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Telemedicine for low resource settings: Exploring the generative mechanisms

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ABSTRACT

Information Communication and Technology for Health (ICT4H) initiatives, such as telemedicine, can potentially bridge the gap between the health care services available in rural and urban areas. However most of such initiatives have not been able to sustain or obtain optimal results. Comprehending knowledge about what drives success in telemedicine initiatives would be highly valuable for practitioners, policymakers and academicians. In this study, through a qualitative analysis of doctor-patient interactions over a telemedicine initiative in India, we attempt to identify the mechanisms that can enable successful telemedicine interventions. Based on the perspective of critical realism, we explore the phenomenon through the lens of 'generative mechanisms'. Specifically, we identify three different mechanisms that underlie successful telemedicine, namely, (1) Mechanism of rich connectivity, which refers to the expanding scope of information flow between the nodes to include multiple aspects- clinical, managerial and technological; and both online and offline communication; (2) Mechanism of tutoring, which involves learning and skill development of the peripheral doctor; and (3) Mechanism of moulding, which concerns the moulding of naïve patients to expert patients, both in technology use and self management of disease. In addition, the paper demonstrates the efficacy of critical realism as a philosophical perspective for providing substantive insights in the field of ICT4H initiatives.

1. Introduction

Seventy-five percent of health care facilities (infrastructure and manpower) in India are concentrated in urban areas, which accounts for only 27% of the population. The lack of manpower is mainly at the specialists' level with about half of the posts for surgeons, gynecologists, pediatricians and physicians lying vacant in rural areas (Bhandari and Dutta, 2007). Information Communication and Technology for Health (ICT4H) interventions, such as telemedicine, acting as a conduit of information, offer promise to bridge the knowledge gap between the "haves" and the "have-nots", between the urban and rural areas (Miscione, 2007). Telemedicine has been defined as a distant delivery of health related services through transfer of audio, video and graphical information via telecommunication networks, including consultative and diagnostic services along with enablement of planning, coordination, collaboration and education (Singh et al., 2009). However, despite the promise, adoption of ICT4H initiatives such as telemedicine, has been slow, uneven and limited in scope (Chandwani and Dwivedi, 2015; Sims, 2016), especially in low-resource settings such as India (Miscione, 2007). In this paper, we conceptualize a low-resource setting as one that is characterized by infrastructural constraints, both, in terms of access to healthcare services and the technical infrastructure (Miscione, 2007).

To achieve the potential of telemedicine in a low-resource setting, there is a need for researchers to develop a comprehensive and deep understanding of how the telemedicine process works in such contexts- including an understanding of processes, contingencies, structures and causal mechanisms. This deep knowledge would be highly valuable for managers and professionals involved in design and implementation of telemedicine. Our research focuses on the mechanisms that contingently underlie successful telemedicine in low-resource settings such as India. Specifically, by examining the doctor-patient interactions over a successful[1] telemedicine initiative in India, we attempt to understand "What are the mechanisms underlying successful telemedicine design and implementation, especially in low-resource settings."

One of the important reasons for slow and uneven adoption of

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[1] By successful we mean that the telemedicine intervention sustained over a period of time; increasing number of patients used the system; the system was regularly used and both doctors and patients found the sessions useful.

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telemedicine, is the lack of fit between the technology design and the human dimensions of the technology usage (Avison and Young, 2007; Miscione, 2007). The literature on impact of telemedicine has largely focused on the technological aspects of telemedicine (Mair and Whitten, 2000; Nelson, Miller and Larson, 2010). As highlighted by Whitten, Sypher, and Patterson (2000), '*we know a good deal about bandwidths and resolutions, but little about the human dimensions that make practice possible*' (p. 112). Telemedicine can result in marked changes in technical and interpersonal context within which communication takes place (Miller, 2011: 55). Indeed, successful diffusion of telemedicine programs is dependent upon the capacity of the actors to communicate effectively in this new medium (Miller, 2011); accordingly, we examine both social and technological dimensions- interactions amongst various actors and the interactions of actors with technology. As the purpose of the research is to explicate underlying mechanisms for successful telemedicine, we propose critical realism (CR) as a lens for the study, given its emphasis on generative mechanisms (Archer et al., 1998, Bhaskar, 1998, 2013; Sayer, 1992).

Generative mechanisms are defined as "*causal structures that generate observable events*" (Henfridsson and Bygstad, 2013). The idea of generative mechanisms draws from Bhaskar's philosophy of critical realism where these are understood as originative arrangements that make possible the visible situations that emerge (Bhaskar, 1998). Aligning with the theoretical lens and the philosophical underpinning of critical realism, we take an interpretive approach and adopt qualitative methods for the study. Qualitative methods are opportune in making sense or meaning of the observable events to delineate underlying generative mechanisms (McGrath, 2013).

Our research contributes to the literature in multiple ways. First, we identify three generative mechanisms that determine successful telemedicine interventions and how these mechanisms contingently lead to the outcomes specifically in the low-resource settings. The focus on generative mechanisms driven by critical realism advances current knowledge about why some telemedicine interventions evolve successfully while others do not sustain (Sims, 2016). Further, the paper demonstrates the efficacy of critical realism as an important perspective for making substantive contributions to the ICT4H literature.

The rest of the paper is structured as follows. In the following section we dwell on the theoretical framework of critical realism and generative mechanisms. Then we explicate the research context and the methodology. Next we present the findings of the study. In the discussion section we analyze the findings and tie them to the theory. We further outline the contributions to theory and practice. We conclude by highlighting the key insights from the study and outlining the directions for future research.

2. Theoretical framework- critical realism and generative mechanisms

Much of the extant IS literature is either situated in an (a) interpretivist paradigm, focusing on the rich understanding of meaning-making of the socio-technical milieu by the actors or in (b) positivist paradigm, focusing on the directly observable phenomena in the empirical domain. The CR perspective on the other hand positions itself as an alternative paradigm (Wynn and Williams, 2012), leveraging elements from both perspectives. CR combines a realist ontology with an interpretive epistemology (Henfridsson and Bygstad, 2013: 10) emphasizing that though our worldview is socially constructed, reality exists, often independent of the actors (Mingers, 2004).

The CR paradigm explicitly focuses on establishing causality, by exploring how and why complex observable events occur in a specific context, instead of merely describing the phenomena, testing theories or proposing models for prediction (Wynn and Williams, 2012: 804). Given the ontological and epistemological bases of CR, "*the [research] question must be of the form 'What caused the events associated with the phenomenon to occur?'*" (Easton, 2010: 123). In other words, a causal research question entails a focus on mechanisms in a specific context (Wynn and Williams, 2012). CR-based research attempts to dig deeper into the observable events to effectively identify and explicate the underlying mechanisms that link the "*chains of indeterminate events and complex interactions*" (Grover et al., 2008: 45). These linkages can be explicated in the form of generative mechanisms.

Generative mechanisms are underlying causal structures that result in observable events in the empirical domain (Bhaskar, 1998, 2013). Generative mechanisms refer to "*one of the processes in a concrete system that makes it what it is - for example, metabolism in cells, inter-neuronal connections in brains, work in factories and offices, research in laboratories, and litigation in courts of law*" (Bunge, 2004: 182). As compared to Hume's conceptualization of causality, critical realists posit that the underlying structures have causal powers; though such causality is contingent and contextual as the observable outcome of a mechanism depends upon existence of other mechanisms (Elder-Vass, 2007; Sayer, 1992). Mechanisms, inherent to physical or social structures, are causal powers that can enable or limit the expression of a phenomenon in the empirical realm (Fleetwood, 2004; Sayer, 1992; Smith, 2006).

As the purpose of this research is to understand the mechanisms determining successful telemedicine interventions in a low-resource setting, we adopt a CR perspective in this study. CR is opportune in understanding linkages between design and implementation of specific contextual technological interventions and their respective outcomes (Straub and Ang, 2008). In other words, the CR perspective allows for exploring explanations that account for both the observable empirical events (such as successful telemedicine interventions in a specific context of a low-resource setting) and the embedded contingent causality.

Telemedicine involves doctors providing healthcare advice to the patients over virtual media. The interventions are highly contextual as "different technologies can shape and be shaped by action in specific contexts" (McGrath, 2013). For example, the socio-cultural, economic and technological aspects in low-resource settings such as India would be drastically different from that of high-resource contexts in the developed world. Therefore, researchers have argued that rather than searching for universal social laws and meta-theories which attempt to explicate a broad range of social phenomenon across contexts, scholarship should focus on mid-range contextual theories. Based on the CR perspective, the lens of generative mechanisms allows for building mid range theories to explicate socio-technical phenomena (such as telemedicine) through context-specific explanations.

2.1. Generative mechanisms and telemedicine

Generative mechanisms occupy the middle ground, linking the social laws and observations (Peter Hedstrom and Swedberg, 1996). Volkoff and Strong (2013: 821) posit that Generative mechanisms potentially provide explanations for the observable events, proposing that "*predictive theories based on statistical correlations can only tell us what may happen, and even then depend on debatable assumptions of system closure, variable independence, and normal distribution*." They suggest that retroduction allows researchers to explore the mechanisms that operate under the surface and ascertain causal explanations for the phenomenon (Volkoff and Strong, 2013).

Astbury and Leeuw (2010) position mechanisms between social laws and description. Similarly, Henfridsson and Bygstad (2013) posit that generative mechanisms delineate underlying causes that connects social laws to observable outcomes. Bhaskar (1998: 38) posits that "*Generative Mechanisms must be analysed as the ways of acting of things; and their operations must be understood in terms of the exercise of tendencies and causal powers*". In other words, the researchers need to develop an in depth understanding of the observable phenomenon and based on these events/observations, determine the underlying generative mechanisms.

Henfridsson and Bygstad (2013) explicate generative mechanisms