



## The Role of Image Quality in Telehealth: Adoption Challenges in the Subcontinent

Avijit Chowdhury<sup>1,\*</sup>, Abdul Hafeez-Baig<sup>2</sup>, Raj Gururajan<sup>3</sup>, Amanda McCubbin<sup>4</sup>,  
Mirza Akmal Sharif<sup>5</sup>, Shah J Miah<sup>6</sup>

<sup>1</sup>University of Southern Queensland, Australia, [chowdhury.avijit@gmail.com](mailto:chowdhury.avijit@gmail.com)

<sup>2</sup>University of Southern Queensland, Australia, [abdulhb@usq.edu.au](mailto:abdulhb@usq.edu.au)

<sup>3</sup>University of Southern Queensland, Australia, [gururaja@usq.edu.au](mailto:gururaja@usq.edu.au)

<sup>4</sup>Federation University, Australia, [a.mccubbin@federation.edu.au](mailto:a.mccubbin@federation.edu.au)

<sup>5</sup>University Medical & Dental College Madina Teaching Hospital, Faisalabad, Pakistan,  
[akmaldr@gmail.com](mailto:akmaldr@gmail.com)

<sup>6</sup>The University of Newcastle, Australia, [shah.miah@newcastle.edu.au](mailto:shah.miah@newcastle.edu.au)

### Abstract

**Background:** *The purpose of this paper is to explore the underlying challenges in the telehealth environment in India and Pakistan that impede the delivery of high-quality images between a patient and health care professional.*

**Method:** *An exploratory study was conducted among healthcare professionals in India and Pakistan to assess their perceptions regarding image quality, which is used for the diagnosis and treatment decision making. This cross-sectional qualitative study used semi-structured interviews with healthcare professionals in both India and Pakistan.*

**Results:** *The interviews were analyzed using a thematic analysis, which revealed three major themes. These themes being: ICT infrastructure and connectivity, expertise of persons taking images, and multiple transmission degrading image quality.*

**Conclusions:** *Findings indicate that in both countries, the main underlying challenge is the lack of consistency in the network infrastructure between urban, rural and remote areas. Additionally, training patients to use hand-held devices to take high-quality images could hold the key to improving the reliability and, consequently, the quality of images transmitted between patients and health care professionals.*

**Keywords:** Image Quality, Telehealth, Developing Countries, Healthcare Challenges.

Citation: Chowdhury, A., Hafeez-Baig, A., Gururajan, R., McCubbin, A., Sharif, M. A., & Miah, S. J. (2021). The Role of Image Quality in Telehealth: Adoption Challenges in the Subcontinent. *Pacific Asia Journal of the Association for Information Systems*, 13(3), 131-145. <https://doi.org/10.17705/1pais.13307>

Copyright © Association for Information Systems.

## Introduction

Image quality in providing telehealth services is an ongoing concern within the healthcare domain (Johansson et al., 2019; Saha et al., 2018). In recent years, there has been an increased interest among healthcare professionals to provide tele-diagnosis services (Alkmim et al., 2019; Aoki et al., 2019; Qazi et al., 2019). Tele-diagnosis may involve direct interaction with the patients, or it might be a collaboration between healthcare professionals (Ahir et al., 2019). As such, real-time transmission of high-quality medical images, graphics, and video is a pre-requisite to achieve this goal. Apart from organized telemedicine services, healthcare professionals use the benefits of social media and messaging tools to receive reports, images, and videos, either to deliver consultation to the patients or to seek expert opinion from another healthcare professional. These types of online consultations may be the initial contact between the patient and the healthcare professional, or it may be a follow-up consultation. Thus, it is evident that to enable the transmission of high-quality images, graphics and videos and to handle the large amount of data generated, it is essential to have high-bandwidth network infrastructure.

There is limited research in the information systems literature on the decision making aspects of telehealth by the healthcare professionals in developed countries (Dinesen et al., 2016; President's Council of Advisors on Science and Technology, 2014) which points out the actual competency requirement by the healthcare professionals and emphasize on the technology adoption decision making process by the health professionals to provide care using patient-generated data. This research study provided some insight for the identification of the perceptions of healthcare professionals in India and Pakistan regarding the aspects of decision making challenges associated with the quality of medical images, graphics and videos used for diagnosis and treatment of patients. The identified challenges through this research may drive the assertion with which innovative knowledge is required to drive healthcare policy and provide further encouragement for collaboration between researchers and practitioners to adopt new practices (Dinesen et al., 2016).

The research study is organized as follows: the next section describes relevant literature that indicates the status of telehealth studies in developing countries. The section after that provides methodological details followed by a discussion on the findings and overall studies, including its key limitations. Finally, we present a conclusion of the study reported in the paper.

## Literature Review

Within India and Pakistan, there are several challenges associated with the face-to-face delivery of healthcare. These include; substantial distances between patients and the nearest healthcare services facility and geographical and topography barriers in some regions (Balarajan et al., 2011; Keyani et al., 2009). Furthermore, there is a shortage of healthcare professionals in some rural and remote regions (Bodavala, 2002; Khan, 2019). One possible solution to address these challenges is the use of technology to conduct live, interactive consultations between primary care physicians, allied health professionals and patients and to transmit medical images and graphics to health professionals for diagnosis (ATA, 2019).

A review of the literature reveals that several specialized medical areas, including dermatology, ophthalmology, radiology, and nursing have benefitted from image transmission via mobile devices (Börve et al., 2015; Charlston & Siller, 2018; Johansson et al., 2019; Khodaie et al., 2015; Saha et al., 2018; Tandjung et al., 2015). It is also evident that mobile phone technology has been used to transmit digital images from neurosurgical patients to health professionals, resulting in informed decisions being made about patient transference to specialized facilities (Bullard et al., 2013). Additionally, research has identified that the removal of blocking filters

on mobile phone cameras enable these devices to use near-infrared imaging to improve the quality and validity of images for diagnosis purposes (Ghassemi et al., 2017). In India, satellite-based screening for retinopathy has been recommended; however, the viability of using such systems remains problematic due to the inconsistency of broadband delivery across the country (Das et al., 2015). It is evident that in both Pakistan and India, there is a similarity of challenges faced by the healthcare sector associated with the reliability of the countries ICT infrastructure (Balarajan et al., 2011; Bodavala, 2002; Kareem & Bajwa, 2011; Malik, 2007; Nishtar et al., 2015; Rathi, 2017).

There have been a range of studies, conducted in India and Pakistan regarding the adoption of ICT within the healthcare domain (Chowdhury et al., 2019; Dasgupta & Deb, 2008; Ganapathy et al., 2019; Ghia et al., 2013; Gururajan, 2007b; Hafeez-Baig & Gururajan, 2012, 2014; Iyer, 2014; Kumar & Ahmad, 2015; Marcelo et al., 2015; Mathur et al., 2017; Pal et al., 2002). Chandwani and Dwivedi (2015) suggested challenges in the adoption of telemedicine can be classified across policy, societal, institutional and medical infrastructural levels. Elder and Clarke (2007) identified that the specifics of the local environment had to be acknowledged when conducting research on the adoption of ICT within healthcare, as each environment has its own unique challenges. It is also evident that different cultures within countries may respond differently to the adoption of technologies for primary health care (De Rosis & Seghieri, 2015).

Within Australia; Carati and Margelis (2013) suggested that barriers and enablers be identified in order to maximize the locus of telehealth implementation. Further, Dodel (2015) suggested the need to construct cost-effective, quality research instruments and to test the ICT assets of access, usage and appropriation as independent variables in further studies on the adoption of ICT within healthcare. Recently the development of a conceptual framework, designed to guide research within the Indian telehealth environment identified that image quality and the network infrastructure were significant determinants in the adoption of telehealth by healthcare professionals (Chowdhury et al., 2019).

Other determinants that have an impact on the adoption of telehealth in India and Pakistan include accessibility to healthcare professionals, the quality and reliability of the ICT infrastructure within a region, the shortage of healthcare professionals in rural and remote locations, patient education regarding the benefits of telehealth, patient demographics and technology safety and awareness (Chowdhury et al., 2019; Dasgupta & Deb, 2008; Ganapathy, 2002, 2014, 2015; Ghia et al., 2013; Gururajan, 2007a, 2007b; Gururajan & Hafeez-Baig, 2014; Hafeez-Baig & Gururajan, 2012, 2014; Kareem & Bajwa, 2011; Marcelo et al., 2015; Qazi et al., 2019). This research focuses on one specific determinant, the quality of images transmitted within the telehealth environment in India and Pakistan, as it is evident, from a review of the literature that scant studies have been undertaken on this topic. This paper addresses a gap in the current literature as there is a paucity of research on the perception of Indian healthcare professionals regarding the quality of images transmitted in the telehealth environment and the viability of image transfer for medical consultations. This is despite previous studies indicating that interest in telemedicine is high in both health professionals and students (Gschwendtner et al., 1997; Mairinger et al., 1996).

## Methodology

The aim of this research was to gain an understanding of the challenges affecting the quality of images used by health care professionals for diagnosis in India and Pakistan. This small-scale, exploratory qualitative research was conducted using in-depth semi-structured interviews with a range of health care professionals in both India and Pakistan, to collect their perceptions about the quality of images transmitted within the telehealth environment. Doctors and other allied healthcare staff were interviewed with their responses being recorded. The

research study followed an interpretivist approach wherein the semi-structured interviews yielded rich data and afterwards qualitative content analysis delved deeper into the healthcare professionals' perceptions to find out the latent meanings hidden inside the rich dataset. This is based on the premise within the interpretivist paradigm that to understand the meanings which individuals select and interpret depends on the situation one is placed and where the individual is headed (Blumer, 1969). A manual thematic analysis (Braun & Clarke, 2006) was conducted to analyze the healthcare professionals' narratives so as to identify, evaluate and report themes regarding the image quality within the telehealth environment. Ethics approval to conduct this research was obtained from the relevant authorities prior to conducting the interviews.

## **Design**

The design of the research was exploratory in nature, reflecting the paucity of information on this topic (Stebbins, 2001). Semi-structured interviews were selected as they enabled the researcher to prepare questions prior to the interview. They also enabled the participants the freedom to express their individual opinions and provided reliable, comparable qualitative data (Cohen & Crabtree, 2006). Additional considerations for selecting semi-structured interviews instead of focus groups included outreach and costs. Constraints associated with focus groups, including finding a convenient interview time, participants not willing to contribute their opinions, participants being under pressure to concur with the dominant views and the results being difficult to analyze were avoided (Barbour & Morgan, 2017). Additionally, the costs of gathering participants together for a focus group were reduced as interviews were conducted with each participant either face-to-face or via a telephone.

## **Qualitative data collection**

Cross-sectional data collection was used in this research (Kijisanayotin et al., 2009; Schmeida et al., 2007; Shin et al., 2017), with 11 semi-structured interviews being conducted between February 2019 and June 2019 with health professionals located in India and Pakistan. The Head of each healthcare department was contacted prior to this research occurring. They authorized this research being undertaken in their workplace and assisting in organizing the written consent of each participant. The site of each interview was decided prior to the interview taking place and was mutually agreed upon. Sites included the healthcare professionals' workplace or where appropriate and convenient, via a telephone conversation. Each semi-structured interview was audio recorded to enable translation of the conversations into text for analysis.

The participant healthcare professionals were situated in the Punjab state (four participants) in Pakistan and in the Indian states of Uttar Pradesh (three participants), West Bengal (one participant), Maharashtra (two participants) and Tamil Nadu (one participant) and all were involved in providing a range of telehealth services. Random convenience sampling was used for selecting the participants based on ease, accessibility and low costs (Acharya et al., 2013; Creswell, 2014). Seven participants were male and four were female. Among the healthcare professionals eight were doctors, two were dietitians, and one was a healthcare administrator. Four of the participants were involved in primary care telemedicine and seven were involved in medical advising through an online medium.

A pilot study was conducted by considering the initial four interviews to test and confirm the reliability and validity of the questions and respective dataset (Creswell, 2014; Saunders et al., 2016). The interview questions were refined accordingly after the pilot study.

## Analysis, Findings and Discussion

The initial phase of data analysis involved the transcription of the recorded data to written data by the researchers. The researchers elected not to use computer aided software to assist with the transcription as, although it is faster, the researchers wanted to become immersed in the data and get a sense of the whole interview prior to commencing the initial search for themes (Creswell, 2014; Dohan & Sanchez-Jankowski, 1998). An inductive thematic analysis was applied to the transcribed data as it enabled the researchers to identify and develop themes via iterative readings of the transcripts (Elo & Kyngäs, 2008; Vaismoradi et al., 2013).

Three main themes, associated with image quality, emerged from the analysis of the transcripts. These themes were:

- ICT Infrastructure and Connectivity
- Expertise of persons taking images
- Multiple transmission degrading image quality

### *ICT Infrastructure and connectivity*

Two different categories, both associated with ICT, emerged from the data collected. The participants situated in Pakistan identified that that main issue with image quality was the inconsistency in the infrastructure between institutions. As there is no standard infrastructure used between telehealth facilities, the quality of the image can be affected. Participant P1 identified:

*“The first thing is the infrastructure. The infrastructure should be there in all the institutions you want to involve patients and others for this purpose”*

This was supported by participant P2:

*“You can have very good internet facility in your center, but the same sort of facility has to be available to the remote areas, only then you can deliver the services”*

Within India the problem with image quality is the consistency in the connectivity of the broadband throughout the country. Participant I1 stated:

*“Basic connectivity should be more robust. Instead of tower and cable based, satellite based broadband is required for much better service. The bandwidth needs increasing so there is an uninterrupted supply; a robust and steady bandwidth”*

Further evidence of the issues associated with connectivity in India came from participant I3:

*“The platform has to improve. In future it may be good for communication. Now it’s not up to the mark, there is lots of scope for improvement. In our country we have to sit in a place where we can connect, we can’t afford to walk and talk to a client”*

Participant I7 said:

*“The one-to-one connection in the virtual window needs to be improved. We also need to work on the platform. The challenges in the virtual platform are the ease of use and the network problems”*

In another example, participant I6 said:

*“First of all connectivity, it is not always seamless particularly in terms of voice connectivity as lot of people are using the same bandwidth. The quality of voice is poor and it getting worse, there is no point of having a good telephone and a bad line”*

The connectivity specifically affects the use of digital equipment and the associated recorded image. Participant I1 said:

*“Configuring the digital instruments are a challenge due to the disruptions in connectivity”.*

As evident from the above excerpts, two related categories affecting the quality of images is the different infrastructures used by different telehealth set-ups and the connectivity in rural and remote locations, specifically in India. In Pakistan the telemedicine hubs located in urban hospitals have adequate broadband and ICT infrastructure. Similarly, the urban ICT infrastructure in India is robust, however, the connectivity in rural areas is inconsistent.

### **Expertise of person taking images**

From analyzing the data, the second theme that emerged was the difference in the quality of the image depending upon who took the image. If the image was taken in an organized telemedicine set-up and handled by a trained technician, it was evident that the quality was superior which made for easier diagnosis by doctors and other health professionals.

Participant P1 said:

*“There are conditions in which you can directly see the problem of the patient, you can ask to focus the camera on the problem, you can see problem, you can take the picture, you can get the reports online, and then you can tell the patients something about the treatment”*

Participant P2 said:

*“Our technical people they can make a very good audio-visual connection, so the image and audio-visual is very clear. We can watch everything on our screen, look at the CT scan images and ask questions which they can answer. They make a very good audio-visual connection”*

Participant I2 agreed:

*“If the health workers facilitates the interaction between the doctors and patient and sets up connected devices like digital stethoscope, patient examining camera and other things to measure blood pressure, hypertension, diabetes, random blood sugar fasting, oral cancer detection, the doctor can clearly see the issues, give advice and prescribe a treatment”*

However, it appeared that in both countries there were consistent challenges associated with patients taking images of their health issues:

In Pakistan, participant P1 suggested that:

*“There are so many challenges, which are related to knowledge of IT. The thing which is important is the availability of the gadgets, every second person is holding a smart phone, they can easily connect to many things, but these things need to be organized at higher levels so people at the lower levels can get the benefit. General education and knowledge is important”*

The lack of education in using smart phone technology and transmitting images using different apps was evident in the responses of participant P3:

*“A few of the patients, they are educated, and we can give them the services. Using WhatsApp via the internet only a few people get the benefits as many of our patients cannot afford these services now. Only the educated patients can understand and know how to use them”*

Participant P4 thought that the main issue when using smart phone technology was language based:

*“Some of the people in remote areas they can write in English with Urdu knowledge, but they can't read English”*

In contrast, participant I4 thought:

*“I think the majority of the people are illiterate, but they know how to use headphones, how to use mobiles, it would not be difficult to train these persons regarding using them for telehealth”*

Participant I6 also agreed that training would assist in the use of smart phone technology for telehealth imaging:

*“I think training is useful, very useful, but that has to go with good quality technology as well”.*

The issues associated with the patient using a smart device to take images appears to be the lack of knowledge regarding the use of different apps both to take the image and to transmit it to healthcare professionals. Additionally, it is not evident that there is any consistency in the type of app that is preferred by healthcare professionals for image transmission. Connectivity and the ease of use by the patient are the two main criteria by which apps are selected.

Participant I5 said:

*“Skype has some sound issues. I use Appear.in which has good connectivity and no sound issues. Patients do not have to log in which is an advantage for the non tech-savvy patients. It has a virtual video room where the doctor-patient can interact, and images can be observed”*

The selection of app to use for best interaction between the client and healthcare professional was supported by participant I7:

*“We need to have video conferencing; they have a much better connectivity and feel when compared to the small apps such as video chat. Using video conferencing systems such as Zoom we get better connectivity.*

The importance of the quality of the image received by the healthcare professional was highlighted by participant I3 who said:

*“We are judging by pictures only. The picture quality matters as online consultations are only in 2D whereas in physical/face-to-face consultations you can see everything in 3D”*

Participant I2 mentioned that the transmission of images was:

*“A lifestyle changer, not only for medicine, but pictorials, multimedia, films can be sent over the internet and seen on the computer. The challenge is that human resources are required to run this technology effectively and efficiently with focus and institutional interest”*

The findings indicate that high quality images are important when diagnosing conditions. Images taken and transmitted are of higher quality than those taken by patients using hand-held devices. The lower quality images taken by patients appear to be the result of clients being uneducated in using apps on hand-held devices and the inconsistency in the apps used by different healthcare set-ups. All healthcare professionals interviewed agreed that the quality of the image was extremely important in determining the issue and diagnosing treatments.

### **Multiple transmission degrading image quality**

The third theme evident from the analysis of interview transcript was the transmission of digital images to other doctors and specialists to get a second or expert opinion. If the initial image quality is poor, it is difficult for specialists and doctors to make an evidence-based decision or determine appropriate treatment.

Participant P1 talked about the convenience of using digital images to get a second opinion:

*“I have a patient over there, this happens to me every day or every other day. I see that patient and I seek another opinion. I need the opinion of some other person, so I will take the picture and send it on WhatsApp to the other person. I will then call him, give him the history of the patient, what my findings are and ask him to give me their opinion”*

Participant P2 said:

*“We use them as experts, calling them and sending them data to look at and give their expert opinion. Even during operations, the surgeons need consultation. I used to call my professor and share my findings for expert opinion. If I can take a picture and send it through WhatsApp, then the professor can advise me of the next steps after watching the pictures”*

As most of the healthcare professionals work in an organized telehealth set-up the transmission of images between them for expert opinion depends upon the organizational ICT infrastructure. Images are frequently transmitted for expert opinions and any degradation in the image, through compression of photos, distortion from device-to-device or unreliable infrastructure can affect the quality of the image.

Thus, the above findings corroborate the need for consistency in the development of ICT infrastructure throughout the subcontinent. Telehealth, as an alternative solution can have maximum outreach only if the ICT infrastructure is extant and there is reliable bandwidth for seamless connectivity for image transmission, which in turn enables efficient diagnosis, treatment, monitoring, and promoting health awareness. Nonetheless, the implementation of modern technologies such as 5G can increase ICT outreach as well as, solve the connectivity issues such as increased bandwidth. The purpose of telehealth to be a cost-effective alternative solution lies with the successful training and awareness development to healthcare professionals as well as the patients. The development of low latency and easy-to-use telehealth applications with low bandwidth requirements and which can be installed in smartphones is another area to look upon for successful adoption of telehealth in the subcontinent. The collaboration between healthcare specialists can also be useful in such cases across the subcontinent.

### **Implications and Limitations**

Technology is improving readily and improvement in image quality in the telehealth environment in the developing countries have implications in gaining trust of the healthcare professionals as well as for the patients to adopt the cutting-edge technologies available today for seamless image transmission. At the same time, healthcare professional’s training and



confidence is required to adopt such technologies. Furthermore, this research also highlighted some amount of patient awareness development is required. Especially, apart from the domestic patients, the health tourism sector can benefit if quality consultations are made available overseas (Chandra, 2019). One of the factors highlighted through this research study, the quality of transmission to achieve optimal level consultations through telehealth infrastructure and seamless image transmission can play vital role in the adoption of such technology. This research also provided evidence that emerging 5G technologies may hold the future for such seamless image transmissions (Chen et al., 2017; Latif et al., 2017). Nevertheless, today's insignificant healthcare expenditure of the developing countries can be increased to boost such scenarios (Ahmed & Shaikh, 2008; Akram et al., 2008; Datta, 2019).

This research study envisages valuable insight on the decision making process to improve image quality in the telehealth environment in developing countries. Further, this research study encourages innovation regarding improving the same. As this research is based on a limited scale opinion of healthcare professionals, the findings cannot be generalized unless by conducting a wider scale quantitative survey. This paper encourages such future research endeavours as to the decision making process regarding the challenges faced by the telehealth environment in seamless image transmission. The present cutting edge technologies can be used to solve the challenges, only if there is a robust adoption process (Bartolini & McNeill, 2012). Patient awareness development and in relation to that increase in healthcare expenditure to address such issues is the need of the hour.

## Conclusion

This research study was conducted in India and Pakistan to uncover the perceptions of healthcare professionals regarding the quality of medical images transmitted and the viability of such images within telehealth set-ups.

Three main themes emerged from the research:

- ICT Infrastructure and connectivity: The infrastructure and connectivity within countries affect the image quality.
- Expertise of persons taking images: Images taken by telehealth professionals are superior to those taken by the patients on hand-held devices.
- Multiple transmission degrading image quality: Transmission of images within healthcare environments can degrade the quality of the image.

The principal findings of the research identified that the ICT infrastructure of both countries needs to be further improved to enable consistency in the quality of digital images across states and within telehealth organizations. It is evident that city and urban areas in both countries have more reliable ICT infrastructure and connectivity than those found in rural and remote regions. Given that one of the aims of telehealth is to diagnose and treat patients who live in these regions and who are not able to travel to cities and large towns, the unreliability of ICT inhibits both the transmission of quality images to telehealth centres (Ganapathy et al., 2019; Ghia et al., 2013; Keyani et al., 2009; Khan, 2019) and the transfer of images between healthcare professionals. Finally, the improvement in hand-held devices can be seen as a major driver in improving the image quality sent by the patients to the doctors (Luxton et al., 2012), however, lack of patient knowledge of how to use the inbuilt camera and different apps for transferring digital images greatly decreases the quality of the images when compared with those taken by health care professionals. Further training and education of clients in using hand-held devices is recommended to enhance the image quality. This understanding would further be utilised for developing design artifact (Miah & Ahamed, 2011; Miah et al., 2008; Miah et al., 2019) in a real practical clinical environment.

## Acknowledgments

The authors acknowledge the support received by Avijit Chowdhury from the University of Southern Queensland in the form of fees research scholarship for PhD studies.

## References

- Acharya, A. S., Prakash, A., Saxena, P., & Nigam, A. (2013). Sampling: Why and how of it. *Indian Journal of Medical Specialties*, 4(2), 330-333.
- Ahir, Y., Rathkanthiwar, S. V., & Kale, Y. (2019). A Review on teleconsultation and telediagnosis using IoT Module. In *2019 International Conference on Communication and Signal Processing (ICCSP)* (pp. 0153-0156). IEEE.
- Ahmed, J., & Shaikh, B. T. (2008). An all time low budget for healthcare in Pakistan. *Journal of the College of Physicians and Surgeons Pakistan*, 18(6), 388.
- Akram, N., Padda, I. H., & Khan, M. (2008). The long term impact of health on economic growth in Pakistan. *The Pakistan Development Review*, 47(4-II), 487-500.
- Alkmim, M. B., Silva, C. B. G., Figueira, R. M., Santos, D. V. V., Ribeiro, L. B., Paixão, M. C., Marcolino, M. S., Paiva, J. C., & Ribeiro, A. L. (2019). Brazilian national service of telediagnosis in electrocardiography. *Studies in Health Technology and Informatics*, 264, 1635-1636.
- Aoki, L., Pereira, I. C., & Matayoshi, S. (2019). Comparative study between conventional camera images and smartphone images for eyelid tumor telediagnosis. *Revista do Colégio Brasileiro de Cirurgiões*, 46(1).
- ATA. (2019). Telehealth: Defining 21st Century Care. *American Telemedicine Association*. Retrieved from <https://www.americantelemed.org/resource/why-telemedicine/>
- Balarajan, Y., Selvaraj, S., & Subramanian, S. V. (2011). Health care and equity in India. *The Lancet*, 377(9764), 505-515.
- Barbour, R. S., & Morgan, D. L. (2017). *A New Era in Focus Group Research: Challenges, Innovation and Practice*. Springer.
- Bartolini, E., & McNeill, N. (2012). Getting to Value: Eleven Chronic Disease Technologies to Watch. *Network for Excellence in Health Innovation*. Retrieved from [https://www.nehi-us.org/writable/publication\\_files/file/getting\\_to\\_value\\_eleven\\_chronic\\_disease\\_technologies\\_to\\_watch.pdf](https://www.nehi-us.org/writable/publication_files/file/getting_to_value_eleven_chronic_disease_technologies_to_watch.pdf)
- Blumer, H. (1969). *Symbolic Interactionism: Perspective and Method*. Berkley. University of California Press.
- Bodavala, R. (2002). ICT Applications in Public Healthcare System in India: A review. *Administrative Staff College of India Journal of Management*, 31(1-2), 56-66.
- Börve, A., Gyllencreutz, J. D., Terstappen, K., Backman, E. J., Alden-Bratt, A., Danielsson, M., Gillstedt, M., Sandberg, C., & Paoli, J. (2015). Smartphone teledermoscopy referrals: A novel process for improved triage of skin cancer patients. *Acta Dermato-Venereologica*, 95(2), 186-190.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in Psychology. *Qualitative Research in Psychology*, 3(2), 77-101.
- Bullard, T. B., Rosenberg, M. S., Ladde, J., Razack, N., Villalobos, H. J., & Papa, L. (2013). Digital images taken with a mobile phone can assist in the triage of neurosurgical patients to a Level 1 Trauma Centre. *Journal of Telemedicine and Telecare*, 19(2), 80-83.

- Carati, C., & Margelis, G. (2013). *Towards a National Strategy for Telehealth in Australia 2013-2018*. Paper presented at the Global Telehealth 2012, Sydney.
- Chandra, A. (2019). Exploring medical tourism opportunities in India (With special reference to Delhi/NCRZ). In *Proceedings of 10th International Conference on Digital Strategies for Organizational Success*.
- Chandwani, R. K., & Dwivedi, Y. K. (2015). Telemedicine in India: Current state, challenges and opportunities. *Transforming Government: People, Process and Policy*, 9(4), 393-400.
- Charlston, S., & Siller, G. (2018). Teledermatologist expert skin advice: A unique model of care for managing skin disorders and adverse drug reactions in Hepatitis C Patients. *Australasian Journal of Dermatology*, 59(4), 315-317.
- Chen, M., Yang, J., Hao, Y., Mao, S., & Hwang, K. (2017). A 5G cognitive system for healthcare. *Big Data and Cognitive Computing*, 1(1), 2.
- Chowdhury, A., Hafeez-Baig, A., Gururajan, R., & Chakraborty, S. (2019). Conceptual framework for telehealth adoption in Indian healthcare, *24th Annual Conference of the Asia Pacific Decision Sciences Institute*. Asia-Pacific Decision Sciences Institute (APDSI).
- Cohen, D., & Crabtree, B. (2006). *Qualitative Research Guidelines Project*. Retrieved from <http://www.qualres.org/HomeSemi-3629.html>.
- Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publication.
- Das, T., Raman, R., Ramasamy, K., & Rani, P. K. (2015). Telemedicine in diabetic retinopathy: Current status and future directions. *Middle East African Journal of Ophthalmology*, 22(2), 174.
- Dasgupta, A., & Deb, S. (2008). Telemedicine: A new horizon in public health in India. *Indian Journal of Community Medicine*, 33(1), 3-8.
- Datta, S. (2019). Political competition and public healthcare expenditure: Evidence from Indian states. *Social Science & Medicine*, 112429.
- De Rosis, S., & Seghieri, C. (2015). Basic ICT adoption and use by general practitioners: An analysis of primary care systems in 31 European countries. *BMC Medical Informatics and Decision Making*, 15(70).
- Dinesen, B., Nonnecke, B., Lindeman, D., Toft, E., Kidholm, K., Jethwani, K., Young, H. M., Spindler, H., Oestergaard, C. U., Southard, J. A., Gutierrez, M., Anderson, N., Albert, N. M., Han, J. J., & Nesbitt, T. (2016). Personalized telehealth in the future: A global research agenda. *Journal of Medical Internet Research*, 18(3), e53.
- Dodel, M. (2015). An analytical framework to incorporate ICT as an independent variable. In A. Chib, J. May, & R. Barrantes (Eds.), *Impact of Information Society Research in the Global South* (pp. 125-144). Springer Open.
- Dohan, D., & Sanchez-Jankowski, M. (1998). Using computers to analyze ethnographic field data: Theoretical and practical considerations. *Annual Review of Sociology*, 24(1), 477-498.
- Elder, L., & Clarke, M. (2007). Past, present and future: Experiences and lessons from telehealth projects. *Open Med*, 1(3), 166-170.
- Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, 62(1), 107-115.
- Ganapathy, K. (2002). Telemedicine and neurosciences in developing countries. *Surg Neurol*, 58, 388-394.
- Ganapathy, K. (2014). Telehealth in India: The Apollo contribution and an overview. *Apollo Medicine*, 11(3), 201-207.

- Ganapathy, K. (2015). Distribution of Neurologists and Neurosurgeons in India and its relevance to the adoption of telemedicine. *Neurology India*, 63(2), 142-154.
- Ganapathy, K., Alagappan, D., Rajakumar, H., Dhanapal, B., Rama Subbu, G., Nukala, L., Premanand, S., Veerla, K. M., Kumar, S., & Thaploo, V. (2019). Tele-Emergency Services in the Himalayas. *Telemedicine and e-Health*, 25(5), 380-390.
- Ghassemi, P., Wang, B., Wang, J., Wang, Q., Chen, Y., & Joshua Pfefer, T. (2017). Evaluation of mobile phone performance for near-infrared fluorescence imaging. *IEEE Transactions on Biomedical Engineering*, 64(7), 1650-1653.
- Ghia, C. J., Ved, J. K., & Jha, R. K. (2013). Benefits of telemedicine and barriers to its effective implementation in rural India: A multicentric e-survey. *Indian Medical Gazette*, 146, 1-7.
- Gschwendtner, A., Netzer, T., Mairinger, B., & Mairinger, T. (1997). What do students think about telemedicine? *Journal of Telemedicine and Telecare*, 3(3), 169-171.
- Gururajan, R. (2007a). Drivers of wireless technology in healthcare: An Indian study, *European Conference on Information Systems 2007* (pp. 2245-2258). Gallen, Switzerland.
- Gururajan, R. (2007b). Factors influencing the intention to use wireless technology in health care: A study in India. *Journal of Telemedicine and Telecare*, 13(Suppl 3), 40-41.
- Gururajan, R., & Hafeez-Baig, A. (2014). An empirical study to determine factors that motivate and limit the implementation of ICT in healthcare environments. *BMC Medical Informatics and Decision Making*, 14(1), 1-8.
- Hafeez-Baig, A., & Gururajan, R. (2012). Pakistani study on the determinants of wireless technology in healthcare. *Computer Technology and Application*, 3(2), 194-200.
- Hafeez-Baig, A., & Gururajan, R. (2014). Handheld wireless devices and opinions of physicians in healthcare environment: A case of Pakistan, *Australasian Conference on Information Systems 2014* (pp. 1-6). University of Auckland.
- Iyer, M. (2014). Telemedicine adoption in India: The new drivers. *Health and Medicine*.
- Johansson, A., Esbjörnsson, M., Nordqvist, P., Wiinberg, S., Andersson, R., Ivarsson, B., & Möller, S. (2019). Technical feasibility and ambulance nurses' view of a digital telemedicine system in pre-hospital stroke care – A pilot study. *International Emergency Nursing*, 44, 35-40.
- Kareem, S., & Bajwa, I. S. (2011). A virtual telehealth framework: Applications and technical considerations, *International Conference on Emerging Technologies 2011* (pp. 1-6). Islamabad, Pakistan: IEEE.
- Keyani, S., Mumtaz, A., Mushtaq, H., & Hussain, A. (2009). Affordable and Accessible Tele-Healthcare to Rural Areas of Pakistan through Web and Mobile Based Technologies, *International Symposium on High Capacity Optical Networks and Enabling Technologies 2009* (pp. 110 -114). Alexandria, Egypt: IEEE.
- Khan, J. Z. I. (2019). Expected challenges in e-health implementation: A case of rural hospitals in Pakistan.
- Khodaie, M., Askari, A., & Bahaadinbeigy, K. (2015). Evaluation of a very low-cost and simple teleradiology technique. *Journal of Digital Imaging*, 28(3), 295-301.
- Kijsanayotin, B., Pannarunothai, S., & Speedie, S. M. (2009). Factors influencing health information technology adoption in Thailand's community health centers: Applying the UTAUT model. *International Journal of Medical Informatics*, 78(6), 404-416.
- Kumar, A., & Ahmad, S. (2015). A Review study on utilization of telemedicine and e-Health services in public health. *Asian Pacific Journal of Health Sciences*, 2(1), 60-68.

- Latif, S., Qadir, J., Farooq, S., & Imran, M. (2017). How 5G wireless (and concomitant technologies) will revolutionize healthcare? *Future Internet*, 9(4), 93.
- Luxton, D. D., Mishkind, M. C., Crumpton, R. M., Ayers, T. D., & Mysliwiec, V. (2012). Usability and feasibility of smartphone video capabilities for telehealth care in the US military. *Telemedicine and e-Health*, 18(6), 409-412.
- Mairinger, T., Gable, C., Derwan, P., Mikuz, G., & Ferrer-Roca, O. (1996). What do Physicians think of telemedicine? A Survey in different European regions. *Journal of Telemedicine and Telecare*, 2(1), 50-56.
- Malik, A. Z. (2007). Telemedicine country report-Pakistan, *International Conference on e-Health Networking, Application and Services 2007* (pp. 90-94). Taipei, Taiwan: IEEE.
- Marcelo, A., Ganesh, J., Mohan, J., Kadam, D., Ratta, B., Kulatunga, G., John, S., Chandra, A., Primadi, O., Mohamed, A. A. S., Khan, M. A. H., Azad, A. A., & Marcelo, P. (2015). Governance and management of national telehealth programs in Asia. *Global Telehealth 2015: Integrating Technology and Information for Better Healthcare*, 209, 95.
- Mathur, P., Srivastava, S., Lalchandani, A., & Mehta, J. L. (2017). Evolving role of telemedicine in health care delivery in India. *Prim Health Care*, 7(260), 2167-1079.
- Miah, S. J., & Ahamed, R. (2011). A cloud-based DSS model for driver safety and monitoring on Australian roads. *International Journal of Emerging Sciences*, 1(4), 634-648.
- Miah, S. J., Gammack, J. G. & McKay, J. (2019). A Metadesign Theory for Tailorable Decision Support. *Journal of Association for Information Systems*, 20(5), 570-603.
- Miah, S. J., Kerr, D., Gammack, J. & Cowan, T. (2008). A generic design environment for the rural industry knowledge acquisition. *Knowledge-Based Systems*, 21(8), 892-899.
- Nishtar, S., Chishtie, F., Chishtie, J., Malik, M., Ehsan, H., Qazi, Y., & Amjad, S. (2015). Pak-India collaborations in health: Insights and way forward. *Global Public Health*, 10(7), 794-816.
- Pal, S. K., Pandey, G. S., Kesari, A., Choudhuri, G., & Mittal, B. (2002). Telemedicine: E-health and hospital of the future. *Journal of Scientific & Industrial Research*, 61, 414-422.
- President's Council of Advisors on Science and Technology. (2014). *Report of the President better health care and lowercosts: Accelerating improvement through systems engineering*. Washington, DC: Executive Office of the President.
- Qazi, S., Tanveer, K., ElBahnasy, K., & Raza, K. (2019). From telediagnosis to teletreatment: The role of computational biology and bioinformatics in tele-based healthcare. In *Telemedicine Technologies*, 153-169
- Rathi, A. (2017). Inequalities in financing of healthcare in India. *Trends in Immunotherapy*, 1(1), 50-51.
- Saha, S. K., Fernando, B., Cuadros, J., Xiao, D., & Kanagasingam, Y. (2018). Automated quality assessment of colour fundus images for diabetic retinopathy screening in telemedicine. *Journal of Digital Imaging*, 31(6), 869-878.
- Saunders, M., Lewis, P., & Thornhill, A. (2016). *Research Methods for Business Students* (7 Eds.). Harlow, England: Pearson Education Limited.
- Schmeida, M., McNeal, R., & Mossberger, K. (2007). Policy determinants affect telehealth implementation. *Telemedicine and e-Health*, 13(2), 100-107.
- Shin, D.-H., Lee, S., & Hwang, Y. (2017). How do credibility and utility play in the user experience of health informatics services? *Computers in Human Behavior*, 67, 292-302.
- Stebbins, R. A. (2001). *Exploratory Research in the Social Sciences* (Vol. 48). Sage Publication.

Tandjung, R., Badertscher, N., Kleiner, N., Wensing, M., Rosemann, T., Braun, R. P., & Senn, O. (2015). Feasibility and diagnostic accuracy of teledermatology in Swiss primary care: Process analysis of a randomized controlled Trial. *Journal of Evaluation in Clinical Practice*, 21(2), 326-331.

Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing & Health Sciences*, 15(3), 398-405.

## About the Authors

**Avijit Chowdhury** is a PhD student in Health Informatics at the University of Southern Queensland, Australia. His research interests include exploring determinants of telehealth adoption in developing countries, ICT and technology adoption in healthcare, and knowledge management systems in healthcare. His research findings are continually published in IS journals and conference proceedings.

**Abdul Hafeez-Baig** is an Associate Professor of Information Systems at the University of Southern Queensland, Australia. He holds a PhD in healthcare and information systems from the University of Southern Queensland. He also has numerous publications in renowned IS journals having extensive experience in the area of information systems, especially relating to the healthcare sector. He has supervised numerous postgraduate research students.

**Raj Gururajan** is a Professor of Information Systems at the University of Southern Queensland, Australia. He has published numerous impactful research in the information systems and healthcare domain and has supervised numerous postgraduate research students. He holds a PhD from Edith Cowan University, Australia.

**Amanda McCubbin** is an Accreditation Manager at the School of Education, Federation University, Australia. She holds a Doctor of Education (EdD) from the University of Notre Dame, Australia. Amanda coordinates and manages the accreditation of all School of Education Initial Teacher Education Programs in early childhood, primary and secondary education for associate, undergraduate and postgraduate degrees. She is also an approved supervisor for postgraduate research students.

**Mirza Akmal Sharif** is a Professor and HOD of medicine at University Medical & Dental College Madina Teaching Hospital, The University of Faisalabad, Pakistan. He has nearly 40 years of experience in medical practice and teaching medical students.

**Shah J Miah** is the Head of the Business Analytics, Economics & Politics and Professor of Business Analytics at Newcastle Business School, The University of Newcastle, New South Wales, Australia. Since receiving his PhD degree from Griffith University in Business Decision Support Systems, his research interests have expanded in the subfields of Business Intelligence, Business and Big-Data Analytics. Prof Miah has produced more than 50 A/A\*/Q1 ranked journal articles. His outstanding work has appeared in top-tier outlets of the information systems and sciences, such as Journal of the Association for Information Science and Technology, Journal of the Association for Information Systems, Information and Management, Information Technology and People, and Knowledge-Based Systems. Shah's applied and problem-solving based research have already contributed to various Australian industries for improving their processes and practices.