



On-Cloud Healthcare Clinic: An e-health consultancy approach for remote communities in a developing country



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ABSTRACT

Advances in telecommunication and online service solutions help to bridge the digital divide between rural and urban healthcare services, enabling provision of suitable medical diagnosis and treatment consultations. Although applying e-health solutions has brought some positive impact full potential has not yet been realised, especially in regions where expertise is scarce. In this study we develop and evaluate an e-health consultancy system utilizing cloud computing (we so called “On-Cloud Healthcare Clinic”) that enables doctors and healthcare workers to identify and treat non-communicable diseases in rural and remote communities in Bangladesh, a developing nation.

Adopting a design science research approach we developed the solution based around stakeholders’ collaborative participation in prototyping and then evaluated the design using focus groups. The cloud-based solution supports doctors in evaluating and diagnosing patients’ data and medical history through intermediary health care workers or community clinics. The design also knowledgeably allows informed decisions on a course of treatment with follow up for remote or underserved communities. Previously unavailable clinical work is thus practically achieved through utilization of the cloud based e-health system, and generalisation of this approach in healthcare management is discussed.

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1. Introduction

Electronic health (e-health) services have the potential significantly to enhance patient diagnosis and to improve the accessibility and quality of treatment. The reality, however, has not yet matched the potential, with deployment in hospitals far short of maximum even in top performing countries, and remote monitoring of patients in European hospitals around just 9%, with a European average of under 42% across all deployment indicators (EU, 2013).

In developing countries, the healthcare situation is considerably worse, and is a pressing practical issue particularly in delivering healthcare services for rural and remote communities. Many developing countries such as Bangladesh have large rural populations, but lack proportionate medical expertise. Bangladesh has only one doctor for every 1700 patients, against a Millennium Development Goal of at least 2.5 physicians, nurses, and midwives per 1000 people needed to provide adequate coverage with primary care interventions (World Bank, 2015). The health sector in Bangladesh remains mostly unde-

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veloped not only due to limited government resources but also in the use of appropriate information and communication technologies (ICT) for rural and remote communities.

The growth of online ICT based innovative solutions (such as telemedicine, online health records and mobile based health applications) have for some time implied the capability, if used effectively, to bridge social and economic gaps that divide rural and urban communities and areas (Gurstein, 2005). These potentially improve access and allow provision of a wider range of health services to enhance the wellbeing and quality of life of underprivileged or underserved populations. In many countries specific ICTs have become essential components in successfully delivering operational healthcare services in rural areas (Barjis et al., 2013), through for example, Internet-enabled tools, mobile technologies and telemedicine (Marston et al., 2011; Hage et al., 2013; Hu and Bai, 2014). Very few effective and sustainable initiatives, however, have been introduced in Bangladesh to improve the quality of the healthcare service delivery for the people (e.g. Patients) in remote locations and communities. The availability of an adequate public health system in rural and remote areas is still scarce, severely impacting the quality of life for people when they become ill. In larger cities, some of the very few large private hospitals have attempted to develop e-health and telemedicine services, but are geared towards their registered patients and limited to specialised services. Various non-governmental organizations (NGOs) funded by international and private ventures have attempted small-scope initiatives such as rural health camps, mobile clinics, and organized visits by doctors from larger hospitals. However, for a densely populated country like Bangladesh, the impact and reach is very small, and scaling up such initiatives become prohibitively resource intensive.

So although e-health solutions through mobile communication networks promise impact, full potential has not been realised, especially across communities in remote locations where medical expertise is scarce (Sailunaz et al., 2016; Kaur and Chan, 2014; Hossain, 2015). Existing and legacy e-health solutions in developing nations have been error prone, inefficient and require extensive internal and external resources (Barjis et al., 2013; Hage et al., 2013). For the health care industry, both government and private, to maintain and improve diagnosis, clinical and business operations, a new focus on effective ICT platforms and solutions is required.

Over the history of evolving use of e-healthcare systems, emerging technologies have increasingly been pushed to shift the role of the healthcare professionals towards meeting more accurate, prompt and real-time treatment support not only for urban patients but also for those in remote communities. Paradoxically however, many recent mobile-based e-healthcare solutions have mainly focused on the engineered product and often, relevant users' participation in designing such types of solution and satisfaction with the outcome has not been fully considered. Specifically, attention to the end users' context and specific practice details need to be reflected into the solution design, consistent with good system development practice.

Moreover, with the more recent emergence of cloud computing, an affordable, configurable and scalable platform for enabling e-health solutions becomes possible, for example by linking medical information and practitioners who are geographically dispersed, enabling online communication about medical issues, diagnosis and treatment. Cloud computing is a ICT service model where computing services (both hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location (Marston et al., 2011). Cloud computing adopts a service oriented architecture (SOA) and supports the functionalities of an integrated e-Health system as a number of interoperable software services (Hu and Bai, 2014). Utilizing cloud computing for e-health introduces many opportunities for healthcare service delivery, and especially for developing nations. Cloud solutions using software-as-a-service (SaaS) are increasingly deployed in healthcare elsewhere with the main reasons given including cost savings, deployment speed, and overcoming lack of qualified staff on premises (HIMSS, 2014). This paper describes an *ensemble* artefact¹ (Orlikowski and Iacono, 2001) approach to designing a new cloud-computing based e-health solution that ensures relevant end-users' active participation in, and satisfaction with, the application development.

General questions concern how effective access to healthcare services should be designed and managed. One basic requirement concerns the technology and literacy required to convey relevant patient data for knowledgeable initial diagnosis and consultation. Such consultation outcomes could result in medicine prescriptions, diagnostic tests, medical referrals and follow-up checks. Rather than requiring rare expert time for organised visits and one-on-one consultations, bringing the data to geographically dispersed doctors (healthcare professionals), and managing the consultation outcomes via more locally based paramedics suggests a more scalable and responsive general model for managing healthcare. This requires a pragmatic design cognizant of the realities of technology, expertise, resources, processes and end-user practice.

More specifically, the core question our research program focuses on is: "What e-health solutions could be designed to meet the diagnosis and treatment demands of rural and remote communities in Bangladesh?" Although the literature on healthcare ICT presents various studies addressing developing nations (e.g. Ruxwana et al., 2010; Hage et al., 2013; Lin et al., 2014), innovative developments in e-health application provision for rural healthcare have not, as yet, received much research attention. Our work therefore aims to develop and evaluate a general approach to e-health utilizing online services and cloud computing for effective patient consultation and health diagnosis. Whilst we detail the development and evaluation of one context-sensitive cloud based e-health solution for the case of rural communities in Bangladesh, we specify the design towards a wider applicability.

¹ For designing a solution artefact the ensemble view is an embedded system view that emphasises the dynamic interactions between target users and solution technology. This includes not only the use, but also the construction, implementation and deployment of the solution artefact (Orlikowski and Iacono, 2001:126).

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