professionals' way of doing things, and as a competitor to this people-centred model." (Berler et al., 2005). Among many problems attributing to this complexity, acceptability and usability has been well known as reasons (Darbyshire, 2004; Mills et al., 2013; Stevenson et al., 2010). Therefore, impacts of a specific system on the health service providers and their reactions are difficult to predict and need to be examined carefully. ANT can help to understand that how the resistance to socio-technical change can be met by re-organising the relations in actor-networks and translating their interests into common goals. Counter-claims and disagreements that arise from different actors in a network can harm the stability of the network. The concerns regarding aggravated costs, healthcare quality, safety and efficiency of communication channels and most importantly acceptance of a new system shapes the problemisation stage. The Hospital Secure Messaging and Communication Platform is the primary actor as well as the Obligatory Passage Point between other actors. Competing roles between the incoming primary actor (Hospital Secure Messaging and Communication Platform) and the out-going actor (old hospital messaging and communication tools) requires that links between the latter (old hospital messaging and communication tools) and other actors (e.g. nurses, medical staff, allied health professionals and patients) are weakened. In addition, the ties (interests) between the incoming actor (Hospital Secure Messaging and Communication Platform) and the other actors need strengthening, through interessement, to be successful. If this process succeeds, then it can facilitate the enrolment stage in which actors accept and align their positions in new networks where the actor old hospital messaging and communication based tools leaves the network and the Hospital Secure Messaging and Communication Platform enters the network. Mobilization happens when the new networks become active and stable with the new actor.

The foundation of networks is built upon the rules of interactions between actors. Therefore, continuous translation of interests at different levels is a primary source of social order. It is therefore, also important to understand the role of controlling elements and their influences and contribution (Law, 2006).

4.2 Activity Theory (AT)

Activity Theory, or cultural-historical theory of activity, (Vygotsky, 1978) was first developed in the 1920s and 1930s by Lev Vygosky, a Russian psychologist, together with his colleagues. The fundamental building block of the theory is a human activity involving a Subject i.e. a human agent, and an Object i.e. an objective or goal of activity. This subject-object relationship is mediated by a Tool(s) i.e. an instrument(s) that can be physical tools, signs, and/or cultural means. Activity Theory with its core triangle of Subject-Object-Tool aims to study the human doer and his/her complex and mediated activity in context.

Activity Theory was extended by Leontiev (2009) to describe a three-layer model of human activity consisting of activity, actions and operations. Along with these, there is another hierarchy of motivation consisting of motive, goals, and conditions. An activity is associated with motive at the top level and can be characterized as high-level, significant and holistic. Activity can be achieved through a set of actions and each consisting of operations. An action can be associated with an intention (to achieve

a specific goal) and operations. An operation is to be performed routine to complete the action under certain conditions.

Activity Theory was further extended by (Engeström 1987; Engeström, 1999) to include the collective characteristic of the human activity system. The extended model includes additional collective elements of rules, community and division of labour. Rules and division of labour can be explicit or implicit. Rules refer to conventions, regulations and social relations within a community and division of labour refers to the organisation of a community to enable the transformation. Therefore, rules mediate the relationship between subject and community while division of labour mediates the relationship between object and community. The mediating roles of tools, rules and division of labours are historically formed and evolve over time. Further, Engeström's (1987) structure of activity also emphasises the transformation of an object to an outcome.

Activity Theory has been explored and argued to be a useful theoretical lens to study in Information Systems (Crawford and Hasan, 2006; Häkkinen and Korpela, 2007; Hasan and Banna, 2010; Sadeghi et al., 2014). Activity Theory has been found to be useful to explore and elicit users' requirements for an information system as a mediating tool to achieve their professional goals in the healthcare context (Häkkinen and Korpela, 2007; Sadeghi et al., 2014). Activity Theory was found to be an effective framework to unpack healthcare activities when assessing e-health readiness in community hospitals in South Africa (Coleman and Coleman, 2013). In the context of IS design, Activity Theory was found to be a powerful unit of analysis to gain deep understandings of the complexity and dynamics of human activities in public healthcare (Hasan and Banna, 2010).

This study builds on previous research, in which Activity Theory was found to be a useful theoretical lens to examine IS development and use in human activities in their immediate context of use. In this study, Activity Theory is used to examine the mediating role for a new Hospital Secure Messaging and Communication Platform in a private hospital setting. This is one of the first studies to use Activity Theory along with Actor network theory in this context.

5 Conceptual Framework

The initial conceptual framework for the study identifies the human and non-human factors for successful Hospital communication device development, implementation and adoption as can be seen in fig 1. At this stage, we have combined the two-presented socio-technical theories for the conceptualization of the framework. Documents and archival records of healthcare services provider organizations, government agencies and private organizations involved in healthcare service delivery and hospital communication mobile application development and implementation are also analysed. Important activities involved in hospital communication were identified coupled with key considerations and enabling and inhabiting factors for the successful implementation and adoption of communication solutions. All these financial, organizational, and social, people and technological factors were analysed at the micro, meso and macro level respectively. This has facilitated the development of the proposed conceptual framework. The proposed model identifies a network of different actors interconnected to each other. It further illustrates that a central issue with the evaluation of IT based healthcare is influenced by the complexity of the evaluation objects and includes both social and technical considerations (Ammenwerth et al., 2003). For instance, the nature of the integration of healthcare information systems with the culture and business processes of healthcare organisations puts more emphasis on the evaluation methods and goes beyond the technology aspects of hardware and software. Furthermore, external and internal environmental factors as well as an understanding of the diverse nature of system effects in the healthcare settings is required (Ammenwerth et al., 2003). This emphasis is on creating a better fit between human, contextual and technological factors for the successful implementation and adoption of health information systems (Dansky et al., 2006; Kukafka et al., 2003; Yusof et al., 2008).

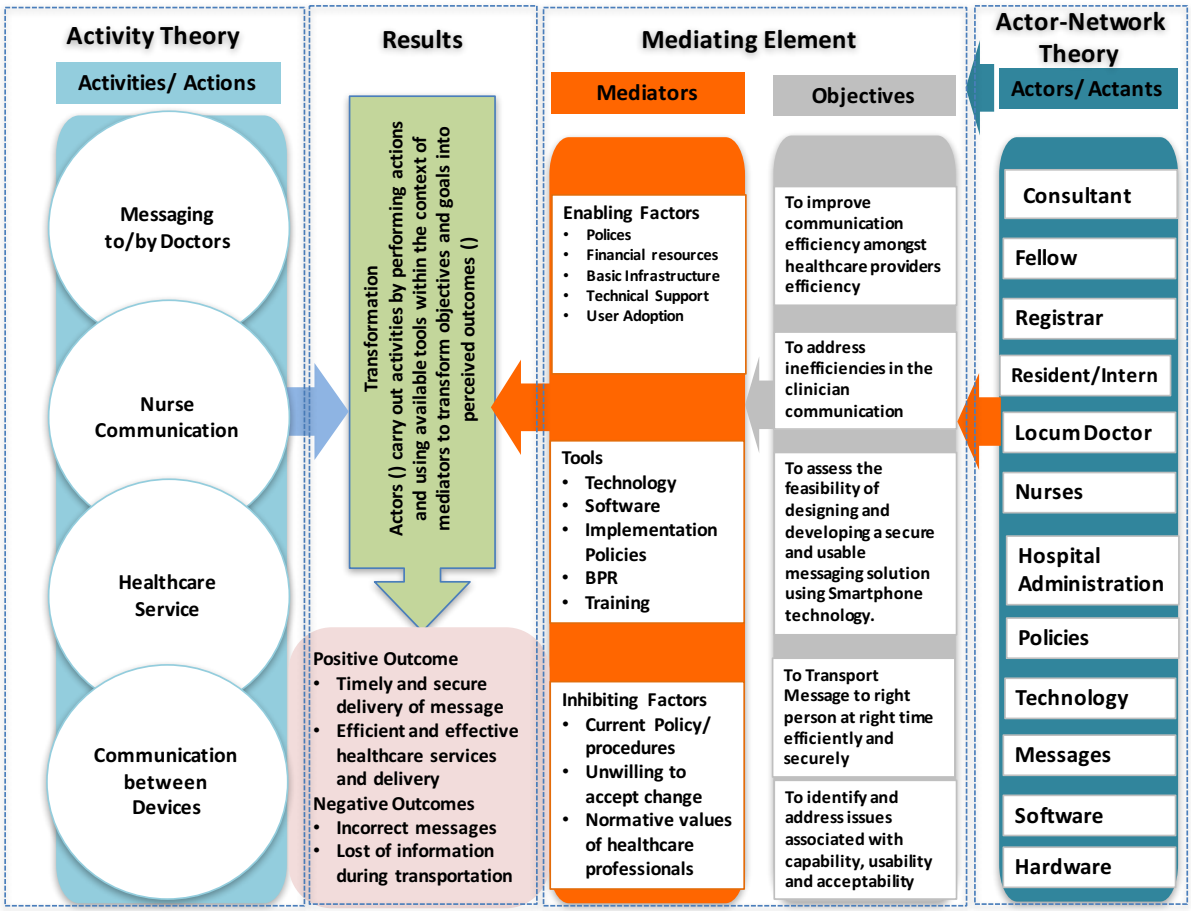

Figure 1. Structure of human activity in Activity Theory.

To study this complex network of interactions of humans with technology in organisations and certain individual levels a Socio-technical System (STS) perspective is indeed prudent (Cresswell et al. 2011).

The researchers note that in the conceptual model (Fig 1) it is possible to view these factors at different levels. In particular, micro level issues (ie issues related to the individual user level, such as technology acceptance and communication failures), meso level issues (i.e., issues related to the organisational level such as organisation wise communication policy) and macro level issues (ie issues related to the Governance such as national health standards) and dealing with policy regarding funding and privacy aspects. However, it is important to remember that the actual factors concerned to the activities in hospital information and communication delivery and distribution are relevant at all levels (micro, meso and macro levels) and together form a heterogeneous network as per Actor-Network Theory (Latour, 2005), and thus it is important at least initially to view them at the same level much like the way Actants are all treated equally in ANT (Latour, 2005).

Therefore, to study this complex network of interactions of humans with technology as the hospital communication platform project necessitates, the holistic approach is a necessity. Holistic means that analysis should be done as a whole including all the interdependent parts of the system and avoid any separate or individual analysis (Latour, 2005). This approach serves to capture all issues relating to financial such as funding, organizational such as policy and procedures and social, people and technological factors such as technology acceptance and use during the design, implementation and adoption phases of the Hospital Communication Application.

Our initial investigation into hospital communication solutions and their adoptions has served to indicate a great need to start focusing on social and organisational issues and shift away from the current techno-centric obsession of how the technical system can be made to work right. The literature clearly

outlines that the failure is not just because of a poor understanding of technological issues but also, and more importantly, about a lack of understanding and interest in organisational, cultural and social issues (Sharma et al., 1999). Ignoring the existing organisational workflows and social interactions in redesigning the organisational processes may hinder the implementation and adoption process, which could have adverse effects on healthcare service outcomes (Muhammad et al., 2012). Therefore, the information system alone might not be the decisive factor but the social factors are likely to have much more importance in the decision-making process. A socio-technical design provides a well-thought-out approach to acknowledge the complexities of the healthcare environment and explain the interaction between a social system, Hospital activates and a technology (Altman, 1997; Atkinson et al., 2001; Coiera, 2011). Hence the researchers believe it is only through the adoption of a socio-technical approach that it will be possible to not only fully capture the complexities and richness of healthcare operations but also be able to analyse them effectively and appropriately and thereby assess critical issues for successful development and implementation to ensue.

6 Conclusion and Recommendations

The need for IT based interventions in the healthcare services delivery to improve information and communication flow is well recognised all around the globe. Different e-health solutions are being implemented with mixed success to address this challenge (Protti & Smit 2006; Basch 2005; DesRoches et al. 2008; Greenhalgh and Stones, 2010). It is, therefore important to evaluate these technologies with theoretically informed approaches to enjoy more successful outcomes.

We believe it is important to develop a deeper understanding of the sociotechnical complexities to the development, adoption, implementation and diffusion of various hospital communication solutions. Specifically, we suggest that a socio-technical approach can inform and facilitate such evaluations and we illustrate this by presenting a conceptual framework for the development and implementation of hospital communication system in a private hospital based in Melbourne Australia. We are confident that this approach can be beneficial to both practitioners and researchers.

This paper has served to outline the key concepts of ANT and AT that are relevant in the context of the hospital communication system adoption and implementation and discussed the appropriateness of a theoretical lens for the evaluation of hospital communication system in very complex environment of healthcare service delivery. We have also noted that ANT has been criticised by several scholars based on its appropriateness as an ontology and/or epistemology (Latour, 2005). Therefore, we recommend that to reduce the negative impact of these limitations the use of Activity Theory along with Actor-network theory be incorporated. A theoretically conceptualized framework in Figure 2 offers a practical approach to viewing a complex sociotechnical phenomenon such as the development, implementation and adaption and deployment of ICT based communication tools in hospital environment, and its integration into healthcare services and delivery. Practically, this socio-technical framework offers analytical tools that can assist managers, policy makers and other actors to make sense of the underlying factors surrounding the implementation of technology policies in the societal settings at different levels local in hospital and at macro level including government levels. Further, it will serve to establish proof of concept by theoretical conceptualization of hospital messaging system and usability and feasibility of the proffered solution.

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