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The Role of Contradictions and Norms in the Design and Use of Telemedicine: Healthcare Professionals' Perspective

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Abstract:

Telemedicine's potential to improve healthcare's accessibility and quality has been advocated for decades. However, its adoption has been fraught with problems. In this paper, we apply a socio-technical approach and, specifically, activity theory to study how healthcare professionals (HCPs) in Sri Lanka adopted and used telemedicine. We depict two application-based telemedicine services in Sri Lanka, one improvised and one intended. We found out how contradictions in how HCP used the improvised telemedicine facilitated their adoption of the intended telemedicine. We also highlight the influence that social norms have on how individuals use telemedicine and on the technological features of the digital platforms that enable shared economy services. Based on our findings, we recommend that telemedicine application designers need to consider: 1) subjects' (a la activity theory) motivations to engage in the activity that telemedicine mediates, 2) the norms and rules that mediate the activity, 3) contradictions in the existing activity system, and 4) the application's technological characteristics. To stimulate its adoption, new technology should help to address contradictions in existing activity systems, concur with social norms, and offer users the ability to influence social norms that can cause contradictions.

Keywords: Telemedicine, Healthcare Professionals, Activity Theory, Contradictions, Social Norms.

Jose Abdelnour-Nocera was the accepting senior editor for this paper.

1 Introduction

The healthcare sector continues to undergo a transformation due to information and communication technologies (ICTs) (Agarwal, Gao, DesRoches, & Jha, 2010; Fichman, Kohli, & Krishnan, 2011; Gianchandani, 2011). Telemedicine—that is, using ICTs to deliver healthcare services over geographical distance (Xue, Liang, Mbarika, Hauser, Schwager, & Kassa, 2015)—should play an increasingly important role in the way that healthcare professionals (HCPs) deliver healthcare services (Helsel, Williams, Lawson, Liang, & Markowitz, 2018).

However, telemedicine adoption has been slow and fraught with problems from its roots in the 1960s projects, which did not become established, through to renewed interest in the late 20th century (Klecun-Dabrowska & Cornford, 2002; Darkins & Cary, 2000; Perednia & Allen, 1995) and current initiatives (Dorsey & Topol, 2016).

Researchers have identified many barriers that prevent healthcare practitioners from adopting and using telemedicine. Examples include technical issues, societal issues (i.e., a lack of access or skills to use the technology), legal issues, reimbursement arrangements, and clinical issues (such as the quality of the patient-physician relationship and the quality of care) (Dorsey & Topol, 2016). In low- and middle-income countries in particular, researchers have singled out legal, sustainability, culture, language, and contextual factors as important to consider when one implements telemedicine (Saliba et al., 2012). However, most studies have tended to adopt an engineering/computer science perspective, highlighted discrete factors that hinder telemedicine's diffusion, and presented technological solutions. Papers that focus on telemedicine's diffusion and adoption have tended to approach it either from a macro-level perspective whereby they identify structural factors or from an individual-level perspective whereby they focus on technology acceptance and predominantly apply quantitative approaches informed by the technology acceptance model (TAM) (Davis, 1989), unified theory of acceptance and use of technology (UTAUT), or the coping model of user adaptation (CMUA) (Beaudry & Pinsonneault, 2005). Such studies often do not consider the social context that shapes how individuals adopt and use telemedicine services in depth (Greenhalgh et al., 2013), yet research has shown the local social context to be important to designing and using such services (Miscione, 2007; Saliba et al., 2012; Thapa & Sein, 2018). Telemedicine's fit with HCPs' lives, their notions of good patient care, and broader social norms and regulations influence HCPs' motivations to and how they actually use telemedicine (Walker & Whetton, 2002). In addition to studies on practitioners' initial attitudes to telemedicine, we also need studies that analyze their interactions with patients through telemedicine and that take a holistic process-oriented approach that considers the context in which those interactions occur (Sam, 2012) and the technology's characteristics.

Inspired by a socio-technical approach and informed by the rich tradition of applying activity theory in the human computer interaction (HCI) field, we take the human activity, which technology and society mediate (e.g., through norms and rules)—that is, the activity system as Engeström (1987) conceptualizes it—as the fundamental unit of analysis to study telemedicine use (Roth & Lee, 2007). Therefore, we apply activity theory to study telemedicine use in Sri Lanka to 1) better understand conditions that may lead HCPs to continue to use telemedicine and 2) help explain how one might design such services. Specifically, we examine the following research questions (RQ):

- RQ1:** What motivations do HCPs have to adopt telemedicine?
- RQ2:** What telemedicine characteristics facilitate its use?
- RQ3:** To what extent and how does telemedicine use help to address contradictions in the HCPs' activity system?
- RQ4:** How do social norms shape telemedicine use and how are they shaped by it?

With our study, we stress the contextualized and social transformation that implementing an individually based telemedicine brings about and illustrate how socio-technical aspects influence the way users experience complex and multifaceted information systems (IS) (in this case, a telemedicine system). We also make suggestions pertinent to designing technology and its implementation and use in a broader socio-technical system.

In our case study, we examine a commercial telemedicine service that uses smartphone-based software applications and caters mainly for urban, techno-savvy patients who seek convenient access to healthcare. As such, one can refer to the case we analyze as a shared economy service based on how Apte and Davis (2019) define such a service; that is, as a service that 1) connects customers (patients) and providers

(HCPs) offering services, 2) uses a smartphone application based on a digital platform, and 3) supplies unused capacities. The mediating technology largely accounts for the shared economy's success (Frenken, 2017), although researchers do not agree on the technology's characteristics (Sutherland & Jarrahi, 2018).

Our analysis of a smartphone-based telemedicine application use reflects a new trend in the way HCPs practice telemedicine (Dorsey & Topol, 2016; Helsel et al., 2018) and complements the literature on telemedicine services that link healthcare professionals with one another, that involve dedicated technologies in hospitals and satellite clinics, and that usually focus on providing care for populations who live in remote areas. Furthermore, most studies focus on patient adoption and use but neglect HCPs' intention to accept and use telemedicine (Segrelles-Calvo, Chiner, & Fernández-Fabrellas, 2015), which we focus on in our case study. From a HCI perspective, we present an interesting case since it examines HCPs' engagement with patients through social networking sites and a more formal digital platform based service, which offers a shared economy service by linking patients and HCPs for remote consultations through a smartphone-based application in a highly institutionalized and regulated environment.

This paper proceeds as follows: in Section 2, we describe the paper's underpinning theoretical perspective, activity theory. In Section 3, we describe our methodology. In Section 4, we describe and analyze the case study. In Section 5, we discuss the main points and themes that we identified from the case study and relate them to the literature. Finally, in Section 6, we discuss the study's main contributions and limitations and further research opportunities.

2 Insights of Activity Theory to the Study of ICT-mediated Activities

HCI and work studies have extensively applied activity theory (Nardi, 1995; Korpela, Soriyan, & Olufokunbi, 2000; Clemmensen, Kaptelinin, & Nardi, 2016). Further, more recently, the theory has begun to enjoy increasing popularity in information systems (IS) (Nardi, 1995; Korpela et al., 2000; Karanasios & Allen, 2018). The theory has its roots in psychology and initially dealt with the complexities of human-material interaction and how the human mind works but, since then, has evolved to encompass theoretical concepts for studying collective activities and organizational practices (Clemmensen et al., 2016). At its core, the theory (as formulated by Vygotsky and extended by Leont'ev (1978)) focuses on "activity"—"a purposeful, social, mediated, multilevel, and developing interaction between actors ('subjects') and the objective world ('object')" (Clemmensen et al., 2016, p. 609). The theory sees subjects (a person or a collective) as being motivated to achieve a specific object-transformation towards an aspired outcome. An object may be material (such as software), less tangible (e.g., plans or strategy), or even totally intangible, such as shared ideas "as long as it can be shared for manipulation and transformation by the participants of the activity" (Kuutti, 1995, p. 27). It also might be human: for example, in Engeströms' (1999) study, the patient represents the object of hospital work. While one might consider viewing a patient as an object controversial, in activity theory, the object exists in a reciprocal relation with the subject who transforms it. This relation evolves when the subject attains its immediate goals, learns lessons, or changes its interests and perceptions. An object frames an activity of a subject (human agent) acting towards the object's transformation (Karanasios, 2018). Tools reflect humans' extended agency and mediate the subject's activity. While the subject may use tools for one activity, the tools can also affect other activities as they are part of social processes (Blunden, 2010).

Activity theory according to Leont'ev (1978) differentiates between motives and more concrete goals and distinguishes between related levels of analysis: the activity, the individual action, and the operation. An activity is motive driven (object oriented) and realized through concrete, short-lived actions (such as updating an electronic record) that are goal oriented (e.g., to have up-to-date patient records). In turn, a subject's actions are realized through unconscious operations (such as moving a computer mouse). Operations are conditioned by the relation between the goal, the action's current state, and its material context (Roth & Lee, 2007). For example, the operation "moving a computer mouse" relates to the goal of having an up-to-date record, the action's state (finished entering data and ready to save), and the mouse's placement on the table.

Engeström (1987) extended Vygotsky's and Leont'ev's (1978) versions of activity theory by introducing the activity system model that elaborated the notion of collective action and introduced several components of the activity system: community (in and for which an activity takes place), rules and norms, and the division of labor. This conceptualization has opened up the possibility to understand different, even contradicting perspectives represented in one activity system or across a network of various activity systems.

Activity theory adopts the key notion that one cannot understand each component of an activity in separation; rather, it posits that one can understand them only through interactions with the other components. Furthermore, the theory sees activities as historically and culturally constructed. For example, the capitalist system and historically developed notions of a doctor-patient relationship have conditioned “patient” (an object). Applying those insights to IS suggests we can only understand an information system’s use, “impacts”, and transformative potential through a practice perspective that conceptualizes IS use in a broader socio-technical system. Norms and rules, seen as regulatory element towards appropriate behavior (Karanasios, 2018), maintain an important role in any human activity system.

An activity system can be interlinked with many other single activities that affect one another. Activity systems can increase in complexity over time (Spinuzzi, 2008), which “multiple mediations” (Engeström, 1999, p. 66) in a single activity and a network of activities reflect. The mediation concept is important for HCI and IS scholars because one can conceptualize information systems as “tools” (albeit often complex and ambiguous (Karanasios, 2018)) that mediate the subject’s actions and influence both the subject and the object.

An activity system has a dynamic nature (Allen, Karanasios, & Slavova, 2011), and changes in one component lead the whole system to transform (Ditsa & Davis, 2000). Subjects initiate changes in order to resolve occurring contradictions (Engeström, 1999). The literature refers to contradictions as conflicts, (systemic) tensions, or misfits and to their visible manifestations as problems, raptures, or breakdowns and disturbances (Kutti, 1995). We believe that one needs to analyze contradictions to understand information system use and to (re)design information systems; thus, we focus on analyzing them in our research. According to activity theory, first-order contradictions appear in an activity. These contradictions occur either 1) in the activity’s individual constituent components (as, e.g., in Engeström’s (1999) example, one may see a patient as a person that needs care or as a source of revenue; a tool may become a source of contradictions), 2) between the components (e.g., between the community and the division of labor), and 3) between an activity and its more advanced form (e.g., before and after someone has introduced an information system) (Karanasios, 2018). Secondary contradictions refer to the interaction between different activity systems (Engeström, 1999). Contradictions in an activity (Engeström, 1987) and between activities give rise to change and transform the individual activity system (Engeström, 1999).

By providing concepts that place human-technology interaction in a larger context of purposeful human activities, activity theory allows one to more deeply understand technology, its meaning for people and its design and use (Karanasios, 2018; Bødker, 1989; Kuutti, 1995). In the healthcare context, researchers have applied activity theory to study how hospital work has transformed (Engeström, 1999), how patients use assistive technologies at home (Woll & Bratteteig, 2018), and chronic disease management (Cornet, Volda, & Holden, 2018). Those studies illustrate how activity theory, on its own or with other theories, can help to provide insights related to how healthcare and self-care practices transform. Thus, activity theory offers a useful lens to study telemedicine use in healthcare consultations.

3 Methodology

Based on our research questions and activity theory as our conceptual model, we applied a qualitative research design to better understand how telemedicine emerges and how healthcare professionals (HCPs) adopt and use it (Sam, 2012). We conducted a case study on how HCPs’ used a specific telemedicine application, Remodoc (name changed for anonymity). In this section, we overview our case study and describe our data-collection and analysis methods.

3.1 Case Study

We conducted our case study in Sri Lanka. As a less economically developed country (LEDC), Sri Lanka offers a comparatively high standard of healthcare for its population (Edirippulige et al., 2007). Although the public sector offers free healthcare service for everyone, the country also has a private healthcare sector (Pallegedara & Grimm, 2017). In order to acquire their specialization, HCPs need to work for at least one year abroad and initially in the public sector once returning. We identified that HCPs predominantly sought work in the public sector for job security and in the private sector for better pay. Given that Sri Lanka has highly dense smartphone ownership, few organizations have begun to develop applications for HCPs to use to provide healthcare there. In this study, we focus on a teleconsultation service (targeting the private healthcare sector) between patients and healthcare professionals (HCPs) from various specialties. A private company provided a digital platform (Remodoc) that connected HCPs and patients without any

governmental support. Patients needed a bank account to register. The Sri Lankan Ministry of Health vetted HCPs before the platform would register them. Remodoc legally accepted digital prescriptions with the following information: the HCO's signature and medical registration number and a photograph of the HCP's stamp (each HCP had a government-registered seal). The platform supported video communication, a messenger function for doctor-patient communication, and a digital prescription function. Although not the only telemedicine application on the market in Sri Lanka, only it had a video consultation function and prescription option. At the time we conducted the study, Remodoc facilitated around 2,000 consultations each month and had more than 120 registered HCPs from several disciplines. As such, we had the opportunity to study an established and widely used telemedicine service.

3.2 Research Design and Data Collection

Given the healthcare sector's complex nature and our desire to understand the underlying motives and goals of the HCPs engaged in the telemedicine service, their interactions with patients that telemedicine structured, and the connections between the activity systems in question, we followed a common practice in IS healthcare research and used a single case study to collect empirical data (Boudreau & Robey, 2005). This method allows one to depict "diverse and possibly contradictory perspectives" (Caronna, 2012, p. 71) and place individual actions in broader activities and a cultural-historical context.

We collected empirical data through 20 semi-structured face-to-face interviews in Sri Lanka between July and August, 2018, and through reviewing all registered doctors' data about how they use the application (number of total consultations, unique patients, average rating, price per consultation, membership length) in order to triangulate our data (Denzin, 1978). In this study, we focus on the qualitative part—we used quantitative data only for validation purposes.

We initially contacted the HCPs with the support of an employee of the company that provided the telemedicine platform. We used mail to contact interview partners for their consent and availability, and we informed them about the research's content. We randomly selected the HCPs we interviewed from the provider's HCPs sample and assessed their representativeness based on their total work experience, the work they had conducted on the platform, and their background. We felt that, with 20 interviews, we could reach theoretical saturation. Following "naturalism" (Pope & Mays, 2006, p. 4), we held interviews at HCPs' place of work or home. Interviews, which we audio-recorded and transcribed verbatim, ranged from 30 minutes to two hours.

We derived the questions we asked in the interviews from activity theory's conceptual framework as Engeström (1987) describes it. The questions related to the following categories: subject, object, tool, division of labor, community, rules and norms. We developed further questions as we interviewed participants and collected data.

Table 1. Interviewee Demographics

Interviewees	Age range	Years of overall work experience	Monthly consultations held by HCPs	Smartphone savviness	Workplace
20	33 – 64	1 - 36	3 - 15	Inexperienced, familiar, savvy	Government clinic, private clinic, self employed
Professions	General practitioner (9), nutritionist (2), psychiatrist (2), family physician (2), surgeon, physiotherapist, diabetes care, sexual health, gynecologist.				

3.3 Data Analysis

The first author analyzed the themes in the data, an approach that many qualitative studies adopt (Nowell, Norris, White, & Moules, 2017)—particularly in healthcare and psychology (Pope & Mays, 2006)—using the six-stage method that Braun and Clarke (2006) introduced: 1) become familiar with the data, 2) generate initial codes, 3) search for themes, 4) review themes, 5) define and name themes, and 6) produce a report. We used thematic analysis to abstract themes and see their patterns. We applied a mixed deductive and inductive coding approach because we developed initial codes based on the concepts from activity theory and adjusted them throughout the iterative coding and clustering process into thematic units (Miles &

Huberman, 1994). We used Nvivo software to perform this process. The second author subsequently reviewed the coding.

4 Description and Analysis of the Case Study

In this section, we describe how patients and HCPs remotely engage through digital technology (telemedicine). Thereby, we highlight the cultural-historical context and the way rules and social norms influence telemedicine use. HCPs' handling mobile phone-based interactions with patients presents a typical human-computer interaction. Furthermore, the case study we examine represents a shared economy service based on digital platforms. Through the lens of contradictions and tensions and from HCPs' perspective, we analyze how interactions between patients and HCPs transformed at both the individual and collective HCP levels. We identified two telemedicine services, which we refer as the improvised and the intended telemedicine. The improvised telemedicine self-emerged as patients and HCPs started digital communication through varied social messaging applications. In contrast, Remodoc, the intended telemedicine service, was based on a smartphone application that a for-profit organization purposefully developed to provide telemedicine.

In this section, we reveal how problems that the improvised telemedicine caused for HCPs created the base for the transformation towards their using Remodoc. The company that provided Remodoc identified several of those problems and tried to address them through their telemedicine application. We apply the notion of the human activity system introduced by Engeström (1987) to investigate complexity of mediated relationships that HCPs (the subject in our study) face to deliver better healthcare service to private patients (the activity system's object). The holistic perspective that activity theory provides helps to explain the contextual influences and their mediating role.

4.1 Rise of the Improvised Telemedicine Service

In analyzing the motivations and attitudes of HCPs who handled telemedicine in Sri Lanka, we found that, prior to using Remodoc, they used to communicate with their patients through social messaging applications. Ilyenkov (1982) stated that every transformation towards a new mode that contradictions cause first introduces itself through an individual action that deviates from the norm. In our case study, interviewees revealed the engagement between HCPs and patients transformed towards technology-supported communication. This transformation began about a decade ago when an unknown doctor or doctors started handing out their private phone numbers to patients to provide them with a better service.

Nowadays, HCPs in Sri Lanka commonly hand out their private phone number to patients. Senior and long-working HCPs referred to different times when patients did not demand their personal phone number and when they did not feel obligated to provide them in order to retain patients in a competitive private market but noted that now: "Routinely we do give the private number for emergencies!" (HCP 02).

The interviewees gave the following reasons for providing their phone number: to improve patients' healthcare, to adhere to social norms, and to respond to patients' demands and market pressure (applied through patients as consumers). They wanted to spare their patients from travelling and waiting for follow-up appointments and to strengthen the patient-HCP relationship, and they believed that offering patients the possibility to contact them instantly at any time would lead patients to better trust them.

Thus, the doctor's (or doctors') initial actions affected the activity of other HCPs as a collective. Other HCPs who also started handing out their private phone number and patients who begun to demand it changed the collective activity in the engagement between HCPs and patients (see Figure 1). HCPs stated that patients' expectations about their perceived work changed over the years towards a service provider with required availability at any time. The activity system changed as social norms changed (as giving a phone number becomes normalized; that is, becomes a typical thing to do), it affected the collective activity system.

Contextualizing the interaction, we need to distinguish the governmental from the private healthcare system since they had a different patient-HCP relationship. HCPs reported that patients in the private sector came to see a specific HCP. In contrast, in the public sector, patients saw a specific unit and received treatment from the next available HCP (potentially someone different every visit). As HCP 18 said:

Because in the private sector, they come specifically to see me. In the Government sector, they come to the unit not to see a particular doctor. ...In the government sector, we don't have name tags. They don't know that I am so and so.

Patients in the private sector sought a more personal interaction with their specialist, which frequently meant that they contacted their HCP outside a consultation. The relationship between patients and HCPs rested on trust, which patients understood as constant accessibility. As HCP 18 said: “In the private sector, it goes beyond the consultation”.

Technological advances in mobile devices—specifically smartphones—enabled new communication opportunities, such as social messaging applications and the possibility to send and forward pictures. These advances also led to changes in the way patients and HCPs interacted. Young HCPs’ purposefully advised their patients to use a social networking application to contact them in order to reduce their paperwork and receive instant messages and easily access photographs. By communicating and providing advice to patients via social messaging applications such as WhatsApp or Viber, HCPs used an unstructured and improvised form of telemedicine. As HCP 5 said:

So even my patients before [Remodoc], for example, if I want to see some reports you know for the patient's convenience I have them send them to me through WhatsApp or Viber rather than having them come over once again or pages to show the reports.

When asked for their motivation to engage in the improvised telemedicine HCPs cited improving patient care and being pressured to do so through patients and market expectations.

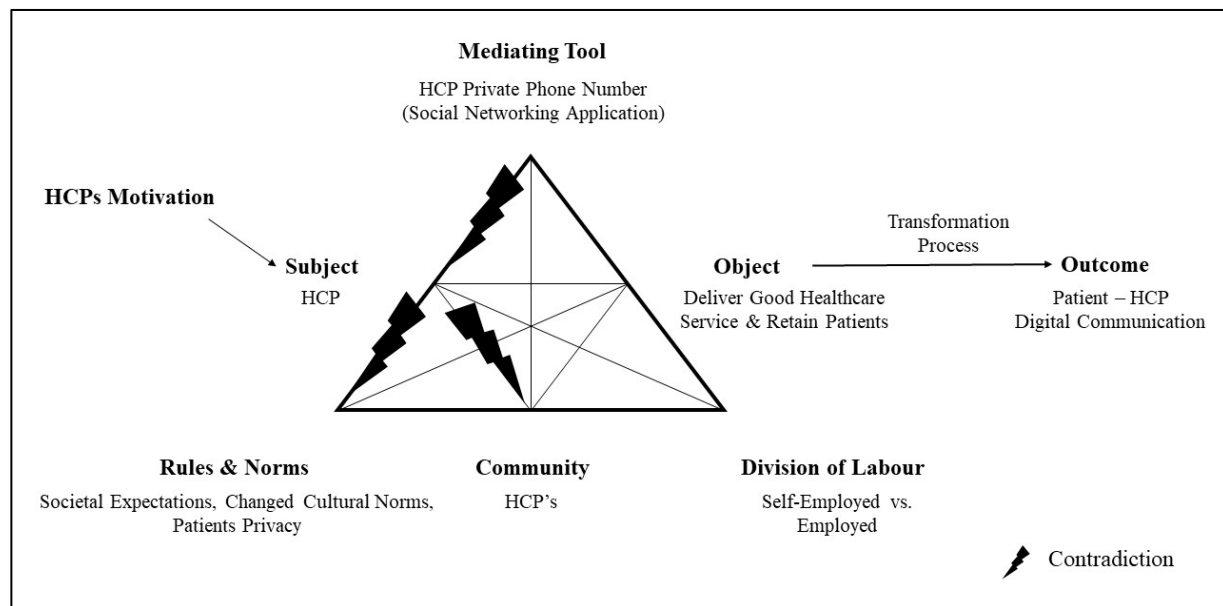


Figure 1. Improved Telemedicine Service—Collective Activity System

4.2 Occurring Contradictions from the Improved Telemedicine Service

The improvised telemedicine service, which began with HCPs’ aiming to retain patients and improve their healthcare services, raised major intertwined contradictions through social norms, market competition, and an open technology. For instance, a contradiction developed over time as patients expected HCPs to provide their private phone number to them despite their unease about losing their privacy (see Figure 1). Social expectations manifested themselves in new norms (see Section 4.1). Patients expressed their distrust if HCPs did not comply with their expectations. HCPs’ attempts to overcome these social pressures by acquiring a second telephone number that they did not use or answer caused patients to lose trust in their HCP and switch to another. HCP 14 said: “And if the doctor doesn’t answer...the patient feels deprived and...loses the confidence with the doctor saying he’s not credible because he doesn’t want to talk”.

On the other hand, HCPs mentioned concerns about liability issues that could arise while using online messengers to converse with their patients since no clear legal regulations governed the practice, and they feared needing to substantiate their consultation advice afterwards since they took no notes or records during such informal appointments. In addition, HCPs should consider security issues and risks to patients’ privacy as using online messengers as social networking applications have received criticism for lacking

adequate encryption (Watson, Pathiraja, Depala, O'Brien, & Beyzade, 2016). Nonetheless, HCPs generally expressed more concern about their own liability, so they consciously avoided recommending medication.

The conflict between the individual subjects (i.e., the HCPs) and the wider HCP community—a first-order contradiction between the activity system's components—was intertwined with the social context. Long-term competition between HCPs in the private sector (especially general practitioners) supported the pressure for HCPs to retain their patients' loyalty and meet their expectations. Some HCPs blamed the increase in competition on the national healthcare system, which did not require patients to see a general practitioner for a referral before they could see a specialist. Instead, patients could freely choose their HCP at their own discretion. The community's actions drove individual HCPs to provide their private phone number to patients. As HCP 1 said: "But again, there is a trend now a lot of consultant they know that if we don't give them our private mobile number, we might lose some patients! We might win them [if we provide our phone number]!"

Another contradiction for HCPs lied in the nature of social messaging applications. In the improvised telemedicine, patients exploited social messaging applications' open design for their benefit, which the social norm about HCPs' accessibility supported.

Open accessibility between individuals who use social messaging applications depends on their sharing their telephone number. Despite the advantages for HCPs' handing out their private telephone number to patients, they began to experience a disadvantage in that they had no control over how patients used their private number. According to the HCPs we interviewed, patients abused the privilege by calling in the middle of the night or making multiple attempts to contact their HCP in a short time, which interrupted their private life. Furthermore, patients sometimes also attempted to avoid paying the consultation fees that would apply if they had attended a consultation in a private hospital or clinic by using the improvised and informal consultations via a social networking application. As a result, the HCPs lost income since providing consultation service via a social networking application constituted unpaid work. The contradiction lied in the HCPs' right for privacy and pay opposed to the social network application's design, which meant the HCPs could not control how people contacted them or achieve remuneration. As HCP 2 said: "In the past where we just provided free WhatsApp consultation. I lost a lot of revenue through WhatsApp!"

In Section 4.3, we discuss how contradictions in the activity system that the improvised telemedicine applications mediated helped HCPs and patients accept Remodoc.

4.3 The Intended Telemedicine Application Responding to Current Contradictions

According to activity theory activity systems have a coherent nature. Thus, changing one element in the activity (e.g., in our case, changing mediating tool) leads to changes in the other elements. HCPs' responses showed that Remodoc's design responded to contradictions (see Figure 1) that HCPs experienced over time while using the improvised telemedicine (social messaging) application. However, the new mediating tool (i.e., Remodoc platform) gave rise to other changes, such as norms and rules that guided healthcare provision. In the latter parts of this section, we discuss those changes. We begin by describing Remodoc's technical design.

4.3.1 Technical Design of the Mediating Tool

Remodoc included video communication, a messenger for HCPs and patients to communicate, electronic medication prescriptions, and a feedback function. The application recorded contact time and duration between HCPs and patients, transferred documents, photographs, and other data on securely stored servers that complied with American data-security standards. Although patients initially reported problems with local pharmacies' recognizing their prescriptions, these issues settled in time and with further acceptance of the application thanks to publicity.

When using Remodoc, HCPs mentioned that it had similarly easy-to-use technical features as the improvised telemedicine (social messaging) applications. They saw ease of use for both patients and themselves as rudimentary but essential aspects that motivated their engagement. Since the interviewees joined the platform at different stages, some were active for a long time and recalled the different development stages from a computer-based system to a smartphone application and the version it took when we conducted the study.

In contrast to the improvised telemedicine, HCPs stressed they benefitted from being able to charge for consultations and prescribe drugs remotely and directly through Remodoc. They also referred to the benefits

in being able to see patients through video streaming. Some HCPs revealed that they purposely refused patients' attempts to contact them via video calls through other applications and referred them instead to Remodoc. The on-off status button allowed HCPs to indicate when they were not available and, thus, to retain some degree of control over their time.

Remodoc systems developers engaged HCPs in designing and adapting the application, which helped to alleviate problems that HCPs experienced when using different social messaging applications.

4.3.2 Rules and Norms

Although HCPs could use Remodoc at their own convenience and maintain some control over their privacy as they did not need to submit their personal telephone number, the social norm (and market pressure) of pleasing patients requests remained strong as most HCPs we interviewed still handed out their personal telephone number to their patients on request. Few interviewees responded that they purposely channelled their patients through Remodoc to ensure their privacy while hoping that they would retain their patient base. They motivated patients to contact them through Remodoc by presenting arguments for patients' convenience in being able to stay at home and avoid travel or waiting times at clinics. However, some HCPs felt they should remain available online all the time. For example, HCP 13 said:

Yeah I like it when it's under my control I like it, but sometimes I feel it may not good for the client because from client side they call from the video consultation they expect the doctor to respond immediately.

Remodoc provided a way for HCPs to charge patients for online consultations. However, HCPs could decide whether to do so and often did not charge for consultations that did not lead to a resolution (e.g., when the patient required a physical examination) since they saw such behaviour as congruent with social norms. Nevertheless, they still considered using Remodoc as favorable to providing free consultations via social messaging applications. Remodoc became a source of additional income for HCPs with telemedicine consultations conducted outside their regular work (e.g., in public hospitals) and sometimes even in working hours (e.g., during shifts in public hospitals).

However, the HCPs saw referring patients from a public sector contact to the private telemedicine platform as ethically problematic, and one HCP reported to feel bad for charging such a patient. As such, professional norms still seemed negotiable and left to individual HCPs' judgment.

Responding to the shifting control in communication and the return of remuneration, patients changed their behavior. HCPs reported that patients started to approach them with more serious and urgent concerns compared to when they could freely contact them through social messaging applications.

Remodoc also better addressed liability issues that concerned HCPs in remote consultations as HCPs had to take notes of patients' history and current state of health as justification for prescribing drugs. As HCP 10 said: "For the benefit of the patient and safety of mine. Because documentation is vital, I have to have clear documentation."

Generally, the healthcare system in Sri Lanka required patients to store and take care of health records themselves. In face-to-face consultations, forgotten documents can cause delays and difficulties in patients' treatment plan as history examination plays an essential role. However, Remodoc enabled HCPs to track patients' history through centrally stored data. HCPs liked the ability to review a returning patient's data before a consultation and felt that it benefitted both them and their patients as HCP 14 said: "Every comment and every like, presenting complaints, it's all in the platform, and it's good for the patient also, so both parties have some validation points".

4.3.3 Intrapersonal Factors of Motivation

HCPs often expressed technology savviness and their interest in using technology at their workplace as an underlying motivation for them to engage in both improvised (social messaging) and intended (Remodoc) telemedicine applications. Although we predominantly found this personal interest among the younger practitioners, some older HCPs engaged with passion the new technology as well. In addition to their interest in technology, HCPs expressed motivation to use digital approaches to interact with patients as an additional channel to accommodate patient's expectations about availability and additional service opportunities. A HCP mentioned the possibility that HCPs' availability on a telemedicine platform might become a competitive advantage and that patients might depend on telemedicine in the future. Another HCP said:

“One is the hassle is less and also if you are motivated and if you love medicine and love technology then this is one of the best things to have” (HCP 10).

Next to the secondary income source, Remodoc incentivized HCPs to use it with flexible work hours and workplace independence (e.g., at home or while travelling). Among our interviewees, we interviewed two mothers who stayed at home and stressed how Remodoc enabled them to continue to practice their profession while enabling them to look after their children. Whereas another HCP reported that Remodoc helped him to organize his work as it offered the possibility to consult patients in the evening conveniently from home.

However, at the time we conducted the study, HCPs and patients had only just begun to adopt Remodoc, and we found rising tensions that might morph over time into contradictions. For instance, the HCPs tended to log into Remodoc all the time such that online consultation requests sometimes interrupted their face-to-face consultations. Additionally, HCPs sacrificed their private time at home through their constant accessibility. Some HCPs considered opening up their own private practices once they acquired a certain patient base through Remodoc. In the longer term, the HCPs could potentially affect private hospitals if patients contacted HCPs directly through Remodoc and skipped the hospitals' registration fee. Thus, such tensions could cause second-order contradictions (between the central activity and other activity systems).

5 Discussion

5.1 Overview

While the studies in the literature tend to focus on telemedicine applications that a single organization or a consortium of organizations purposely create, no one organization governed or owned the improvised telemedicine we examined. Further, the applications used in the improvised telemedicine were characterized by open access and simple usability and had an unstructured nature. This self-emerging service helped HCPs and patients engage with each other through opening a new and already familiar communication channel. Through HCPs' accounts, we traced their motivations to switch to Remodoc (intended telemedicine application).

To address our research questions, we examine our findings through the lens of activity theory (Engeström, 1987). Specifically, we focus on HCPs' motivations, social norms, contradictions in the activity system, and how technology design addressed these contradictions.

5.2 Subject's Motivation to Engage in the Activity

In our case study, we identified that contradictions in the existing activity system led to new motivational drivers that led to adjustments in subjects (HCPs) motivations to contact patients digitally and in their private time. HCPs used Remodoc due to the interconnected, intrapersonal, and contextual (external) factors. They had intrapersonal motivations to improve patients' care (e.g., by saving patients travel time and providing faster report consultations and better accessibility) and to maintain doctor-patient relationships. In addition, HCPs expressed the desire for flexibility in their working practices (e.g., being able to work from home) to maintain (some level of) control over their privacy and work-home balance. The two telemedicine applications they used (improvised and Remodoc) facilitated these motivations in different ways. Contradictions that arose from HCPs' and patients' using the improvised telemedicine led to additional motivating factors for both parties, HCPs and patients, to use Remodoc. In particular, financial benefits of using Remodoc played an important role in HCPs' willingness to use it.

The cultural-historical context affects individuals' motivations to adopt new technologies that mediate activities, while ecological boundaries determine it (Bertelsen & Bødker, 2003). Contextual elements, which activity theory refers to as norms and rules, affected HCPs' (the subject) motivation as they used the two telemedicine systems. For example, evolving norms (patients "right" to be able to contact HCPs instantaneously) demanded certain behavior from HCPs and, intertwined with other intrapersonal factors, motivated HCPs to use telemedicine.

5.3 Norms and Rules Mediating the Activity

While scholars have come to a consensus on an established definition for norms, they have argued that, when considering the influence social norms have on behavior, one should distinguish between descriptive norms (what is; that is, what others typically do and, hence, what appears to be sensible to imitate) and

injunctive norms (what ought to be done; that is, what constitutes morally approved or disapproved behavior) (Cialdini, Reno, & Kallgren, 1990).

Our research shows both descriptive social norms (e.g., that others shared their personal telephone number) and injunctive norms (e.g., of what a good care means) influenced HCPs. HCPs in the private sector in Sri Lanka mentioned social norms that influenced their own willingness to hand out their personal phone number to patients, provide free consultations, and privately engage with patients. This development towards such collective expectations started through an individual HCP's action to hand out his/her private telephone number to patients (in the private sector), which, in time, led to emerging new social norms. HCPs described that their role had become "a personal service provider". The relationship between HCPs and patients relied on trust. HCPs realized that patients' ability to access them in emergencies or whenever they wanted strongly influenced the latter's trust in them. The literature has shown that social values influence patients' decision-making process when selecting HCPs (Kim & Han, 2009). HCPs who used the improvised telemedicine applications on a smartphone lost their private time and work-life balance (Duxbury & Smart, 2011) due to their constant accessibility. Communication via social messaging applications caused liability concerns (due to lack of record keeping, non-legal prescriptions, and lack of security). HCPs' attempts to withdraw from patients' expectations led patients to switch HCPs.

Remodoc's design allowed HCPs flexibility to reflect social norms (rather than organizational rules; see Engeström (1987)) due to the nature of the healthcare sector in this case. At the same time, the use of Remodoc subtly influenced those norms. Thus, Remodoc allowed HCPs not to charge for a consultation when they felt it did not concur with social norms (e.g., when they needed to physically examine a patient). At the same time, social norms could change and, with each new technology that mediated interactions between HCPs and patients (phones, smartphones with social messaging applications, Remodoc), new social norms evolved (e.g., it was becoming acceptable to charge for teleconsultations).

5.4 Contradictions in the Existing Activity System

Engeström (2001) states that contradictions play an essential role in provoking development though change in human activity systems. Our case study exemplifies the importance of contradictions and "innovative attempts to solve them" (Hasu & Engeström, 2000, p. 65) in that it illustrates how an improvised telemedicine service emerged and the shift towards using Remodoc (intended telemedicine service). Our case shows that norms and rules can manifest contradictions temporarily (as Karanasios (2018) suggests) until the activity system advances.

While HCPs felt pressure to adhere to a social norm to disclose their private phone numbers and provide free consultations to patients, patients (as consumers and income providers for HCPs) could easily take advantage of their superior position. This pressure confirms how contradictions evolve over time in their historical reference (Hasu & Engeström, 2000). Our study suggests that subjects, once contradictions personally affect them, use the easiest solution to resolve disturbing contradictions in their activity. Karanasios and Allen (2014) reveal that subjects use advanced mediating tools to overcome contradictions. We discovered the same phenomena as the mediating tool's (i.e., Remodoc) design and technical features met HCPs' need to overcome the community's social norms and pressure to resolve contradictions in their work practices. Objects, due to their dynamic nature, adapt to different activities and to subjects, which leads to temporary solutions and, thus, causes new contradictions (Engeström, 1990). In our case study, the HCPs adopted Remodoc as it solved contradictions in the previous activity system mediated by social messaging applications. However, despite the advantages that Remodoc offered, social norms hindered HCPs from completely substituting the contradicting, improvised service with Remodoc.

However, solving a contradiction may cause multiple new and differing contradictions to emerge (Engeström, 1999). Our study indicates that, as HCPs and patients use telemedicine consultations more over time, the pressure on the HCPs' time will intensify, and conflicts between their different roles (e.g., as a doctor in a hospital and as a teleconsultant) may arise.

Thus, essential questions related to competing (i.e., new vs. existing) technologies in this context include: "Which mediating technology better solves existing contradictions?" and "Who will mostly benefit from the new arrangements and what new contradictions may arise from the use of the new technology?"

5.5 Technological Characteristics

Remodoc's design addressed HCPs activity systems' contradictions by providing an on/off status indication, an integrated messaging and video call system, an integrated payment aspect, and a prescription and feedback system. An activity log and a cloud-based system that stored patients' medical history addressed HCPs' concerns about liability. Remodoc allowed HCPs to behave in a way that reflected the accepted norms for a private face-to-face consultation and to charge for their consultation when they could diagnose patients or provide help.

While HCPs had used telemedicine for consultations before, Remodoc (in contrast to the emergent improvised telemedicine service) addressed various historically evolved and experienced problems that they faced and provided conditions for its sustained use. Thus, in designing any HCI technology, designers should address contextualized and historically evolved contradictions. Our study shows that Remodoc's characteristics addressed specific pain points that HCPs experienced as contradictions in their work activities while using social messaging applications, but we also found that Remodoc could possibly result in new contradictions. Because objectives and motivations are dynamic, designing a telemedicine application requires constant adjustments to accommodate evolving activity systems—a point that Saigi-Rubió, Jiménez-Zarco, and Torrent-Selles (2016) also make.

Both the improvised telemedicine and Remodoc fostered a shared economy. Important drivers for the shared economy include social media and new technology (Lee, Chan, Balaji & Chong, 2016) as our case study illustrates. The case study also highlights Remodoc's (the mediating tool in the activity system) technological characteristics and how they helped to address at least some of the contradictions in the HCPs activity system mediated by the improvised telemedicine.

We support the position of “activity-centric perspective of how users use artifacts” (Tchounikine, 2017, p. 162) for appropriately designing telemedicine systems, and we emphasize contextual elements (specifically norms and rules in a given society, community, or organization). Hence, relevant questions to ask when designing technologies include: “Who will use the technology?”, “How does the technology's design help solve contradictions in the existing activity system and, thus, help users achieve their goals?”, and “How does the system fit in with and influence social norms to which they subscribe?”.

6 Conclusion

Researchers have extensively discussed drivers of and barriers to telemedicine adoption in the literature (Darkins & Cary, 2000; Dorsey & Topol, 2016; Miscione, 2007; Perednia & Allen, 1995; Saigi-Rubió et al., 2016; Saliba et al., 2012; Segrelles-Calvo et al., 2015; Thapa & Sein, 2018; Xue et al., 2015). However, most case studies focus on purposely designed telemedicine applications (services) and remote populations.

This study's major contributions stem from its historical perspective based on accounts from HCPs about how they used an emergent, improvised telemedicine application and their transition to an intended, specialized telemedicine application (Remodoc). We illustrate that one can use a socio-technical perspective to examine telemedicine use by depicting the complexities of a human-technological interaction with a focus on HCPs' work.

Through analysis informed by activity theory, we show how Remodoc resolved contradictions in the activity system that the improvised telemedicine mediated and how that motivated HCPs to adopt Remodoc. We show that HCPs found Remodoc easy to use and (and perhaps more significantly) that it fitted with their working life, responded to their explicit intrapersonal needs (for flexibility, maintaining control and privacy, building up health practice, financial rewards, etc.), concurred with social norms in Sri Lanka (e.g., maintaining patient relationships through accessibility), and adhered to regulatory requirements (e.g., validated electronic prescriptions and patients records). These findings make contributions to our knowledge about telemedicine services. By highlighting the mediating technology's technological features, our study also contributes to our knowledge about the characteristics of mediating technologies in a shared economy service.

Furthermore, this paper contributes to the HCI literature on activity theory in that we analyze an entire activity system beyond a mediating tool or activity's immediate social and organizational context, which much HCI literature focuses on (Clemmensen et al., 2016). Through broadening the scope of enquiry, we show that one can use activity theory in a different way than HCI researchers usually do.

We suggest that activity theory provides conceptual insights that help one study complex cases such as the one we describe. In particular, its emphasis on how actors historically and culturally construct activities invites analyses that go beyond a focus on immediate actions and that examine how perceptions, meanings, and norms influence an activity. Thus, reflecting activity theory's cultural-historical roots, we show how social norms manifest and enforce certain behavior that, in turn, creates contradictions in the activity system and how, over time, social norms change as individuals adjust their behavior. Specifically, we discuss how evolving social norms shape the design, use, and perceptions of the mediating tool (in our case, telemedicine technology) and how, in turn, the technology's use affects social norms.

Generalizing from our case study, we suggest that: 1) subjects' motivations depend on intrapersonal and contextual elements, 2) contradictions in the activity system drive change and can stem from social norms and how subjects' adopt a new mediating technology, 3) social norms have different manifestations (Engeström, 1987; Karanasios, 2018) and can stimulate or hinder change.

To stimulate users to adopt new technologies, designers should design applications such that they address contradictions in the existing activity system, concur with social norms, and allow users to possibly influence social norms that cause contradictions. Designers also need to consider how the system's context has historically developed to design its interface and not overemphasize specific conflicts (Karanasios & Allen, 2014).

In this study, we concentrate on activity systems that involve HCPs. Further studies could research potentially interrelated contradictions and congruencies that arise from different activity systems that involve telemedicine application providers, patients, healthcare service providers, clinical institutions, and governmental regulators.

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