AARHUS BSS
SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

RESEARCH ANALYSIS OF INTEGRATED TECHNOLOGY-BASED HEALTH APPLICATIONS AND USER SPECIFICITIES FOR TREATMENT ADHERENCE

PhD dissertation

Sadia Anwar

Aarhus BSS
Aarhus University
Department of Business Development and Technology
2021

PhD Supervisor: Prof. Ramjee Prasad

CTIF Global Capsule

Department of Business Development and Technology

(BTECH)

Aarhus University

ENGLISH ABSTRACT

The dissertation focuses on using integrated technology-based health applications and user specificities for adherence to the treatment plans. The use of wireless technologies plays a huge part in increasing life expectancy and reducing the mortality rate. Moreover, it has been investigated those chronic diseases need strict adherence to treatment plans, a fact that requires motivation besides focusing on any relevant patient. The comprehensive literature review suggests that wireless technologies greatly influence the quality of life as they contribute to its improvement via proper implementation. The emergence of 5G technology is a massive drive to improve integrated technology-based health applications because of smartphones' extensive use. Present technological solutions make access to healthcare faster and more efficient. However, there is a requirement for continuous training to ensure that medical practitioners and patients adapt to these technologies. This investigation highlights the barriers regarding the adoption of these technologies among patients and medical practitioners. In addition to these barriers, the above parties may have a varying attitude towards technological solutions. It is emphasized with background investigation that there is a necessity of compliance with these advancements for the patients suffering from chronic diseases as they take more time or stay on medication for their lifetime. The research provides a basis that the integrated technology-based health applications are essential in promoting adherence in patients. The dissertation provides a framework for implementing integrated technology-based healthcare applications necessary to ensure continuous literacy among patients and medical practitioners and—socio-dynamic cues like culture impact or healthcare applications. The dissertation analyzes the importance and implementation of integrated health-based technology applications in promoting patients' adherence to a care plan through easier facilitation of its implementation for patients, regardless of their illnesses, disaster emergencies and geographical locations. The scientific research study results provide a basis or the significance of collaborative strategies, literacy, and connections of chronic illnesses and socio-dynamic cues that influence the applications of assistive healthcare technology as it initiates patients' adherence and conformity to the stipulated healthcare plans. It is also presumed that the co-existence of 5G and telemedicine will enable the adoption of strategies that facilitate patients' easier persuasion towards their adherence and conformity to the care plans and administration of treatment with the proposed 5G framework for telemedicine. The improvisation and design of suitable business models of healthcare, purposefully for the improvement, value proposition, and reduction of cost regarding the services of socio-

economy and digital health care tools sustainability. The dissertation's main contributions are as follows:

- A framework as an "escalation model" supplementing with the mathematical modelling approach has been proposed before starting any telemedicine service.
- The "Preliminary framework" offers to find out the Socio-Dynamic Cues (SDC) relevance for the digital/medicinal product use and its outcome in the form of a patient's behaviour change. The framework divides SDC into four stimuli which can be influential during the process.
- A "surveillance model" (Fight-or-Flight or Rebound Approach) has been proposed to interlink four parameters that work as a tool to optimize the telemedicine services in time of crisis/disaster.
- The research links chronic diseases to the contributing risk factors. SDC based data collection and disease prevalence per region is proposed to estimate adherence strategies, the best use of assistive technology and business model suitability with possible consumer behavioural change.
- A digital software failure case investigates a software business which leads to the formation of essential suggestions "AS IS" and "TO BE" for business model innovation.
- A Comprehensive literature analysis about the use, privacy and security issues of 5G implementation concerning telemedicine healthcare services are interlinked in the research analysis.
- A "Telemedicine-CONASENSE" as a unique platform for providing telemedicine service as well as coupling it to the business ecosystem as it moves around the telecommunication paradigm in seven dimensions of the business model and CONASENSE outlook.
- A comprehensive review about wireless technology, digital assistive tools, smart homes, use of sensors for rehabilitating the elderly, telemedicine services and their overall compatibility for behavioural change regarding adherence with the care plan.

DANISH ABSTRACT

Afhandlingen fokuserer på at bruge integrerede teknologibaserede sundhedsapplikationer og brugerspecificiteter til overholdelse af behandlingsplanerne. Brug af trådløse teknologier spiller en stor rolle i at øge forventet levealder og reducere dødeligheden. Desuden er det blevet undersøgt, at kroniske sygdomme har brug for streng overholdelse af behandlingsplaner, en kendsgerning, der kræver motivation udover at fokusere på enhver relevant patient. Den omfattende litteraturanmeldelse antyder, at trådløse teknologier i høj grad påvirker livskvaliteten, da de bidrager til forbedring heraf gennem korrekt implementering. Fremkomsten af 5G-teknologi er en massiv drivkraft for at forbedre integrerede teknologibaserede sundhedsapplikationer på grund af smartphones omfattende brug. Nuværende teknologiske løsninger giver adgang til sundhedsydelser hurtigere og mere effektiv. Men er der et krav om efteruddannelse for at sikre, at læger og patienter tilpasse sig disse teknologier. Denne undersøgelse fremhæver barrierer vedrørende anvendelse af disse teknologier blandt patienter og læger. Ud over disse barrierer kan ovenstående parter have en forskellig holdning til teknologiske løsninger. Det understreges med baggrundsundersøgelse, at det er nødvendigt at overholde disse fremskridt for patienter, der lider af kroniske sygdomme, da de tager mere tid eller bliver på medicin i deres livstid. Forskningen giver et grundlag for, at de integrerede teknologibaserede sundhedsapplikationer er afgørende for at fremmeoverholdelse hos patienter. Afhandlingen giver en ramme til implementering af integrerede teknologibaserede sundhedsapplikationer, der er nødvendige for at sikre kontinuerlig læsefærdighed blandt patienter og læger og - socio-dynamiske signaler som kulturpåvirkning eller sundhedsapplikationer. Afhandlingen analyserer vigtigheden og implementeringen af integrerede sundhedsbaserede teknologiapplikationer til at fremme patienters overholdelse af en plejeplan ved lettere at implementere den for patienter uanset deres sygdomme, katastrofesituationer og geografiske placeringer. De videnskabelige forskningsresultater giver et grundlag eller betydningen af samarbejdsstrategier, læsefærdigheder og forbindelser mellem kroniske sygdomme og socio-dynamiske signaler, der påvirker anvendelserne af hjælpende sundhedsteknologi, da den initierer patienters overholdelse og overensstemmelse med de fastsatte sundhedsplaner. Det antages også, at sameksistensen af 5G og telemedicin vil muliggøre vedtagelse af strategier, der letter patienters lettere overtalelse mod deres overholdelse og overensstemmelse med plejeplaner og administration af behandling med den foreslåede 5G-ramme for telemedicin. Den improvisation og design af egnede forretningsmodeller for sundhedspleje, målbevidst til forbedring, værdiforslag, og grunduddannelse af omkostningerne

vedrørende de tjenester af socio-økonomi og digital sundhedspleje værktøjer bæredygtighed. Afhandlingens vigtigste bidrag er som følger:

- En ramme som en "eskaleringsmodel" supplerende med den matematiske modelleringsmetode er blevet foreslået, inden der startes en telemedicinsk tjeneste.
- Den "indledende ramme" tilbyder at finde ud af relevansen af socio-dynamiske signaler (SDC) for brugen af digitalt / lægemiddel og dets resultat i form af en patients adfærdsændring. Rammen deler SDC i fire stimuli, som kan have indflydelse under processen.
- En "overvågningsmodel" (Fight-or-Flight eller Rebound Approach) er blevet foreslået til at forbinde fire parametre, der fungerer som et værktøj til at optimere telemedicintjenesterne i krisetider.
- Forskningen forbinder kroniske sygdomme med de medvirkende risikofaktorer. SDC-baseret dataindsamling og sygdomsprævalens pr. Region foreslås for at estimere overholdelsesstrategier, den bedste anvendelse af hjælpemiddelteknologi og forretningsmodelers egnethed med mulig forbrugeradfærdsændring.
- En digital softwarefejlsag undersøger en softwarevirksomhed, der fører til dannelsen af vigtige forslag "AS IS" og "TO BE" til forretningsmodelinnovation.
- En omfattende litteraturanalyse om brugen, privatlivets fred og sikkerhedsspørgsmål ved 5G-implementering vedrørende telemedicinsk sundhedstjeneste er forbundet i forskningsanalysen.
- En “Telemedicine-CONASENSE” som en unik platform til levering af telemedicinsk service samt kobling af det til forretningsøkosystemet, når det bevæger sig rundt telekommunikationsparadigmet i syv dimensioner af forretningsmodellen og CONASENSE-udsigterne.
- En omfattende gennemgang af trådløs teknologi, digitale hjælpeværktøjer, smarte hjem, brug af sensorer til rehabilitering af ældre, telemedicinske tjenester og deres overordnede kompatibilitet med adfærdsændringer med hensyn til overholdelse af plejeplanen.

ACKNOWLEDGEMENTS

In the last five years, I have been very fortunate to collaborate with peers from academia and the scientific research community. These people have provided me with great insights, they have been helpful, and I am grateful to them. I would first love to express my genuine gratitude to my supervisor for the continuous support in my research and guidance throughout the process. I thank him for letting me continue with my research topic and all the pieces of advice, motivation and vision during the research. I am grateful and privileged for having worked under and with him. I also appreciate with much sincerity those who made it to the extensive discussions with my supervisor, without forgetting his family, friends, and colleagues.

I thank my family for the support throughout my education and life up to this moment. I cherish their sacrifices, prayer, and a lot of love that they have shown me to make this moment a possibility. Special gratitude goes to my research Colleagues, who provided essential support and believed that my research is going in the right direction.

Without forgetting, I would also like to appreciate all my co-authors, since every one of you has guided and made me learn new ideas, a fact that has made me the researcher that I am today. You have consequently made me believe in interdisciplinary teamwork. I, therefore, hope and believe that the efforts will reflect on our results. I want to give my department and university thanks for this opportunity to do my research by providing crucial resources.

I conclude by showing my heartfelt gratitude to everyone involved in my research. Above all, I thank my husband for his patience, guidance, and never-ending encouragement that kept me going throughout my PhD.

Any omission in this brief acknowledgement does not mean a lack of gratitude.

Contents

List of Figures

List of Tables

List of Acronyms

5G-5th Generation

B2B-Business-to-Business

B2C-Business-to-Customer

BM-Business Model

BMC-Business Model Canvas

CONASENSE-Communications, Navigation, Sensing and Services

CONASENSE-Communications, Navigation, Sensing and Services

COVID-19-Coronavirus Disease of 2019

ECG– Electrocardiogram

EEA-European Environment Agency

EHR-Electronic Health Record

EMR-Electronic Medical Record System

EU– European Union

Gbps- Gigabit per second

GDP-Gross Domestic Product

GPRS-General Packet Data Rate Service

HMOs-Healthcare Maintenance Organizations

HRMS-Human Resource Management System

ICT– Information and Communication Technology

IoT-Internet of Things

Mbps-Megabit per second

NASA-The National Aeronautics and Space Administration

NCDs-Non-communicable Diseases

NGOs-Non-Governmental Organizations

PD– Potential Deaths

PPLL– Potential Productive Life Loss

QoL- Quality of Life

RQ1-Research Question 1

RQ2-Research Question 2

RQ3-Research Question 3

RQ4-Research Question 4

RRP-Regular Rehabilitation Program

SDC – Socio-Dynamic Cues

TB-Tuberculosis

WHO-World Health Organization

List of Publications

All eight peer-reviewed publications of the applicant have been used to formulate the paper-based PhD dissertation with references inferred from primary publications along with the use of peer-reviewed secondary publications that are only used for reference purpose. It is also essential to note that the references section at the bottom of the dissertation consists of all the references present at the end of all the applicant's peer-reviewed primary publications. Following the reference section of the dissertation, all eight peer-reviewed primary publications of the applicant are attached in appendix section and finally with co-author statements.

Primary Publications

[1] S. Anwar and R. Prasad, “Framework for Future Telemedicine Planning and Infrastructure using 5G Technology,” Wireless Pers Commun, vol. 100, no. 1, pp. 193–208, May 2018, doi: 10.1007/s11277-018-5622-8.

[2] S. Anwar, R. Prasad, and B. S. Chowdhry, “Literacy and Socio-dynamics Cues Insights Decision Analytics for Care Plan Adherence,” Wireless Pers Commun, vol. 113, no. 3, pp. 1597–1613, Aug. 2020, doi: 10.1007/s11277-020-07400-4.

[3] S. Anwar, A. Kumar, and R. Prasad, “Technology-oriented home-based rehabilitation for supporting medication adherence,” in 2018 21st International Symposium on Wireless Personal Multimedia Communications (WPMC), Nov. 2018, pp. 525–529, doi: 10.1109/WPMC.2018.8712931.

[4] S. Anwar and R. Prasad, “Connections of Chronic Diseases and Socio-dynamic Cues for Integrating ICT with Care Plan Adherence,” Wireless Pers Commun, vol. 113, no. 3, pp. 1567–1578, Aug. 2020, doi: 10.1007/s11277-020-07299-x.

[5] S. Anwar, P. Lindgren, and R. Prasad, “Collaborative Strategies and Socio-dynamic cues (SDC) Insights for Assistive Healthcare Technology Applications,” Journal of Mobile Multimedia, pp. 205-224-205–224, Feb. 2021, doi: 10.13052/jmm1550-4646.171311.

[6] S. Anwar, “5G, an approach towards future telemedicine,” Proceedings of the Global WirelessSummit2016,2016. https://www.riverpublishers.com/book_details.php?book_id=462

[7] A. Kumar, and S. Anwar, “5G and Telemedicine: A Business Ecosystem Relationship within CONASENSE Paradigm,” Conasense Book, pp. 41–57, 2018. Link: https://books.google.dk/books?id=xDFuDwAAQBAJ&lpg=PA41&dq=5G%20and%20Telemedicine%3A%20A%20Business%20Ecosystem%20Relationship%20within%20CONASENSE%20Paradigm&pg=PA41#v=onepage&q=5G%20and%20Telemedicine:%20A%20Business%20Ecosystem%20Relatio&f=false

[8] S. Anwar, R. Prasad, B. S. Chowdhary, and M. R. Anjum, “A Telemedicine Platform for Disaster Management and Emergency Care,” Wireless Pers Commun, vol. 106, no. 1, pp. 191–204, May 2019, doi: 10.1007/s11277-019-06273-6.

Secondary Publications

[9] S. Arash, M. Michalowski, and D. Buckeridge. "Health intelligence: how artificial intelligence transforms population and personalized health." p. 1-2, 2018. [Accessed August 30, 2020].

[10] S. Julie, L. Wolfson, and N. Poole. "Technology-Based Substance Use Interventions: Opportunities for Gender-Transformative Health Promotion." International journal of environmental research and public health 17.3, p. 992, 2020. [Accessed August 30, 2020].

[11] C. Desirée et al. "Current state and future directions of technology-based ecological momentary assessment and intervention for major depressive disorder: A systematic review." Journal of clinical medicine 8.4, 465, 2019. [Accessed September 2, 2020].

[12] M. Suzanne et al. "The state of the art and future opportunities for using longitudinal n-of-1 methods in health behavior research: a systematic literature overview." Health Psychology Review 11.4, 307-323, 2017 [accessed 2 September, 2020].

[13] M. Moira et al. "Implementation research methodologies for achieving scientific equity and health equity." Ethnicity & disease, 29.Suppl 1, 83, 2019. [Accessed September 2, 2020].

[14] M. Lisa A et al. "The application of digital health to the assessment and treatment of substance use disorders: The past, current, and future role of the National Drug Abuse Treatment Clinical Trials Network." Journal of Substance Abuse Treatment 112, 4-11, 2020. [Accessed September 2, 2020].

[15] A. Omotosho and P. Ayegba, "Medication Adherence: A Review and Lessons for Developing Countries," International Journal of Online and Biomedical Engineering (iJOE), vol. 15, no. 11, p. 104, 2019. Available: 10.3991/ijoe.v15i11.10647 [Accessed 17 August 2020].

[16] T. Babak, A. Abrantes, and M. Stein. "The role of technology-based interventions for substance use disorders in primary care: A review of the literature." Medical Clinics, 102, no. 4, p 715-731, 2018. Available: https://www.medical.theclinics.com/article/S0025-7125(18)30015-4/pdf [Accessed 30 August, 2020].

[17] J. Creswell. “Mapping the field of mixed methods research,” 2009 [Accessed 23 September, 2020].

[18] E. Guba, G. Egon, and S. Lincoln. "Competing paradigms in qualitative research." Handbook of qualitative research 105, 2.163-194, 1994. [Accessed 23 September].

[19] R. Temoteo et al. "Nursing in adherence to treatment of tuberculosis and health technologies in the context of primary care." Escola Anna Nery 23.3, 2019. [Accessed 17 August].

[20] R. Subbaraman. “Constructing care cascades for active tuberculosis: a strategy for program monitoring and identifying gaps in quality of care.” PLoS medicine, 16(2), e1002754, 2019. [Accessed 17 August].

[21] C. Wu et al. "Risk factors associated with acute respiratory distress syndrome and death in patients with coronavirus disease 2019 pneumonia in Wuhan, China." JAMA internal medicine, 2020. [Accessed 17 August].

1. INTRODUCTION

The section introduces the research by highlighting, discussing the background, motivation, and objective, the theoretical background of the dissertation. It also elaborates on research questions, research methodology, and the research design formulated targeting the core research. The research questions, therefore, contributes to the formulation of the objectives of the research. Thus, the dissertation has research questions that attempt to fulfil, satisfy or answer most of the entire study's formulated objectives.

1.1. Research Introduction

Various patients have diverse needs regarding healthcare, and the continually evolving technologies create gaps along the way and require them to switch or put an adjustment in their care plan. It means that they should be trained continuously on the rolled-out updates. Training increases patient involvement, which is useful for improving their adaptability in technology. Attitude and background are primary factors that affect patients' treatment and technological adherence [2]. It means that integrated technology-based health applications should have designs that motivate people to use them, with additional features to embrace the process. These applications' development should involve medical experts to understand patient behaviour, unlike software developers [2].

The integrated technology-based health applications should be acceptable, sustainable, and user friendly so that all stakeholders are satisfied with the system, which will improve effectiveness. It will also allow collaboration and integration with other features in different industries like food and fitness, complementing medical treatment. It is essential to establish a framework for the integrated technology-based health application solutions that improve patient adherence to treatment [5]. Less involvement from stakeholders, unavailability of specialized settings, and costly healthcare services are the primary factors pushing for integrated technology-based health applications and a framework to assist in the healthcare ecosystem [1]. A framework should be universal to accommodate all integrated technology-based health applications crucial to promoting adherence in patients. A patient's behaviour is reflective of their medical treatment plan adherence. A medical practitioner recommends a plan depending on the patient's diagnosis, needs, and body dynamics like disability also cognitive problems. The program involves the treatment, follow-up,

and relevant interventions [10]. The adherence plan's primary function is to improve patients' quality of life as they continue with treatment and prevent their health problems [4]. Adherence is a huge factor in the patient's future health condition. It minimizes many processes involved in treatment, and the procedures include payments, reimbursements, future relapse, hospital space, regular assessments, and appointments [1].

Issues like motivation, attitude, age, culture, and relationships cause non-adherence in patients. More problems like lack of belief, adaptability, awareness, and treatment plan complications hinder patients' adherence [2]. They can be arrogant as they may not understand how integrated technology-based health applications improve and ease their care plans. Severe conditions may require strict follow-up and, consequently, a comparable level of adherence. Without adherence to a treatment plan, causal microbes like bacteria or viruses can develop medication resistance, which is not suitable for patients [3]. It leads to a low quality of life, and they may require more medication, which would not have been necessary at the beginning. In injuries or surgeries, close follow-up is essential to ensure that the healing process continues well [11]. Patients need to adhere to medications strictly when they suffer from chronic conditions as they can last for their lifetime. It shows that patients need to comply strictly with drugs to ensure that they have a high-quality life, yielding the therapeutic window, and make the treatment processes easier to execute.

The EU has various recommendations on adherence. One is training patients to make proper decisions to stick to their treatment plan to promote adherence. Adherence practices should be put to understanding by all medical practitioners, including doctors, nurses, and pharmacists. The EU recommends that every country develop adherence policies and make them available to the public portal and other media forms [2]. A population of 315 million Europeans is consuming the internet. They are also registered for a gradual increase in the use of IoT. The EU has made the move of using 5G communication networks for improved access of the internet by the citizens and has also adopted the healthcare business models. In their plan for the year 2025, they have decided to switch from 100Gbps to 100Mbps. There will be a revolution of all their forms of communication and implementation of remote monitoring of the telemedicine services [1]. In this perspective, the 5G network reflects an improved degree of effectiveness since it has the capacity of transferring telemedicine-related data and images with a one-millisecond latency or minimal delay and has no interruption. The plan would prove boosted reliability and effectiveness, particularly when patients remote monitoring consumes more time [6]. Adherence with care plan requires addressing health

inequalities, such as staff shortage and financial crisis. Patient health programs or group engagements are essential to ensure they stay motivated to stick to their treatment plans to promote adherence.

Adherence with care plan varies across the world for various reasons, including its administration, dosing frequency, medication cost, and side effects. Besides, the above factors, people with different health conditions also have different rates of adherence. Furthermore, patient factors like menopause, family history, physical and mental health vary and alter compliance in different countries [3]. Different countries exhibit varying misconceptions about therapy and medical conditions, therefore having different rates of adherence. Similarly, pandemics or crises call for coordinated and frequent inputs for a calamity restoration and victim rehabilitation. Variably, the merging of 5G communication, digital tools, and Information Communication Technology (ICT) can help rebuild relief activities, rescue procedures, and restore any disruptive systems in the areas affected by disasters. The presence of inappropriate ideas can precipitate the implementation of wrong decisions and negative situations. In effect, there is the necessity to examine the type of ICT-related solution or technology to offer terminal assistance by reviewing privacy and security issues since the standards may undergo regular scrutiny.

A notable recommendation is to establish a local group of a co-operative team in healthcare and technology sector as it is most popular with the calamity-prone zones. The reason is that such a team can understand every locally-oriented cultures, economies, systems, and disparities. Therefore, they can achieve priority-guided coordination like in the care hub training disaster management, employing the current healthcare services and collaborative strategies with hospitals, multinational/ private agencies, and municipalities [8]. Various nations worldwide bear diverse healthcare ecosystems whose existence is defined by their government policies, managerial/administration hierarchy policies for hospital workers, the addressing of patients' healthcare cases, and the access and purchase of medication.

Also, there are very divergent extents of prescription-related legislation following the purchase of over-the-counter medication in healthcare facilities and even in public. Likewise, there is the existence of other regulations that guide the operations of promotional activities of pharmaceutical companies. The healthcare systems and government policies do not just portray some degree of variance from the above aspects, but also shapes from the parameters of language and cultural differences.

The healthcare business models should be improved by various assistive corporates in healthcare technologies to sincerely dig into the variations/ transition of technologies and SDC worldwide to avoid product under-performance and the patients' behaviour change for proper therapy adherence. Besides, CONASENSE platform can execute a significant role in applying telemedicine services by permitting every part of its verticals to take effect in telemedicine and perform a vital function of enhancing the business influence of the integrated technology-based healthcare applications [7]. The attainment of a complete diversion from the contemporary models based on the products may sound important since the abrupt alteration of old models would create interference by resulting in unsustainable and unhealthy financial burdens [5]. Thus, a dynamic model of business that is strategically sustainable enough remains a necessity.

1.1.1. Overall Structure of the Dissertation

The dissertation has been divided into several sections. The introduction section launches the research by overviewing, expounding on the dissertation's background, motivation, objective, and theoretical background. It also discusses the various forms and ranges of the research questions, methodology, and the research design that encompasses the entire dissertation. These aspects aid in developing research analysis of integrated technology-based health applications and user specificities for treatment adherence. The research is expended further in sections two, three and four by peer-reviewed published papers and lastly conclusions in section five in the form of future scope and recommendations. The below table shows the names of the peer-reviewed published research papers used in the sections' compilation and contributes to the overall dissertation formation.

Table 1: Peer-Reviewed Published Research Papers

No	Category	Title of the paper	Status
1	Journal	Framework for Future Telemedicine Planning and Infrastructure using 5G Technology	Published
2	Journal	Literacy and Socio-dynamics Cues Insights Decision Analytics for Care Plan Adherence	Published
3	Journal	Connections of Chronic Diseases and Socio-dynamic Cues for Integrating ICT with Care Plan Adherence	Published
4	Journal	Collaborative Strategies and Socio-dynamic cues (SDC) Insights for Assistive Healthcare Technology Applications	Accepted and in printing

5	Journal	A Telemedicine Platform for Disaster Management and Emergency Care	Published
6	Conference paper	Technology-oriented home-based rehabilitation for supporting medication adherence	Published
7	Conference paper	5G, an approach towards future telemedicine	Published
8	Book Section	5G and Telemedicine: A Business Ecosystem Relationship within CONASENSE Paradigm	Published

1.1.2. Organization of the Sections

The sections answer four main research questions and their subdivisions based on the published research papers and the organization of all the sections comprised in the entire research dissertation are provided in the section as below:

Section 1 introduces the entire research dissertation by highlighting research introduction, background, motivation, objectives and theoretical background. It also touches on research methodology, research design and methods. It corresponds to peer-reviewed published research papers, 1,2,3,4,5,6,7,8.

Section 2 expounds on the state of the art of the dissertation as it braces on the research literature review, as well as the relevant peer-reviewed journal papers. These include the Framework for Future Telemedicine Planning and Infrastructure using 5G Technology, Literacy and socio-dynamics cues insights decision analytics for care plan adherence. Also. Connections of Chronic Diseases and Socio-dynamic cues for Integrating ICT with Care Plan Adherence, and A Telemedicine Platform for Disaster Management and Emergency Care. It corresponds to peer-reviewed published research papers, 1,2,4,8 in primary publications.

Section 3 bases on the conceptual framework of the dissertation. It relies on one journal article, two conferences papers and one book section to help it achieve its research purpose. These are 5G, an approach towards future Telemedicine, Home-based technology-oriented rehabilitation for supporting medication adherence, and Collaborative strategies and SDC insights for assistive healthcare technology applications. It corresponds to peer-reviewed published research papers, 3,5,6.

Section 4 concentrates on healthcare technology business models. The section emphasizes describing the various effective healthcare-related business models that can promote patients' adherence to the new healthcare systems. A majority of the published papers cover business model aspects. It corresponds to peer-reviewed published research papers, 1,2,3,4,5,7,8.

Section 5 wraps up the entire dissertation by concluding its research. It also suggests the appropriate recommendations to initiate the perfect achievement of the dissertation's objectives and goals, besides touching the main findings and future scope of other related studies. It corresponds to peer-reviewed published research papers, 1,2,3,4,5,6,7,8.

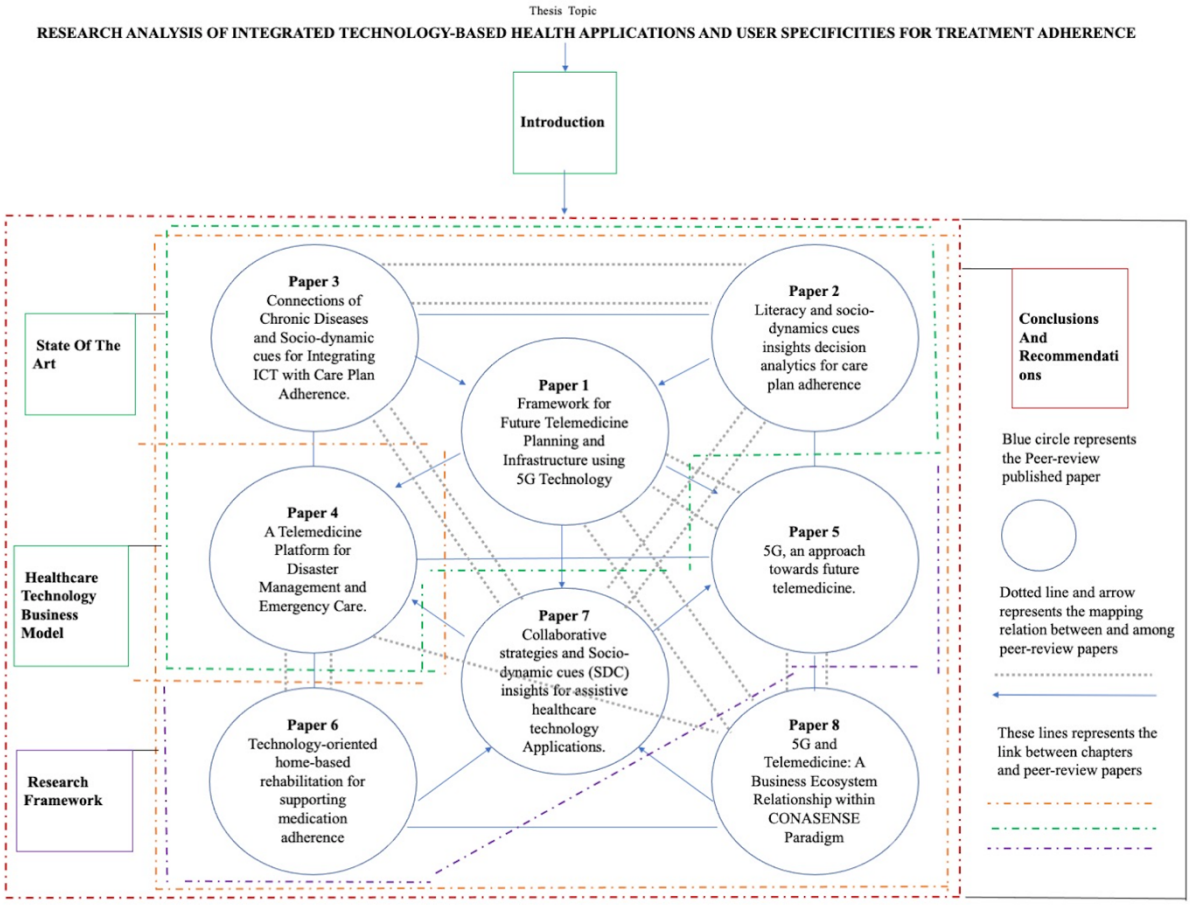
1.1.3. Mapping of Published Research Papers with Sections

The interlink between the papers and sections has been shown in the below diagram, contributing to the overall research. The mapping of the entire five sections of the dissertation relies on the research framework. Section one of the dissertation represents its whole framework. As such, the first section of the dissertation elaborates its entire flow, the relationship between the peer-reviewed research papers, and their links with various related sections.

The first section of the dissertation procedurally explains the research framework's flow, from the research design, conduction of the research, the analysis of the research data, and the conclusion. The latter implies the research objectives' satisfaction, literature review, and collection of the secondary data. From these, the analysis of data and development of conclusions and main contributions follows. Thus, section one links to all the peer-reviewed research papers and the other sections.

Subsequently, peer-reviewed published research paper 1 relates to papers 2, 3, 4, 5 and 7, whereas, paper 7, relates to papers, 1, 4, 5, 6, and 8. On the other hand, while section 1 being the entire dissertation's research framework, it relates to all the other sections and peer-reviewed research paper. Sections 2 and 4 describe papers 1, 2, 3 and 4, whereas, section 3 refers to papers 5, 6 and 7. Section 5 refers conclusively to all the peer-reviewed papers in the dissertation. Paper 3 also relates to papers 2 and 7. Paper 8 links to papers 1, 4 and 5. The below diagram shows the relationship among peer-reviewed published research papers and sections of the entire dissertation focusing on its main topic.

Figure 1: The Mapping of Sections and Peer-reviewed Papers



1.2.Background and Motivation

The research bases on technology applications for healthcare, which precipitates from the necessity to adopt and incorporate digital tools and wireless technology to improve the healthcare sector and the adherence with treatment by the patients in the contemporary generation. As such, the research receives direct support from the requirement to boost healthcare services' delivery and efficiency to different patients despite the illnesses of geographical locations [2]. Moreover, using the literature review of the conducted research and studies, the SDC is missing and therefore, it does not test patients' adherence to care plans in systematic fashions [2].

PhD applicant is part of EC-healthcare project (2017-2022). The PhD applicant conducted the systematic review in the year 2018; as a co-author of one of the highly ranked publication, to see

the technology adaptability for virtual coaching and to assess various features for the patients' persuasion for treatment adherence. Virtual coach train patients to monitor themselves and comply with the stipulated care plan [2]. A selection of 264 papers was conducted from the web sources following the selection criteria [2]. The continued exclusion and analysis resulted in 21 scientific papers for review. The PhD applicant has analyzed that, the findings of the literature, displays the absence of SDC, a fact that should be under analysis during the establishment of a convincing technology for improved treatment results and QoL [2].

Several software and applications possess a facility for language and engagement features; however, SDC specificity for convincing technologies has not been highlighted. If we focus on various cultures, there could be many physical cues, particularly the SDC highlighted in Fogg's book (Persuasive Technology Book, 2003) [2]. The variations of culture have been under general discussion in various books and articles of research for persuasive technologies; however, they do not mention anything regarding adherence to care plan, and SDC need, particularly on the digital tool’s stagnancy in the healthcare ecosystem [2]. Chronic illnesses are a globally recognized constraint on economics and healthcare ecosystem as they lead to premature death rates of over 550,000 individuals whose ages range between 25 to 64 years old annually in the EU nations [4].

These fatalities lead to the dissipation of nearly 3.4 million production life years if the population gets employed and retire at 65 years old, with a similar rate of employment as that of the remaining population [4]. Additionally, an analysis was conducted in 2016, in approximately 28 EU nations for investigating the loss of death and productivity. Which shows an average consideration of €338 000 yearly income of an ordinary employee in the EU nation expenses €115 billion in the EU economy or 0.8% GDP annually [4] since Patients face a challenge to adhere to the care plan as it is challenging to develop new habits and following lifestyle modification.

There is no doubt that Integrated technology-based health applications are essential in medical practice. It involves understanding and accessing medical resources to address a health issue from electronic sources [2], [4]. Integrated technology-based health applications are useful at all levels ranging from patient to physician; therefore, creating a top medical ecosystem as it makes daily operations smoother and faster. However, integrated technology-based health applications at the patient level mean that the patient should also be technology literate [2]. It allows them to make the right decisions and respond well to the programs.

Technological applications give patients motivation to adhere to the treatments they are undergoing, and they come in handy to boost integrated technology-based health applications. They can either be in health applications or be independent. Integrated technology-based health applications allow a patient to access much medical information, and they can have choices which they make depending on their preferences. If a patient does not have enough technological literacy, it can work against them to worsen their health condition. It is because they can make poor decisions regarding the treatment program [1].

Integrated technology-based health applications are essential to provide patients with a treatment plan, but it also gives them a lot more, including the following. They give patients information on signs of disease, obesity, physical activity, sleep cycle, daily goals and motivation, diet plans, and toxicity management. These are services that one can access apart from scheduling appointments with their relevant medical practitioners [4]. The younger population widely utilizes integrated technology-based health applications more than the elderly. Because of the apparent difference in technology literacy, which was not significant until the 21st century, it is growing exponentially [10]. Cognitive impairment is an example of a medical condition that may affect how a person responds to integrated technology-based health applications for their treatment plan.

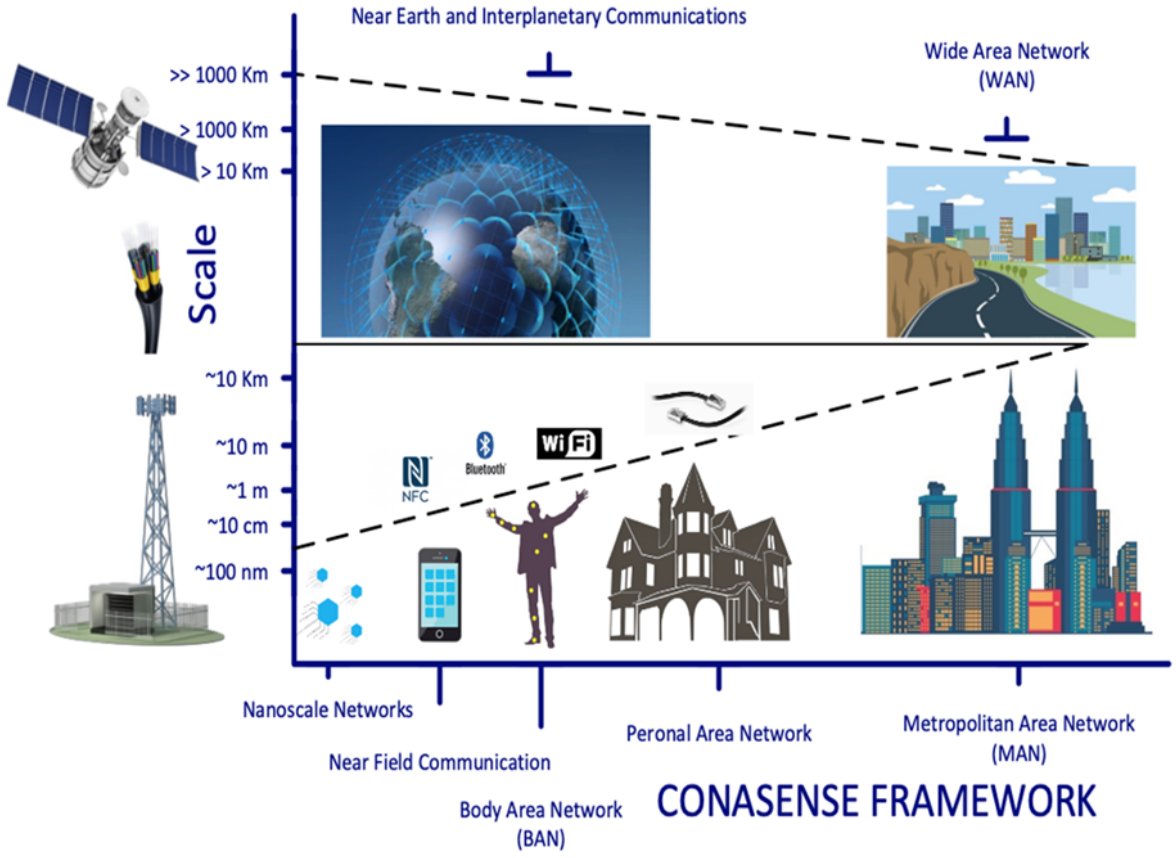
The effective administration of healthcare services calls for adequate training of the healthcare professionals on analytics and information and communications technology to exercise proper adoption of telemedicine applications in providing healthcare services to the patients. Medical practitioners and patients must adopt the technology, which is highly useful for delivering and monitoring treatment plans between them. Awareness, culture, trust, confidence, politics, and legal issues are some factors that may hinder the process [5].

5G technology is already rolled out in many countries globally, mainly in North America, Europe, and Asia [1]. It is a crucial technology that will shape the future of integrated technology-based health applications even though its predecessor, the 4G network, is also quite fast [6]. Health Care Medical and Medicines, Big data analytics, and communication technology are the primary forms of integrated technology-based health applications [3].

The technology of 5G is a new improvement in the above healthcare technologies since it will promote a faster and convenient communication than the previous and present ones. The integrated

technology-based healthcare applications apply a security framework of conventional ICT because the standards are still premature. The technology of 5G remedies accessibility and speed in integrated technology-based healthcare applications; however, there are other issues [9].

Figure 2: CONASENSE Framework Applications and Communication Platform for Telehealth [7]



It is essential that all stakeholders accept, understand, and adapt to mushrooming technological solutions in the healthcare industry. Patients worldwide adopt these solutions as they try to create convenience and reduce costs as they seek healthcare [1]. However, the numbers are still low, as there are less exposure and awareness of all stakeholders towards technological solutions. Medical practitioners seek to improve adherence to medical treatment plans from patients [7].

Individuals, especially the older age groups, feel that these technologies are a burden to them as they find them challenging to adapt, but the younger population is doing quite well [1]. Some medical practitioners may feel that technology is not their specialty, but it has a massive impact

on their profession [1]. Therefore, it is crucial to address these issues in a bottom-up approach by starting with the basics to incorporate integrated technology-based health applications to healthcare. The proper implementation ensures that all the stakeholders adapt to them effectively. It will serve a massive purpose in promoting adherence in patients as they go through their treatment and follow up plans [1], [2], [3], [5].

Integrated technology-based health applications play a considerable role in increasing life expectancy and reducing the mortality rate. It provides many solutions to the patient treatment process and follow-up. It enables monitoring of long-term and chronic illnesses, which has been a hectic process for a long time as it involves patients moving back and forth hospitals or medical practitioners attending to them at their homes. Integrated technology-based health applications eliminate the distance between the patient and their doctors [4]. It shows a considerable need to incorporate integrated technology-based health applications in healing processes, even though adherence is still a significant issue. It will be useful to improve the treatment plan's outcomes and improve the patient's quality of life. Literacy is crucial to ensure proper medical care plan adherence. It gives the patients and medical practitioners the platform to analyze situations and make appropriate decisions.

Literacy allows for effective communication between all parties as they strive to complete the care plans. Communication is oral and via technological platforms, and they should use the tools effectively, for example, to complete appointment sessions. Tools include a microphone, camera, and messaging platforms, and they are vital to ensure communication with all parties involved [8]. Therefore, it is crucial to consider the literacy factor upon deciding between the adoption of integrated technology-based healthcare applications in care plans for various patients.

1.3.Objective

The extent to which a person conforms to the medical guidelines stipulated by their healthcare practitioners to attain healthcare goals describes as adherence (Roger walker& Cate Whittlesea, pg. 24) [2]. On the other hand, a care plan is a piece of medically-related advice based on the patient's distinct body needs, dynamics and diagnostics from the healthcare practitioner involving treatment, and the consecutive follow-up evaluation [2].

The role of adherence in the care plan mainly reduces the medical team's effort (for instance, hospital space, regular assessments, future relapse, appointments, payments, and inappropriate reimbursement). It boosts patients' results, like improving their quality of life and relapse to a healthcare facility at a cheaper cost [2]. The behaviour of different groups that arises from intercommunications of people or their group members as well as the study of the relationship between group behaviour level and individual interactions refer to as the Social Dynamics [1], [2], [3]. [4], [5].

The study's objective is to demonstrate how the user specificities and integrated technology-based healthcare applications facilitate patients' adherence. Patients' global magnitude of conformity to healthcare is limited since they ignore their doctor's prescriptions and guidelines. At times, patients skip medications regularly as others permanently stop. However, medical compliance is a vital tool to attaining good health results.

The objectives of the research and analysis are mentioned below:

- To analyze the importance and implementation of integrated health-based technology applications will promote patients’ adherence to a care plan through easier facilitation of its implementation for patients, regardless of their illnesses, disaster emergencies and geographical locations.
- The scientific research study results will provide bases for the significance of collaborative strategies, literacy, connections of chronic illnesses, and socio-dynamic cues. These will influence assistive healthcare technology applications as it initiates patients' adherence and conformity to the stipulated healthcare plans.
- It is also presumed that the co-existence of 5G and telemedicine will enable the adoption of strategies that facilitate patients' easier persuasion towards their adherence and conformity to the treatment with the proposed 5G framework for telemedicine.
- To improvise and design suitable business models of healthcare, purposefully for the improvement, value proposition and incensement, and the reduction of cost regarding the services of socio-economy and digital health care tools sustainability.

1.4.Original contributions

Some original efforts and inputs anchor the dissertation. The research makes a systematic review of different study articles to develop various fruitful strategies of adopting the most effective decisions regarding the integrated health-based technology applications in the sector of healthcare.

All contributions are available in the attached published peer-reviewed published research paper attached at the dissertation's bottom. In contrast, the dissertation itself summarizes the research analysis and contributions of the published articles.

- A framework as an "escalation model" supplementing with the mathematical modelling approach has been proposed before starting any telemedicine service. The model's productivity is determined through performed tasks analysis, sharing the service pressure with highlighting communication as a primary or main factor in the model, and connectivity with real-time by use of 5G aspects [1].

- Persuasion of the treatment plan and persuasive technological devices use by considering SDC and global dynamic cultural mapping. A "preliminary framework" for SDC for business models in six dimensions proposes the sustainability of care plans and medical assistive devices. The "Preliminary framework" aims to determine the SDC relevance for the product application and its outcome in patient behaviour change. The framework divides into four SDC based stimuli, which can be influential during the process [2],[3].

- For Disaster management, the "surveillance model" (Fight-or-Flight or Rebound Approach) has been proposed to interlink four parameters that work as a tool to optimize the telemedicine services in time of crisis. The model provides multinational telemedicine services, act fast, and solve intricate puzzles if the answer is not possible through a national or local emergency team. Communication follows privacy and security obligations, which is a big challenge. However, through sound and reliable network system is possible. The framework emphasizes the lack of platform particularity, suspension of information, response, and understanding of handling parameters while handling a crisis are part of the surveillance model [8].

- The research also links or connect chronic disease/contributing risk factors. SDC based data collection and disease prevalence per region is proposed to estimate and determine adherence plan strategies, assistive technology best use, and business model suitability with possible consumer behavioural change. The SDC evaluation and application can decrease the socio-economic expenditure, total deaths, increased commitment with care plans, and improve the patients' QoL. Eventually, the lower the prevalence of multi-chronic diseases [3],[4].

- One assistive technological device's successful application cannot be the same if implemented in the other regions/area/country. A digital software failure case investigates a business, which leads to the formation of essential suggestions "AS IS" and "TO BE" for business model innovation. Also, analysis shows research on assistive healthcare devices is still evolving—the analysis emphasis on Collaborative strategies, country-specific data useability, eHealth literacy, and SDC for digital tools [5].

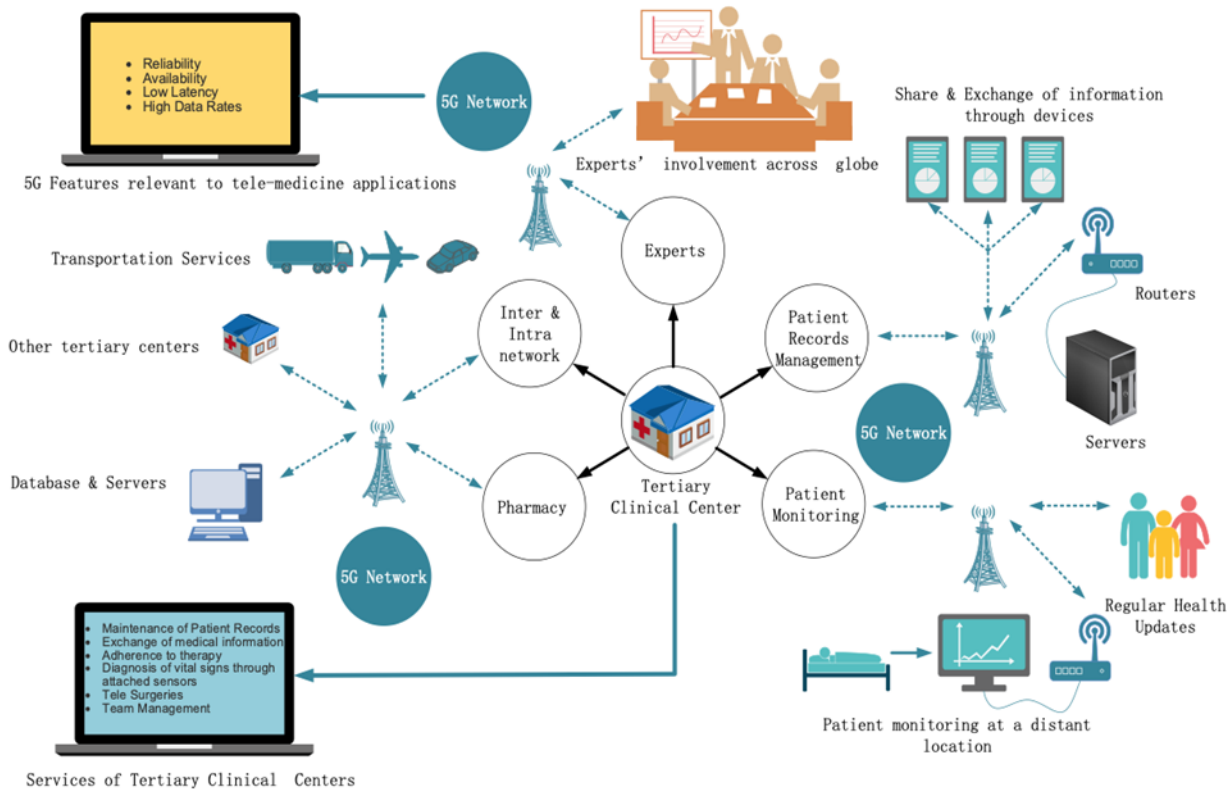
- The research also investigates through comprehensive literature analysis about use, inherent challenges, privacy, and security issues of 5G and telemedicine. Furthermore, it provides the usefulness of wireless technology for digital assistive tools, smart homes, and sensors for rehabilitating elderly and telemedicine services overall and their compatibility with patient behaviour. Moreover, research proposes the "Telemedicine-CONASENSE" platform as a unique platform for providing telemedicine service as well as coupling it to the business ecosystem as it moves around the telecommunication paradigm in seven dimensions of the business model and CONASENSE outlook [1],[2],[3],[4], [5],[6],[7], [8].

1.5. Theoretical Background

The majority of healthcare workers use wireless technology and digital devices nowadays in their profession. It creates a communication platform between them, making it useful and comfortable. There are many integrated technology-based healthcare applications on download platforms, some of which are defined in the published papers and overall core analysis of the research covering the dissertation's main topic. The theory of the Internet of things refers a boost to these applications with the exponential development of artificial intelligence, creating a revolution in everyday life activities, as defined by Doolittle and Spaulding (2006) [1].

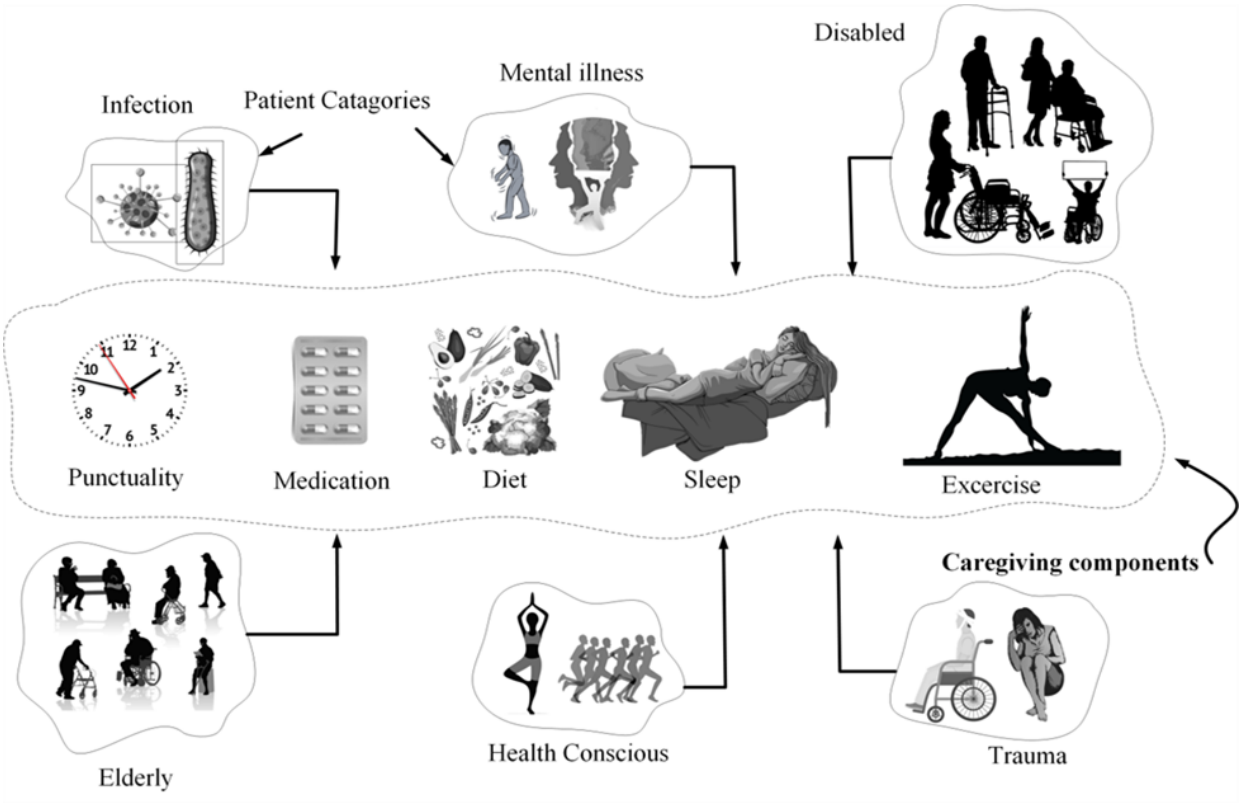
Artificial intelligence makes it possible to develop smart healthcare services to promote adherence to in-patient care plans. According to (Kayange, 2014) wireless communication is key to connecting the medical practitioners and the patients [7]. Smartphones utilize wireless transmission because of its extensive coverage and the ease of access. Patients and medical practitioners get quick updates anywhere they are, either in their home or office.

Figure 3: Applications of 5G in Healthcare [6]



As per Oleshchuk and Fensli, (2010), 5G is a critical component to boost the functionality of integrated technology-based healthcare applications because of time and availability [6]. Availability is the ease of access to wireless technology tools by patients and medical practitioners with the 5G network [6]. Time refers to the swift transfer of data through the 5G network, which exhibits high internet speed. It makes service delivery easy as medical services adopt a practical approach, and speed is critical for effectiveness. Thies et al. (2017) describe that integrated technology-based healthcare applications should have authentication, security, fault-tolerance, global coverage, transparency, and climbable. It is vital for patients and medical practitioners to collaborate and create suitable care plan strategies (Sawesi et., 2016) [5]. The medical practitioners make these plans with patient specificities to fit their needs. It is because of the patient's body or mental dynamics which affect the prescription plans.

Figure 4: Medical Adherence Requirements [3]



About half of the patients' population do not adhere to prescribed medication (Cipolle et al., 2012), leading to preventable premature deaths worldwide [3]. Poor adherence is costly to the patient and the healthcare system, as it increases the amount of medication the patient needs and more appointments with the medical practitioners. Atreja (2005), showed that adherence is cost-saving if the implementation of healthcare plans is complete [3]. Therefore, a patient needs to adhere to all prescriptions and follow the care plan to get the desired healthcare plan. Treatment often results depending on the strength and efficiency of the drugs a doctor prescribes to the patient.

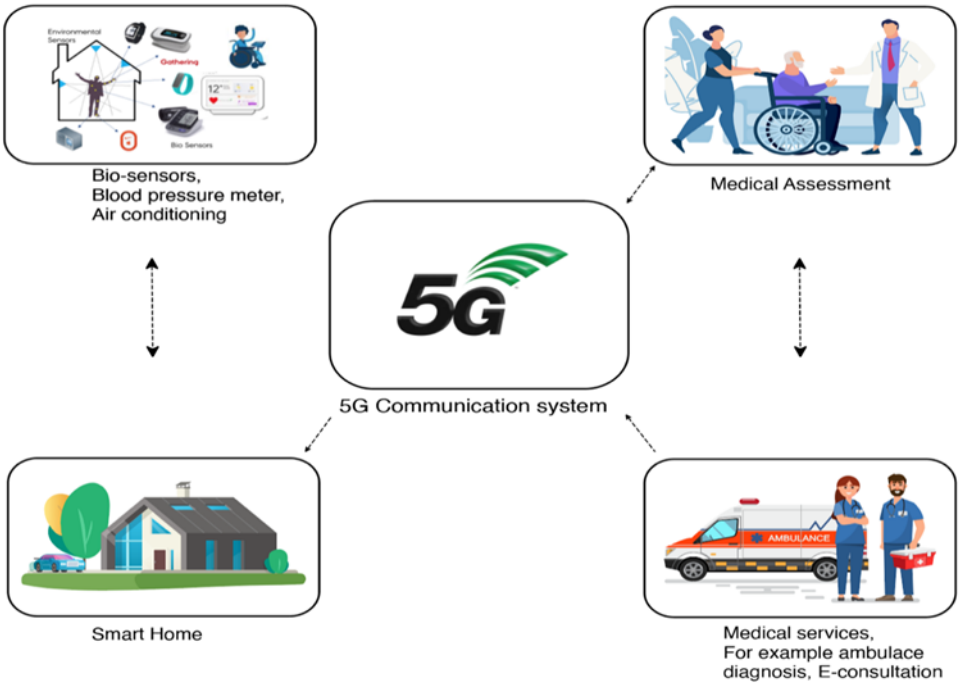
However, failure to follow the prescription plan or avoid the medication reduces the patient's likelihood from healing from the health problem. Medical practitioners and people, in general, must be literate in integrated technology-based health applications. Norman and Skinner (2006) explained that it is useful to them, so they can achieve their desired health outcomes when they are on a health care plan [2]. Therefore, a person should be analytical to decide on adopting integrated technology-based health applications with confidence. Integrated technology-based health applications come in various ways, like services, devices, and resources. A person needs to have the relevant skills and understand each solution's specifications (WHO, 2013) [2].

A medical practitioner should know various integrated technology-based health applications to give patients different solutions to choose from, depending on their preferences and convenience. Some people may not have proper access to primary care and integrated technology-based healthcare solutions. It means that their social status may affect their adherence to their healthcare plans. It can be because of inaccessibility to healthcare facilities, lack of transport, and low literacy levels. However, according to Pathirana and Jackson (2018), the emergence of integrated technology-based healthcare solutions and 5G networks can give them a reprieve as it is less costly and easily accessible at the comfort of their homes. Kaltenbach (2014) meant that people could access a medical practitioner without going to a hospital either during first-time treatment or a follow-up [4]. They are implementing integrated technology-based healthcare solutions in rural areas that may not be complete because not all services of integrated technology-based health applications are affordable, like telesurgery.

However, individuals with lower social status are less likely to participate in activities that may lead to health complications like low diet, lack of physical activity, and alcohol and substance

abuse [4]. When an individual's cholesterol, hypertension, and smoking are under control, they are at a low risk of developing chronic health conditions, which reduces the overall cost of health for the person and the health sector in general. Patient care plans and therapy are now more straightforward with healthcare assistive technologies. It is because of digital tools that allow patients and medical practitioners to access their medical health records and electronic health. It makes processes faster and reliable because it is real-time. A medical practitioner creates healthcare settings and protocols that a patient follows when using these tools. However, these tools must follow socio-dynamic cues like culture for patients and medical practitioners [5]. Medical practitioners also have varying conditions in their working environment, meaning that adaptation is key to proper implementation. Digital tools are useful across the European Union member states, for example, in Copenhagen Hospital, Denmark.

Figure 5: Integrated-Technology Based Health Applications and the Concept of Smart Home [6]



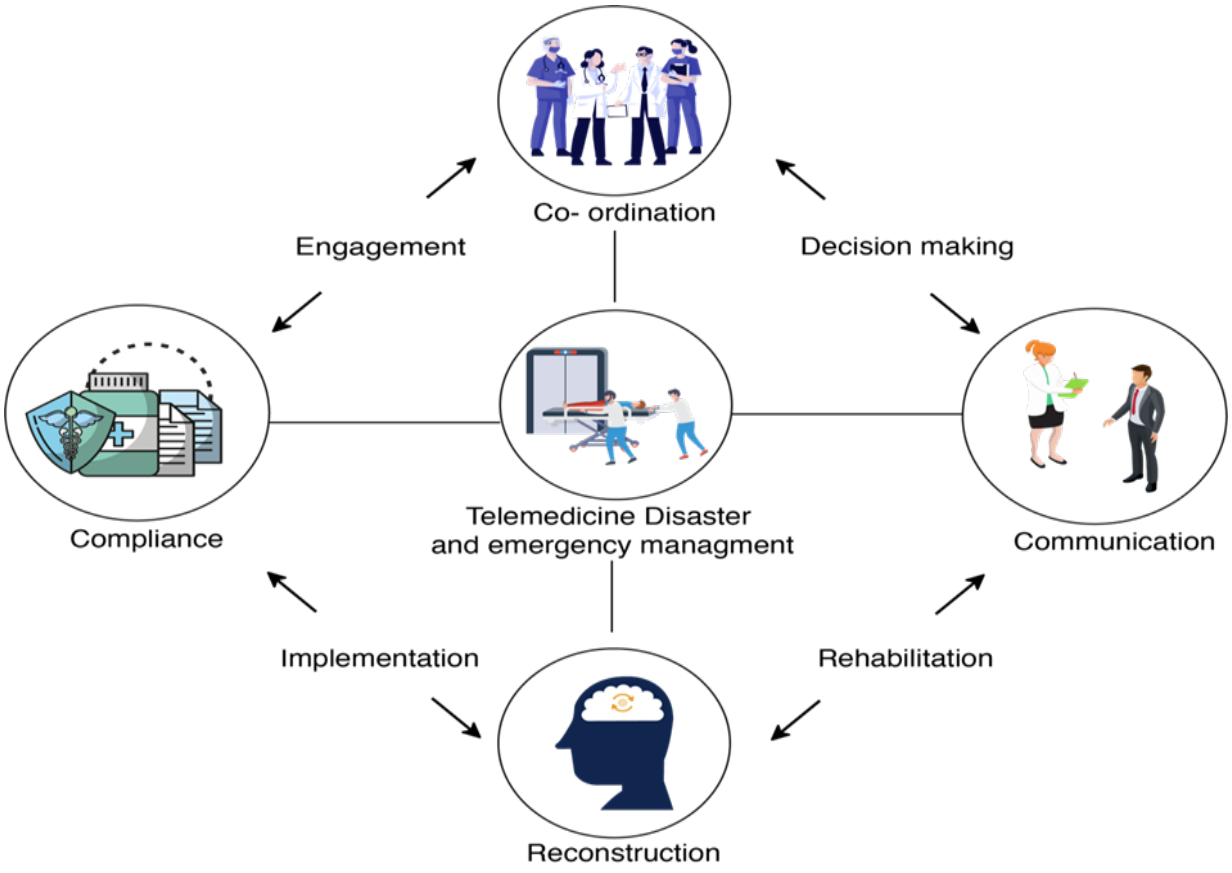
As hospitals adopt integrated technology-based health applications, they need to adapt accordingly to fit user specificities and business models. According to Sawesi et al. (2016), patients and medical practitioners need simple technological applications and devices to meet their needs

and easy use [5]. Therefore, creators should aim to study healthcare facilities' business environment to create custom applications and software to create value for every stakeholder. The current technology solutions in healthcare are showing promising signs, but they have their shortcomings. However, they are useful as they adapt technology to fit patients' needs in their medical care plans. Technology is continually evolving, and emerging tools are even better and replace the old ones. Bernard and Linkous, (2016) argue that technological health solutions create confusion, especially in patients who majorly do not have literacy education on the emerging technologies, unlike medical practitioners who might get constant briefs about them in their healthcare facilities [7]. Therefore, there is a need for patients to adapt constantly to use these integrated technology-based healthcare solutions. It shows a considerable demand for an e-health literacy framework for patients every time new solutions emerge.

In healthcare, emergencies or disasters are inevitable, and integrated technology-based healthcare applications come in handy to manage the situation. A suitable method must apply to restore victims and minimize the damage and casualties (Kellenberg & Mobarak, 2011). Therefore, integrated technology-based healthcare applications are useful for disaster management and have a great room for improvement in the future. It helps patient diagnosis, care plan creation, and patient analysis as it combines medical provision with technology. It is vital to create protocols like a priority for patients in a particular care plan or categorize them. Therefore, the integrated technology-based healthcare applications minimize the time that a patient takes to reach a medical practitioner.

Xiong et al., (2012), theoretically described that it creates a fast strategy with intelligence to ensure communication and coordination between different sectors to ensure that patients get swift assistance in times of disaster or emergencies (Xiong et al., 2012). Integrated technology-based healthcare solutions allow patients and medical practitioners to access medical records useful for care plans to improve the overall quality of life and the healthcare system. It is helpful as a response to physical disasters like earthquakes or hurricanes. In effect, it hastens communication to ensure that the delivery of assistance is swift (Rahman et al., 2016). Therefore, medical practitioners can attend to their patients in emergencies regardless of the time or locations.

Figure 6: Elements and Stages of Disaster and Emergency Care Management [8]



According to Xiong et al. (2012), individuals have varying thoughts toward emerging healthcare technologies, depending on their technical and medical background (Xiong et al., 2012). Therefore, the creation of integrated technology-based healthcare solutions should consider medical practitioners' views as they are ones responsible for implementation. Also, incorporating new integrated technology-based healthcare solutions should follow a particular framework to ensure that every stakeholder understands how to utilize the systems (AlDossary et al., 2017). It gives the healthcare system flexibility in implementation to avoid inconveniences. It also allows healthcare facilities to adjust their business models accordingly and incorporate other organizations to partner with the medical institutions (Oleshchuk & Fensli, 2010).

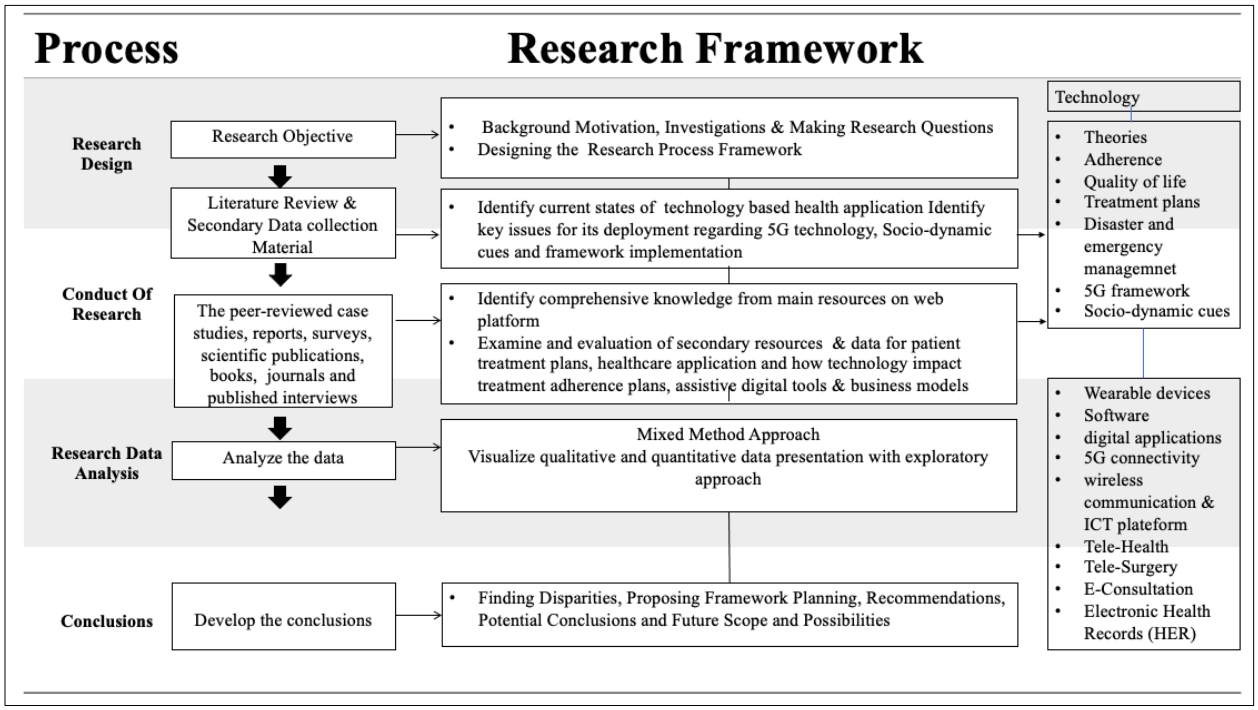
Patients encounter challenges regarding the adherence to healthcare technology applications, as they undergo persuasion to develop a current modification of lifestyle or healthy habits. As per Kayange, (2014), social dynamics is the groups' behaviour that is a resultant emergence from the

group members' interactions, and also to the understanding and study of the connection between interactions among individuals that is one-on-one, as well as the behaviours of the group levels (Kayange, 2014). He also adds that persuasive technologies can aid the stimulation of patients' adherence to healthcare technology applications and their associated care plans (Kayange, 2014). The adoption of assistive technology by the EU advanced between 2010 and 2011 from $3.1 to $4.8 billion (Bernard & Linkous, 2016). Thus, limited adherence to the technological applications' care plan is the propellers for adopting digital tools. These pegs to the culture push for implementing a specific business model towards adopting and influencing healthcare technology applications and their corresponding care plan. Norman and Skinner (2006) argue that a business model can base on value regarding the increase of life quality and productivity, decreased costs of socio-economy for government and municipalities, savings, and revenue generation.

1.6.Research Methodology

On the applied methodology, there is an introduction and outline of the research design and the methodological approaches relevant to the presented studies in the dissertation. Therefore, it elaborates on the general framework that guided the success of the entire research dissertation and the research data analysis. The research framework model presents the research process developed based on the applied research methodology; furthermore, it indicates the potential outcomes of this study.

Figure 7: Research Methodology and Design Summary

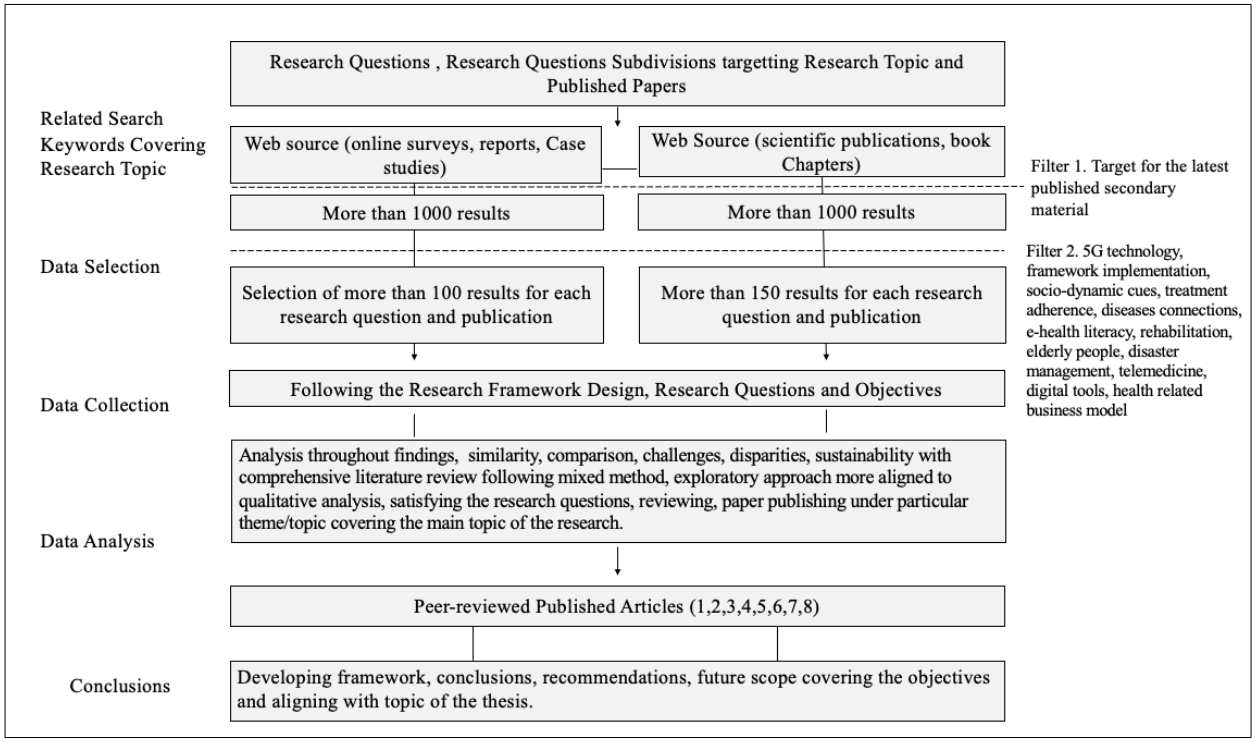


As shown above, the figure procedurally expounds the flow of research framework, from the research design, conduction of the research, the analysis of the research data, and the conclusion. The latter implies the research objectives' satisfaction, review of the literature, collection of data from the peer-reviewed reports, surveys, studies, scientific publications, journals, and published interviews. From these, the analysis of data and development of conclusions follows.

The research study employs secondary data collections techniques, and literature reviews. A mixed-method of research is used to collect information for secondary data collection regarding patients' needs and how they react to treatment plans with integrated healthcare technology-based applications [1]. It has been followed similarly as, (Temoteo et al., 2019), applies a reflective and analytical study on publications to assert the levels of adherence in patients suffering from tuberculosis [19]. Similarly, (Omotosho & Ayegba, 2019); review multiple papers to illustrate how technology influences adherence among patients [15]. This analytical approach is also utilized in the same manner by (Subbaraman et al., 2019). It adopts the sampling methods by analyzing the average cost of treatment for patients adopting integrated technology-based applications [20].

Like in the same way, (Wu et al., 2020), examines papers for the analysis about how wearable devices aids the improvement in patients' adherence [21]. Following those exploiter approaches, the dissertation follows a mixed-method path for secondary data collection to analyze the data and show the adherence strategies in patients [2]. The below figure shows the data selection, collection and analysis in detail with the exploiter approach for secondary data following the mixed method.

Figure 8: Data Collection and Analysis Process in Research Framework Design



Tables 2 and 3 in the applied research question give elaborative details about the data collection process targeting the research questions and published papers addressing those research questions in a step-by-step approach—the above figure sum-up the data collection and analysis procedure following the research framework design. Mixed method approach for secondary data collection is crucial to show the scientific concepts in the research questions. It allows for thematic categorization of information in the research, which is in the form of published peer-reviewed papers. Therefore, it enables creating a testable dissertation with the flow of ideas regarding the use of 5G technology, wireless digital tools, literacy, socio-dynamic cues and adherence. [4].

The writings reveal motivations, themes, opinions, and human behaviour, focusing on integrated technology-based healthcare solutions. For secondary data collection, the publications utilized in the qualitative research design in the papers are inclusive of case studies, focus groups, surveys, published interviews, reports and scientific publications. They provide research with references to give more information on the study topics. A qualitative research design is flexible in analyzing a complex issue in which other research methods may not address them wholly. For example, qualitative data is not enough to show enough patterns and relationships in information as it only describes discrete variables. Thus, the dissertation applies a mixed method of research, which engages qualitative and quantitative data and information to respond to the research questions (Creswell, 2009), which conforms to the research paradigm [17]. The reason being is that qualitative plays the role of describing and showing the study results that are not quantifiable due to their discrete nature. On the other hand, the quantitative technique backs up the qualitative method of data collection and presentation as it describes the measurable results, which are concrete and seen or identified. The approach serves the relevance of ensuring that the information and interpretation techniques complement each other while being an integral component of securing the outcomes' validity (Guba & Lincoln, 1994) [18].

The above methods are vital in supporting the dissertation's main topic, which is in technology-based healthcare solutions and user specificities to promote adherence.

1.7.Applied Research Questions

It was inquired to form research questions that would outline the dissertation's complete analysis and, similarly, provide knowledge dissemination by recognizing, consulting, and developing the academic realm on integrated technology-based health applications targeting main dissertation topic. Based on the research analysis, the below table formulated the following main questions and subdivisions to frame the whole research presented in eight peer-reviewed publications in the below table:

Table 2: Applied Research Questions

RQ1: How does the adoption of integrated health-based technology applications promote patients' adherence to a care plan?

I. How does 5G shape the future of integrated technology-based health applications and its framework and planning?

II. How does the technological approach of 5G promote future telemedicine?

III. How does integrated home-based technology healthcare solutions promote adherence?

RQ2: How do the socio-dynamic cues impact the adoption of integrated technology-based healthcare applications?

I. In what ways do collaborative strategies and socio-dynamic cues influence the assistive healthcare technology applications?

II. How do literacy and socio-dynamic cues affect care plan adherence?

III. How do the connections of chronic illnesses and socio-dynamic cues integrate ICT with an adherence to care plan among patients?

RQ3: How do the co-existence of the technology of 5G and telemedicine influence the impact of integrated technology-based healthcare applications towards patients' adherence?

I. In what ways does telemedicine promote the management of disasters as well as emergency care?

II. What is the relationship between 5G technology and the ecosystem of telemedicine?

RQ4: What are some of the improvisations of business models that affect the implementation of integrated technology-based health applications and user specificities for treatment adherence among patients?

With that, the subdivisions answer the main research questions based on all the peer-reviewed published research papers with data collection and analysis following the main topic of the dissertation which is mentioned in detail in the below table:

Table 3: Applied Research Questions & Sub-Questions and their link with Published Papers

Research Question			
RQ1	How does the adoption of integrated health-based technology applications promote patients' adherence to a care plan? Answered by Peer-reviewed article 1, 3, and 6		
Research Question Subdivisions		**Article Number**	**Subject Studied**
I.	How does 5G shape the future of integrated technology-based health applications and its framework and planning?	1	Framework for Future Telemedicine Planning and Infrastructure using 5G Technology.
II.	How does the technological approach of 5G promote future telemedicine?	6	5G, an approach towards future telemedicine.
III.	How does integrated home-based technology healthcare solutions promote adherence?	3	Technology-oriented home-based rehabilitation for supporting medication adherence.
Research Question			
RQ2:	How do the socio-dynamic cues impact the adoption of integrated technology-based healthcare applications? Answered by Peer-reviewed article 2, 4, and 5.		
Research Question Subdivisions		**Article Number**	**Subject Studied**
I.	In what ways do collaborative strategies and socio-dynamic cues influence the assistive healthcare technology applications?	5	Collaborative strategies and Socio-dynamic cues (SDC) insights for assistive healthcare technology Applications.
II.	How do literacy and socio-dynamic cues affect care plan adherence?	2	Literacy and Socio-dynamics Cues Insights Decision Analytics for Care Plan Adherence.
III.	How do the connections of chronic illnesses and socio-dynamic cues integrate ICT with an adherence to care plan among patients?	4	Connections of Chronic Diseases and Socio-dynamic cues for Integrating ICT with Care Plan Adherence.
Research Question			

RQ3:	How does the co-existence of the technology of 5G and telemedicine influence the impact of integrated technology-based healthcare applications towards patients' adherence? Answered by Peer-reviewed article 7 and 8.		
Research Question Subdivisions		**Article Number**	**Subject Studied**
I.	In what ways does telemedicine promote the management of disasters as well as emergency care?	8	A Telemedicine Platform for Disaster Management and Emergency Care.
II.	What is the relationship between 5G technology and the ecosystem of telemedicine?	7	5G and Telemedicine: A Business Ecosystem Relationship within CONASENSE Paradigm.
Research Question			
RQ4:	What are some of the improvisations of business models that affect the implementation of integrated technology-based health applications and user specificities for treatment adherence among patients? All the eight peer-reviewed primary papers		
Article Number			**Subject Studied**
All the eight primary Papers			All eight journals related to the integrated technology-based health applications and user specificities for treatment adherence.

There is a correlation between the analysis of the integrated technology-based health applications and the research questions. The research questions will be structuring the dissertation by introduction publications answering those questions. The above research questions relate in multiple ways.

For instance, RQ1 links to all its subdivisions; RQ1 (i), RQ1 (ii), and RQ1 (iii), whereas RQ1 (i) which addresses 5G technology, that improves the speed of access to integrated technology-based healthcare solutions in RQ1 (iii). Similarly, RQ2 links to all its subdivisions; RQ2 (i), RQ2 (ii), and RQ2 (iii), whereby, Literacy and socio-dynamic cues in RQ2 (ii), affect the integrated technology-based healthcare solutions in RQ1 (iii) in promoting adherence. Likewise, Socio-dynamic cues in RQ2 (ii) influences the applications of assistive healthcare technology when combined with collaborative strategies, as in RQ2 (i). Uniformly, in RQ2 (iii), the connection of chronic illnesses and dynamic social cues as in RQ2 (ii) and RQ2 (i) integrate ICT with care plan adherence like in RQ1 (iii). RQ3 links to both its subdivisions; RQ3 (i) and RQ3 (ii). In RQ3 (i), the adoption of telemedicine's platform relates to all the questions. In the same sense, it depicts

that telemedicine is an integrated technology-based application that every question fulfils. RQ3 (ii) addresses the relationship between the technology of 5G similarly in RQ1 (i), and telemedicine, alike in RQ3 (i), which influences the care plan adherence of the patients as in RQ2 (ii). In RQ1 (ii), the influences of 5G on future telemedicine are under address. Therefore, it relates to RQ3 (i) and RQ3 (ii), which analyses the impacts that 5G has on the future of telemedicine.

RQ4 links to all other questions. It is the umbrella of the grievances that they address regarding the adoption of integrated technology-based health applications and sustainable business solutions. Therefore, the table below shows the mapping between the main research questions, the subdivisions covering all peer-reviewed published research papers, and the dissertation's main topic.

Table 4: The interlinking of Research Questions between and among the Published Papers

Research Questions	**The Relationship between Research Questions**
RQ1	RQ1 links to all its subdivisions; RQ1 (i), RQ1 (ii), and RQ1 (iii). On the other hand, RQ1 (i) relates to RQ1 (iii), RQ3 (ii) and RQ3 (ii). RQ1 (iii) refers to RQ2 (ii), RQ1 (iii) relates to RQ2 (i).
RQ2	RQ2 links to all its subdivisions; RQ2 (i), RQ2 (ii), and RQ2 (iii). On the other hand, RQ2 (ii) relates to RQ1 (ii), RQ2 (ii) refers to RQ2 (i), RQ2 (ii) relates to RQ2 (iii), RQ2 (i) relates to RQ1 (iii).
RQ3	RQ3 links to both its subdivisions; RQ3 (i) and RQ3 (ii). On the other hand, RQ3 (i) relates to all research questions, RQ3 (ii) refers to RQ1 (i) and RQ1 (ii), RQ3 (i) refers to RQ2 (ii) and RQ1 (ii).
RQ4	RQ4 relates to all the other Research Questions as it is the umbrella topic that addresses and covers peer-reviewed published research papers topics overall.

1.8. Summary

The section contributes to the dissertation by initiating and supporting the fulfilment of its topic; research analysis of integrated technology-based healthcare applications and user specificities for treatment adherence in the following ways:

The section's first contribution to the research is that it provides an introduction to its study by highlighting and discussing the background, motivation, objective, theoretical background, and the epistemology of the dissertation. Secondly, it elaborates on the types of research questions, methodology as well as the research design. These research questions, therefore, contributes to the formulation of the dissertation. The dissertation, therefore, has research questions which attempt to fulfil, satisfy or answer most of the formulated dissertation in the entire study [1],[2],[3],[4],[5],[6],[7],[8].

2. STATE OF THE ART

The section elaborates on the literature review of the dissertation. It relays various research studies in relevance to the topic of the dissertation. Therefore, the section comprises many research papers and journals that relay the facts that support the dissertation.

2.1. Literature Review

The section reviews various research studies and analyses integrated technology-based health applications and user specificities for treatment adherence. Section 1 of the dissertation describes the research methodology from data collection to its investigation. A review of the description highlights how various technological decisions promote the appropriate and successful implementation of the integrated technology-based healthcare applications under coverage in section two. The section responds to the research questions briefly, whereas its details are part of peer-reviewed published research articles at the end of the dissertation. Section elaborates on how the integrated technology-based applications and other related technologies can improve the sector of healthcare. The aim is thus, to achieve the objective through the review of the following peer-reviewed literature:

- Framework for Future Telemedicine Planning and Infrastructure using 5G Technology [1].
- Literacy and socio-dynamics cues insights decision analytics for care plan adherence [2].
- Connections of Chronic Diseases and Socio-dynamic cues for Integrating ICT with Care Plan Adherence [4].
- A Telemedicine Platform for Disaster Management and Emergency Care [8].

Therefore, the section answers four main research questions subdivisions based on the above four peer-reviewed published research papers. These research questions and subdivisions are RQ1 subdivision (i) which bases on the above first journal, RQ2 subdivision (ii) focusing on the second journal above, RQ2 subdivision (iii) on the third journal above, as well as RQ3 subdivision (i) which concentrates on the fourth journal literature above. These peer-reviewed published papers are attached at the bottom of the dissertation.

2.2. Framework for Future Telemedicine Planning and Infrastructure using 5G Technology.

The publication answers RQ1 subdivision (i) How does 5G shape the future of integrated technology-based health applications and its framework and planning?

Regarding the use of ICT remedies, like future wireless communication technologies (5G) and Big Data analytics, the sector of healthcare may attain improvement and efficiency [1]. The attainment of efficiency can be possible both economically by introducing business models based on technology and qualitatively via the technologies whose communication is reliable [1]. The success of a health care system may base on three main pillars of technological sophistication:

- Communication technology
- The analysis of Big data
- Health Care, specifically Medical and Medicines.

It is the justification for the cross-disciplinary approach to a prerequisite for telemedicine services in the future [1]. It is crucial to understand the necessities in the ecosystem of healthcare regarding the mitigations that are based on ICT [1]. The type of telemedicine services can integrate through 5G technology. The telemedicine standards are at their initial stages yet [1]. There is the inadequacy of the security frameworks available for telemedicine services' before seeing dependable properties of adopting the technology of 5G [1].

The discipline of Health-care is itself a wide one. Enough research has not been ready to identify the specific parts of the sector of healthcare that requires or portrays efficiency with the adoption of Big Data and 5G technology [1]. The importance of Framework for the services of telemedicine manifests because of the factors like; the aspects of the economy since the services of healthcare are generally expensive, the presence of the services that are specialized globally, the availability of services that specialize in remote locations in a specific nation, minimal stakeholder and industry involvement [1].

There is a lot of importance in recognizing how to satisfy concerning accessibility by introducing a basic sketch or framework for the identification and provision of the possible mitigations [1]. The emerging technological innovations need acceptance and understanding that

they mean to initiate the healthcare system's revolution [1]. The transition phase implies a continuous change of technology, which causes minimal engagement and understanding regarding its deployment areas to the people [1]. Individuals experience burden or pressure about their knowledge due to their little knowledge or comprehension of technology as a discipline. The most critical issue here is planning or applying a bottom-up strategy, meaning considering the eHealth discipline's deficient aspects instead of integrating the current sophistication with currently established telemedicine services [1]. Before introducing any service, incorporating the fundamental understanding in planning, assessing the affordability and costs, in association with defects or deficiencies and the benefits, are vital considerations to evade the future anomalies [1].

2.3. Literacy and socio-dynamics cues insights decision analytics for care plan adherence.

The publication answers RQ2 subdivision (ii): How do literacy and socio-dynamic cues affect care plan adherence?

In accordance to the survey reports from the World Health Organization (WHO), the literacy in eHealth refers to the skills of understanding, reviewing, and evaluating the medical information that is health-related via electronic or digital sources, and implementing the redundant ideas in a manner of solving health-related problems [2]. The remedies of eHealth are under consideration for creating an ecosystem of sustainable healthcare. The applications of eHealth can be for use in providing and exchanging medically-related ideas at the levels of physicians, patients, or that of state and enabling the improvement of structures of management in the ecosystem of healthcare [2]. Disease treatment proves easier in case the patient subjects' literacy scale remains significant. That optimizes the therapy more practical for such patients since their response regarding the skills of decision making, and that of technology tends to be more satisfactory [2].

The latest advancements in technology enable patients' persuasion about the decisions they make through different devices of assistive technology or applications of motivation, or the virtually-enabled coaching that provides the possibilities of changing or molding the decisions made by any patient [2]. Many variables may regulate an individual's capacity to analyze the decisions they make; the capability can be through analysis via the perception of the surrounding environment [2]. Therefore, anybody can access significant magnitudes of information sources from the internet's websites and acquire the literacy regarding eHealth may also help compare two

information sources and their reliability, more so in a complex or broad society [2]. Individuals whose eHealth literacy levels are low may have the conditions of their diseases exaggerated due to their ignorance following the utilization of the assistive technology applications, or even in the extraction of information [2]. A couple of applications offer information regarding toxicity management in cases where an individual may ingest or inhale any harmful substance into their body system [2]. These applications of the eHealth are instant services before accessing real medical personnel [2].

The literacy of eHealth has a broader perception and provides an individual with the clues about understanding their health status since some conditions are difficult to see or detect; therefore, verification of many various facts can happen. It can also provide a vision for the assistive technology-based business models [2]. Younger individuals actively use eHealth applications as they have their better understanding, which aids them to make the right health-related decisions. [2]. Various illnesses may also affect the capacity to investigate and understand multiple health conditions, for instance, in the case of individuals who are cognitively impaired, mentally ill, or those who have Schizophrenia [2]. Analytical coaching is a requirement for the deployment of ICT applications and appropriate utilization [2].

Many obstacles are responsible for adapting technological remedies and rationalizing them. That is the inadequacy or lacking the applications or analytical tools, several political or legal barriers, the variance of cultures, confidence, the awareness between physicians and patients, and trust [2].

2.3.1. The Necessity for an Analytical Mind-set

eHealth literacy refers to a crucial set of skills, particularly in the current digital age, to enrich the online health information, better health results [2]. The primary analytics or skills are analysis of ancient health-related knowledge, necessary computer skills, information analysis, and application to build enough confidence to follow or adopt the specific use of care therapy or an eHealth device [2]. The eHealth means the aid of electronic resources offered towards improving the system of healthcare [2]. Their productivity depends on whether people understand and appropriately apply them, for instance, how, why, and when to incorporate these devices, resources, or services, the specifications they have, and the set of skills necessary to effectively

and fruitfully apply them [2]. The moment eHealth becomes directed to consumers; it calls the ability to find, integrate, and use what is needed in the electronic world for remedying health-related issues [2].

2.3.2. Cultural Influence or variance and eHealth technology adaptation

The boundaries of culture are the primary source of discrepant views of reality [2]. The eHealth devices or applications must adopt strategies that recognize and account for the opinions and statements from people related to various cultures by not just through the definition of the patient's issues but also in elaborating the mitigations [2]. The experts in such technological fields should psyche for specific patients' care that has to be of a responsive culture [2]. The reason is that the provider's command may help prevent less adherence instead of improving only patient-consultant communications [2].

The inability to realize the problem mentioned above can limit the practitioners' potential in the analysis of the patient's opinions and responsibility in the process of illness [2]. In case of practical use of a health-oriented methodology, an individual must be in accountancy of the patient's perspective and establish a strategy of care that becomes responsible for an interaction that is multifaceted between psychiatric, social, medical, as well as various population matters. [2]

2.4. Connections of Chronic Diseases and Socio-dynamic cues for Integrating ICT with Care Plan Adherence.

The publication answers question RQ2 (iii): How do the connections of chronic illnesses, and socio-dynamic cues integrate ICT with an adherence to care plan among patients?

The Non-communicable Diseases (NCDs) remain unalterable from one person to another, and examples are diabetes, cardiovascular illnesses, and respiratory infections [4]. These illnesses also refer to as chronic diseases that require lifetime treatment stagnancy [4]. Many factors facilitate their occurrence that may be genetic materials, environmental, and physiological [4]. Contrarily, some rely on individual patients' behaviour to oblige to a given care plan or various options of lifestyle. Proofs reveal that 15 millions of NCDs' fatalities occur to those whose ages are between 30-69 years [4]. Risk factors are the primary elements that cause or worsen chronic illnesses' conditions [4].

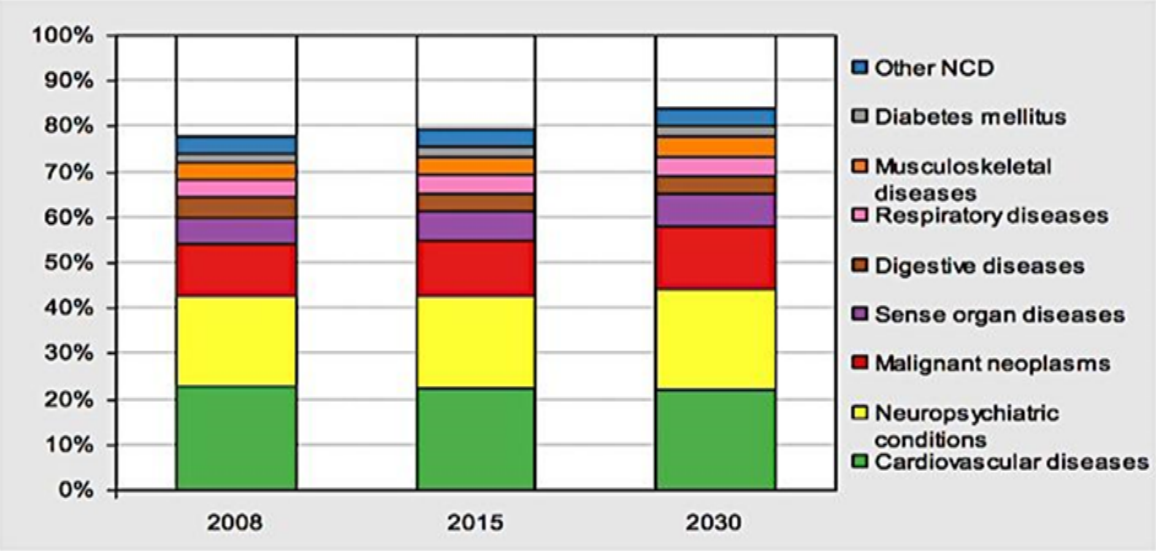
They may also be the primary factors initiating other conditions of chronic diseases concerning the significant chronic illness. The elements of risk may either be biological or behavioural [4]. The behavioural aspects of risk are food choices, more alcohol consumption, tobacco use, and being physically inactive. The modification of such factors of risk is possible if the patient incorporates self-efforts in lowering or ending them [4].

The biological elements of risk include boosted blood pressure, levels of glucose, increased obesity, and high degrees of body cholesterol, among others [4]. The above factors of risk play the leading causes of fatalities or any associated disabilities for their victims in a global span [4]. Therefore, preventing them stands to be the only remedy that guarantees mental and physical wellness and the general good body health. In Europe, fatalities associated with the NCDs lead to an expenditure of about 115 billion Euros [4]. Despite the lately developed technological attainments in healthcare and technical setups, the general expectancy of life has risen; it has, in an equal measure, boosted the rate of survival among the ageing populations who live with chronic illnesses [4].

Socio-economic expenditures are the central aspect that requires attention since it will be of great importance that the patients suffering from chronic illnesses in the future to maintain the plan of treatment frequently [4]. Behavioural irregularities or fluctuations may increase expenditures. Socio-economic caliber plays as another predicting factor regarding the initiation of chronic illnesses [4]. The determinants of the prevalence of chronic infections may also be illiteracy among individuals or low socio-economic levels.

Danish healthcare remains a healthcare system that ranks to be among the topmost kinds globally [4]. As reported by the analysis from the European Observatory on Health Systems and Policies in 2017, Denmark ranks number eight for the percentage of the adults which are reported to be in good health and number seven in expenditure on healthcare [4].

Figure 9: The 2008 WHO Health Statistics in Europe and its Projections until 2030 [4]



There is, however, an emergence of many issues regarding healthcare, which remains to be the nation's serious concerns [4]. According to the above report, cardiovascular, cancer, and ischemic infections are the number one causes of fatalities in Denmark [4]. Also, musculoskeletal infections and depression are significant indicators of deteriorated health in the Republic of Denmark [4].

Other than the EU, Denmark stands to be a significant financial contributor to multiple projects regarding modifying the healthcare paradigm [4]. Among such transformational aspects is the integration of systems of ICT and healthcare [4]. As a result, Denmark maximizes the privilege of enjoying the fruitful utilization of ICT systems in their sector of healthcare [4]. Alongside the treatment of sickness, the Danish healthcare system spends on caregiving and rehabilitation services among its many other projects of research, most of which are either concluded, in progress or commenced, is cantered in the very context of healthcare programs [4].

2.4.1. The relevance of Multi-Chronic Diseases and the Importance of the Care Plan

Chronic illness assumes several adverse effects on the patients' and normal everyday endeavors [4]. The risk factors may be similar in cases where the patient has a lot of chronic illnesses [4]. The requirement here is implementing a care plan to aid the patients in many various ways for the avoidance of its severity, regarding causing many other chronic diseases [4]. The lousy lifestyle behaviours and several chronic infections may cause the variance of the victims' health qualities

and health [4]. The care plan needs to cover the usual adverse aftermath and risk factors for chronic illness for the general body health improvement [4]. If it is a single risk factor that may lead to more than one chronic infection, then there is a need to eradicate such an aspect of risk. Some of the usual side effects in the encounters of many chronic diseases remain to be [4]:

- Related Depression
- Reduced Life Quality
- Therapy (Long term)
- Calls for a persistent strategy both at the levels of the doctor, patient, and service provider
- Modification of Lifestyle (healthy habits Development)
- Motivation
- Poverty Issues
- The burden related to social, economic, and emotional issues
- The technology trust and the commitment of the health care team

2.4.2. Care Plan Non-Adherence and Impact on Society

The Mortality and Morbidity with chronic illnesses possess a significant effect on the entire social growth. The expectancy of life span has risen over the past four decades in 28 European nations [4]. The 3.2 life span years increased in males and 2.5 years for women over 2003-2013[4]. The rise mentioned does not prove healthy for the expectancy of life. At 65 years, just a few individuals enjoy a healthy life, whereas many suffer from several chronic illnesses with reduced life quality [4]. Lowering the quality of life and a risen life expectancy may result in a lot of other problems like [4]:

- Increased socio-economic cost (Burden for the Government and municipalities)
- Reduced population of the workforce
- Increase in the aged population
- A lowered social involvement and engagement in activities as fruitful countrymen and women. Chronic diseases yield the problems of global economics, health and cause to premature fatalities of more than 550,000 (25-64 years) yearly in EU nations [4]. These fatalities cause the dissipation of 3.4 million years of productive life, considering that the

victims were to enjoy their lives until when aged 65 years with a similar rate of employment as that of the remaining population [4]. Analysis of the same was under execution in 28 EU nations, and the results are as below [4]:

Table 5: Health Expenditure of Chronic Diseases in Europe [4]

EU Country	Premature deaths		Potential productive life loss	
	Number (Rate/100,000 population)		Number (Rate/100,000population)	
Denmark	5177	178	29755	1023
Italy	48231	147	312026	952
Spain	38003	142	256969	960
Romania	40621	361	247952	2203

The Annual income consideration for the ordinary EU employees is €33800. The amount results in the economic expenses of the EU to be EUR115 billion or a GDP of 0.8 per year [4]. Patients combat their adherence to the care plan because there is a challenge in developing a new lifestyle or habit modification [4].

2.4.3. Societal Factors and Non-Adherence

Current innovative remedies in guidance by ICT exist for the patients' adherence to the care plan and modification of lifestyle, especially in scenarios of multiple chronic illnesses [4]. The mitigations are based on technology and can lower the usual aftermath, thus increasing the patients' life quality and general health [4]. The below table describes the technological trust and own patient perceptions which is vital to notice in elderly patients [4].

Table 6: Telehealth Technology Trust and Patient Perception [4]

The innovative technologies Acceptance	The literacy of eHealth	The Beliefs in Culture and Religion
• Slow adoption • The ease of technology use	• The requirement of ICT solutions that are user- friendly ICT solutions • All-level consultations	• The illness, health, and death perception? • Beliefs regarding the causes of the illness?

• Learning and reading difficulties due to disability		• Access to the ideas related to health promotion?
• Doubtful attitude • The interest and willingness to invest (attitude) • Limited social network	• The blended staff concept for multipurpose roles • Deploying mitigation -related sustainable technologies	• An individual's experiences and feelings about the disease? • The places of seeking aid by the patients, and their preferences? • Treatment preferences by the patients? • The presence of user-friendly solutions?

2.4.4. Adherence Needs Collaborative Efforts

The care plan adherence is not to confine the patent or medical personnel, but it shows a deployment error. There is the necessity of sharing strategies and roles among the non-clinical or clinical caregivers [4]—either non-clinical or clinical providers of care can initiate a protocol or framework for a plan execution with mutual benefits [4]. The protocol, structure, or framework may be based on the value or cost such as the life quality, boosted motivation, reduced patients' premature fatalities, and a reduced cost of patients' care plan [4]. These my successfully attach to the strategy of the business and the technological application. The non-clinical caregivers maybe pharmaceuticals, the municipalities, or even be technical staff/tech industries [4].

2.5. A Telemedicine Platform for Disaster Management and Emergency Care

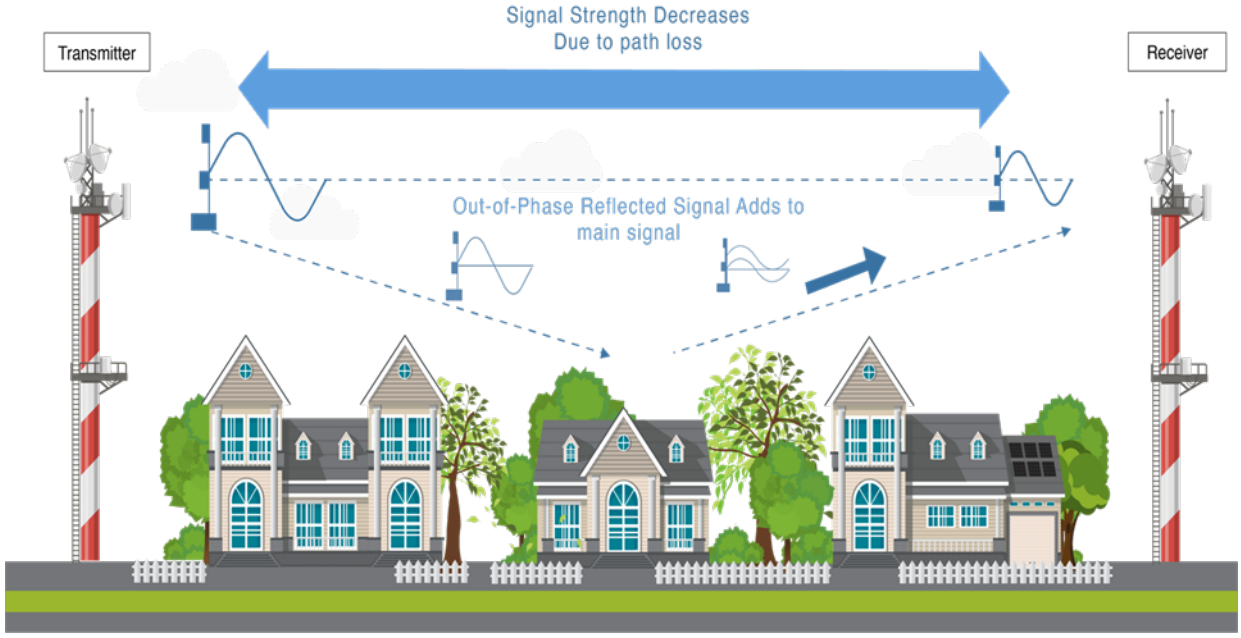
The publication answers question RQ3 (i) as in what ways does telemedicine promote the management of disasters and emergency care?

Telemedicine fits in every condition of disaster through realistic planning and strategy. Telemedicine applies to providing care or monitoring the processes remotely by adopting technology [8]. The prevention of premature deaths, disabilities and instant access to the healthcare

system poses a challenge [8]. In the encounters of managing global disasters and pandemics, telemedicine can provide hospital care, and the services of emergency healthcare as the concerned practitioners can share experiences through easily linking with the more and less affected areas and the global occurrences through a platform of technology [8].

Several technical mitigations are in availability; however, disasters can cause unusual scenarios that deserve strategies of transition or intellectual remedies [8]. In instances where older adults suffer from chronic illnesses and disabilities or critical injuries from catastrophes, there is a need for medical services and other subsequent analyses [8]. The extremely applicable technological devices in such situations are mobile phones meant to communicate emergencies of healthcare service and acquire information regarding the possible medical interventions [8]. Today, many offline specialized applications aid in understanding the crucial clues about critical scenarios in disaster management—for instance, the absence of a platform of communication and even during blackouts [8]. A lot of factors result in a lack of communication links. The National Aeronautics and Space Administration (NASA), for the first instance, applied the strategy of Telemedicine in Mexico City in 1985 [8]. In a duration between 24 hours, the transmission of voice had been confirmed [16]. The many space programs, military agencies, and other different organizations concerned with managing disasters assess several telemedicine simulations services, particularly in the pandemic- or disaster-prone zones [8].

Figure 10: Transmission losses due to Fading in the Communication link [8]



2.5.1. Disaster types, causalities, and economic losses

As per the reports relayed by WHO, disaster is a scenario of disruptions that causes the disorientation of the normal operations of a community and leads to human, infrastructure and a wide range of economic loss that exceeds the available and real resources of a specific community to curb and manage it [8]. Disaster may be categorized as natural, human-initiated, or technical, leading to infrastructure damages, physically-oriented disabilities, or stress and psychological depression; for instance, heat waves, earthquake, cyclone, and floods disrupted 2.6 billion people from the last decade [8]. It still evidently shows that technology has not enough capacity to adequately provide a satisfactory remedy for such situations, which are often variable and random [8].

Since 1970, an estimation of 98,000 natural calamities and disasters approximates to cause casualties of 3.7 million in number and has about 5.8 billion individuals affected, also accounted $1.7 trillion economic loss worldwide [8]. Globally, Asia remains the most disaster-prone region because of its geographical properties [8]. The significant sources of casualties in the continent remain the cyclones, earthquakes, tsunamis, and floods [8]. There is an estimation that the individuals who live in the Pacific zone have a double likelihood of being affected by these natural

calamities than the African people. Thirty times to those living in Europe and North America, as well as six times to those residing in Latin America [8] since 1980 up to 2015, the yearly GDP loss registered to be the highest in the five nations, with Mongolia registering a GDP of 20.1%, Maldives 18.5%, Belize 9.3%, and 8.0% in Solomon island 8.0% which has been the share of their global Gross Domestic Product because of naturally-occurring disasters by flooding and storms [8]. A rise in such calamities' frequencies rose between 1998 and 2009 in Europe as per the reports relayed from the European Environment Agency (EEA) [8].

They consequently led to the disruption of human, environmental, or ecosystem and economic stabilities, which requires a strategy of intelligence and managing risk disasters [8]. The estimated casualties caused by these disasters numbers to be around 100,000, and have resulted in EUR 150 billion economic loss. Drought, heat waves, tornadoes, floods, wildfire, thunderstorms, earthquakes, extreme conditions of winter weather remain to be the most frequent disaster types in America and Europe [8].

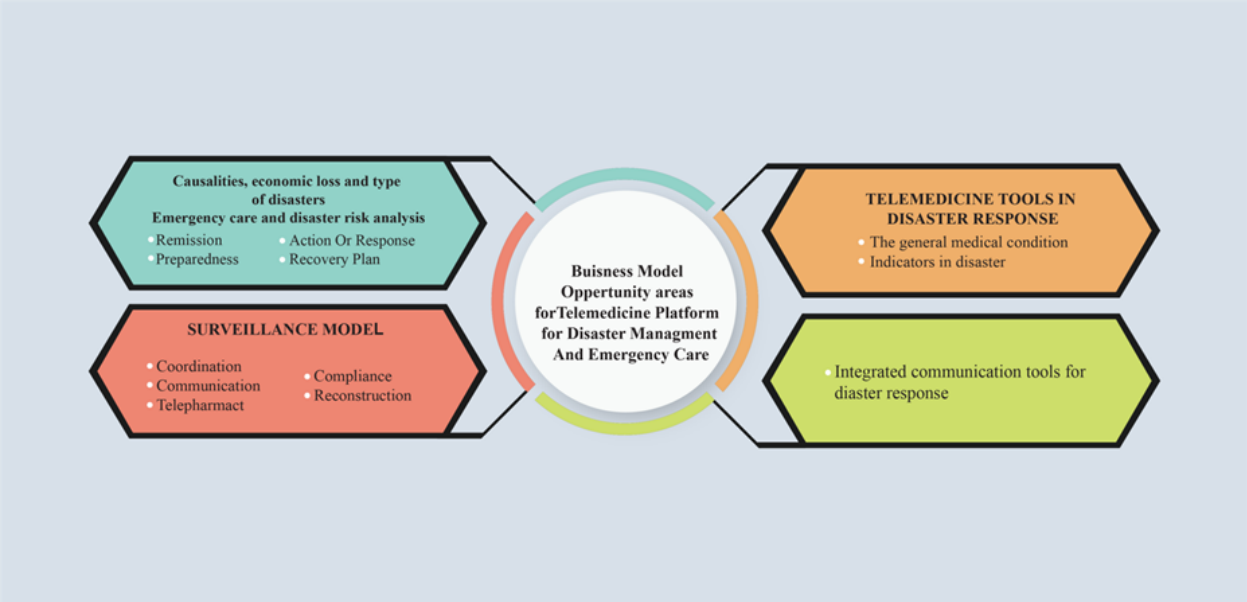
The regulation of providing support has been under adoption by the EU in the aid and favour of places whose likelihoods of experiencing the calamities such as floods and earthquakes are extreme. Regarding the contribution, the EU remains in the hold of the largest part of the Coastal region (95%) [8], the region thus intends to receive EUR 9.8 billion for curbing and managing such disasters [8]. Therefore, in disaster management, the telemedicine systems' designed architecture must conform to an appropriate business model. It will aid successful patients' adherence regarding user treatment specificities and the integrated technology-based applications of health [8].

The adoption of these technologies during disaster management must address the reliable business models that are under consideration, the factors of economic losses, causalities, as well as the disaster types [8]. In the view of the United Nations, disasters are occasions of disruptions that cause the disorientations of everyday human endeavours. It interferes with economic activities, the technology-based infrastructures of health in telemedicine, and the community's general functionality [8]. The business model that enables telemedicine's successful implementation in such disaster-prone areas addresses disaster types, economic losses and

casualties, emergency care, and disaster risk analysis, like those experienced in natural calamities in Belize, Solomon Island Maldives and Mongolia, between 1980 to 2015 [8].

As elaborated, the Model of Surveillance encompasses the element of disaster risk analysis, and emergency care, which incorporates the four phases of planning stages such as remission, preparedness, response or action, and the recovery plan [8]. The model also has the telemedicine tools for disaster response, like the indicators of disasters' medical conditions [8]. It incorporates disaster response tools through integrated communication and the disaster surveillance model, coordination, compliance, communication, and reconstruction [8]. Also, the model offers a similar essence of technique in instances of pandemic or epidemic. The model's phases, such as active stage, fight-or-flight or rebound approach, ends up to be very applicable [8].

Figure 11: Opportunity Area and Business Model for Telemedicine Platform for Disaster Management and Emergency Care [8]



2.6. Integrated Technology-Based Health Applications and User Specificities for Care Plan Adherence in Combating the Spread of Covid-19

The currently widespread pandemic, which global trends as the Corona Virus, has been claiming lives due to the adoption of improper care plans regarding the prevention of its spread. Since the virus has no known definite cure, workable preventive measures can reduce its rapid spread and minimize its effects on people's most vulnerable groups. Most of them are the elderly

and children [3]. The thawing of the pandemic's spread and impact on the victims can incorporate the adoption of the most effective integrated technology-based health application and user specificities to conform to the preventive care plans and measures favouring the infected and those at risk [3].

For instance, the involvement of wireless communication technology of 5G in preventing the spread of the virus can initiate the effective worldwide communication of the appropriate measures that should be under implementation to stop the spread of the virus from the infected to the uninfected [3]. The technology can also aid an effective administration of care plan services in telemedicine on the already infected individuals to boost their rates of recovery and minimize the rates of fatalities [3].

2.7 Summary

Generally, a vast stretch of study literature relevantly favours the dissertation's topic. The contributions of the published peer-reviewed research articles are highlighted in the first section of the dissertation. In contrast, section 2 mentions the published research papers that summaries the facts in support of the entire dissertation and briefly answer the research questions. Therefore, the patients' conformity to the Integrated Technology-Based Health Applications and User Specificities for Treatment Adherence shapes from the Framework for Future Telemedicine Planning and Infrastructure using 5G Technology. Also, with the Literacy and socio-dynamics cues insights decision analytics for care plan adherence. The same form of patients' compliance to the new forms of healthcare also influences from Connections of Chronic Diseases and Socio-dynamic cues for Integrating ICT with Care Plan Adherence and A Telemedicine Platform for Disaster Management and Emergency Care [1],[2],[4],[8].

3. RESEARCH FRAMEWORK

The section mainly focuses on the conceptual framework of the dissertation. The framework relies on various peer-reviewed published research journals and papers to support the dissertation.

3.1. Conceptual Framework

The section relays the presentation of the conceptual framework and the postulated relationships that emerge from the study's framework that is under the proposition. In contrast, the primary proposed models focus on the research analysis of integrated technology-based health applications and user specificities for treatment adherence. The section also targets the re-assessment of secondary research references availed at the beginning of the dissertation and authenticates the complete analysis and research.

The research implements different exploratory strategies for collecting secondary data via the methods named in the first section of the research methodology to gather ideas concerning patients' needs regarding care plan adherence and how they respond to healthcare plans with integrated healthcare technology-based applications. The third section applies reflective and analytical research on publications to assess the rates of compliance and the review done in several papers to demonstrate the influences of technology on the treatment cost for patients and how body-worn devices promote adherence in patients to fulfil the conceptual framework. Therefore, the section centers on three primary published peer-reviewed research papers whose aim is to support the whole dissertation's objective. The research analysis of integrated technology-based health applications and user specificities for treatment adherence bases on the following literature:

- 5G, an approach towards future telemedicine [6]
- Technology-oriented home-based rehabilitation for supporting medication adherence [3]
- Collaborative strategies and Socio-dynamic cues (SDC) insights for assistive healthcare technology applications [5]

The section responds to three research questions subdivisions based on the above-mentioned published peer-reviewed research papers. As such, it clarifies RQ1 subdivision (ii) about the first journal, RQ1 subdivision (iii) centering on the second journal, and RQ2 subdivision (i) which channels its attention on the third research paper.

3.2. 5G, an approach towards future telemedicine

The publication answers question RQ1 (ii): How does the technological approach of 5G promote future telemedicine?

The current and advanced type of present technology often has inherent problems in dealing with new challenges [6]. The mobile communication of 1G, which was the first-generation launched in the 1980s. The fifth-generation (5G) is to be under marketing in 2020 and 2021 [6]. The entire process estimates to be of 40 years. In the encounters of modifying and transforming these advancements, there is still no appropriate infrastructure, security, standards, and legislation about the technology of wireless communication. Research is still in progress to establish the minimum technological standards since the technology has been invented in several nations [6]. Below are the constraints encountered in the wireless communication on telemedicine [6]:

3.2.1. The Requirements of Reliability and Accountability

The latest rise in the occurrence of emergencies and calamities, prediction, or their forecasting is coarse. It usually consumes a lot of time; however, with the recent happenings in technology provide much knowledge regarding curbing such incidents and preventing communication loss in the real-time of such occurrences [6]. These disasters affect populations in billions. Such disasters may be natural, human-enhanced, or technical, leading to severe fatalities, psychologically-related stress, and prolonged disabilities. Hospitals remain active during the management of such incidents, with a lack of proper communication [6]. There is always unavailability of appropriate methodologies and systems to handle effectively, process, and transmit essential data and information in real-time instances, mainly between distant intervals [6].

During calamities, regional communication services become adversely affected, thus the distortion and constriction of communication [6]. Therefore, it calls for the need for an architecture that is much secure regarding the adoption of a wireless system of communication, a fact that will favour the functionality of 5G in eradicating communication impossibilities during the incidents of calamities [6]. The proposition can undergo integration via the system of cloud computing; thus, there will be the reliability and accessibility of health care services [6].

3.2.2. The Required Bandwidth for the Offload of Medical Services and Applications

The clinical services in telemedicine categories into the following main types in clinical organizations [6].

- The services of Inter telemedicine
- The services of Intra telemedicine

The tertiary centers of healthcare implicate two or more medical personnel dealing with a usual patient's health issue, majorly in pediatric cardiology cases. Here, image data or health records transfers to establish single medical mitigation to a specific problem. For instance, it applies in chest radiology, ECG, and neonates' murmurs regarding inter-telemedicine services [6]. Also, various meetings and teleconferences can arrange for medical personnel and other colleagues from multiple departments and are called intra-telemedicine services. It has usually occurred through a wireless technology and communication platform [6].

The video and medical image transmission, wider bandwidth and an excellent resolution for the three-dimensional images remain a necessity [6]. Data compression is essential because it stops the loss of crucial data or the interruption of the necessary information on the receiver's end [6]. There is the sharing of the service by various users simultaneously in the same place. Contrary, this bandwidth quality triggers the scenario into a more critical one when there is the necessity of seeing or monitoring a patient remotely. Such as those with disabilities or the elderly who have degenerative pathologies. The insurgence of other pathologies such as stroke, cardiocirculatory and muscular dysfunction, or Alzheimer [6]. Last clinical advice is to carry out the physical activity regularly every day and uphold a social activity [6]. Therefore, a comprehensive health care plan remains to be a requirement. In effect, a constant engagement with a physician is appropriate [6].

The greatest challenge of socio-economy is that there has been an increase in the ageing population in Europe [6]. As per the EU commission public health policy, in 2025, over 20% of Europeans will age 65 and above. Also, there will be a speedy rise in the population of those beyond 80 years old [6]. There is a need to reduce their hospitalized citizens to relax the hospital environment and staff's expenses. The current General Packet Data Rate Service (GPRS) system cannot provide precise real-time communication. Primarily to capture the movements of different

patients in their encounters of exercise and handle the big data generated; which helps predict future risk factor [6].

3.2.3. The Security and Standards

The technology of 5G, being a currently launched advancement, still lacks standards, and therefore may need several months or years to establish its definition and adoption [6]. Multiple governments and universities organizations are tirelessly researching the improvement of deficits to permit complete reliability of 5G into being a real milestone [6]. The standards were under proposition to begin in 2020. To satisfy the goal, government corporates and many other public universities put much effort to achieve it [6].

The manufacturers' currently recommended software has no activity timeout, requires multiple authentications, offers links to stabilize connection in case bandwidth weakens. It also opens one session at one time for patients counselling are some of the solutions before standards are fully set [6]. The data rate of 10 Gbit/s 5G is more suitable for transmitting these files with much ease at a higher speed, and data rate since it covers all the constraints that arise because of audio-video quality and speed through the provision of a higher bandwidth with reduced latency rates [6].

3.3. Technology-oriented home-based rehabilitation for supporting medication adherence

The publication answers RQ1 (iii) as How does integrated home-based technology healthcare solutions promote adherence?

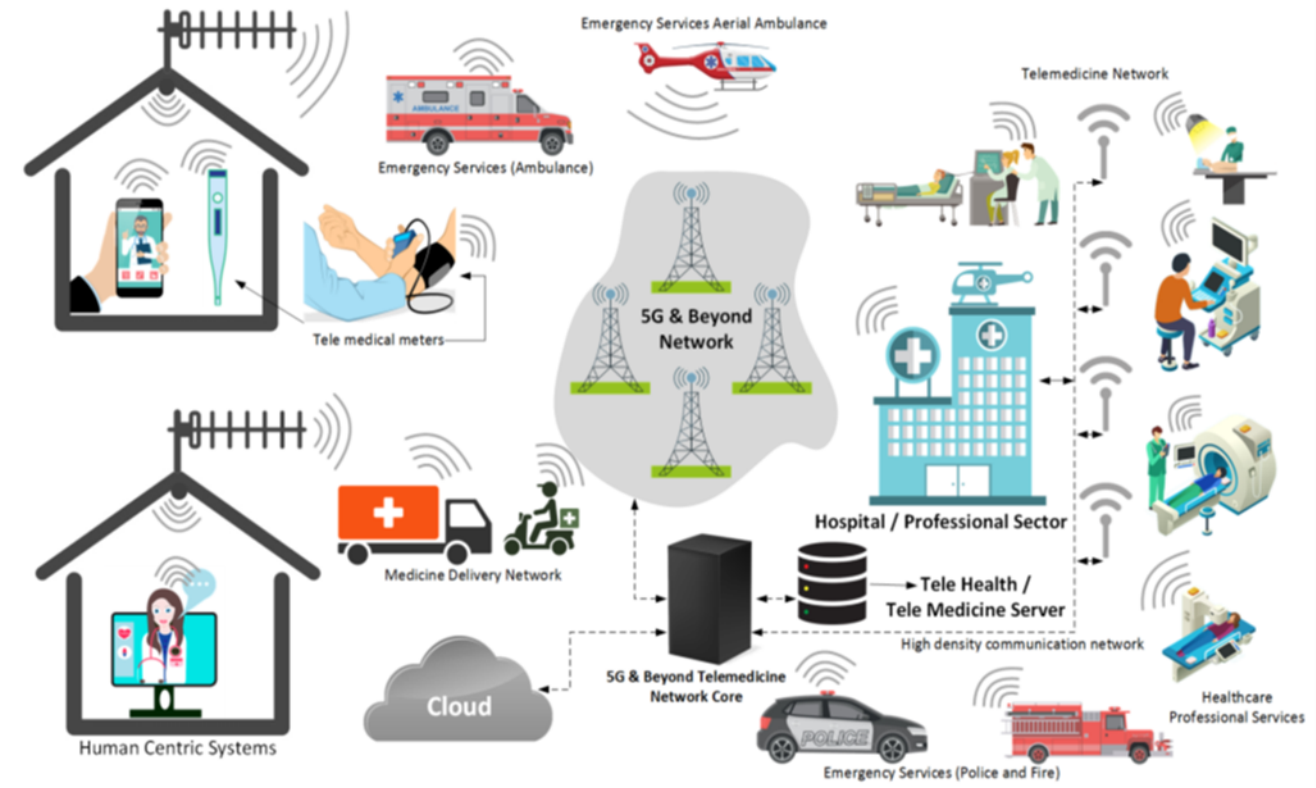
The user needs medication compliance to have the intended results. The reliability of treatment is dependent on the magnitude or concentration of the prescription of the available drug in the bloodstream to actualize the appropriate effect [3]. Therefore, the physician's medical prescription applies after a stipulated interval to manage the drug's therapeutic levels. In case the patient fails to take the prescribed drug, the necessary therapeutic impact can never be attained [3]. It is crucial to create a platform of technology that bases on reminders for medication compliance among older patients as well as those suffering from memory loss, dementia, or cognitive issues to reduced effect of the illness or prevent toxicity in case the patient fails to take or overdose on the medication [3]. A period of 6.9 months is a requirement in Tuberculosis treatment; therefore, medication adherence remains essential in situations where non-adherent patients begin the

medication for another time. It is stressful and requires re-scheduling of mental effort time. Medical compliance is compulsory in chronic illnesses such as Diabetes, Stroke, Hypertension, HIV/AIDS, and Parkinson, among others [3].

The patient's lower literacy for medical administration & self-management, little knowledge on the illness's pathology, and polypharmacy may lead to the missing of drug dosage or cause patient frustration. It can make a patient not comply entirely if the administration technique has complications [3]. Literacy can improve through a technological platform, self-management virtual coaching or repetitive user-friendly guidance. Antibiotics call for medication adherence, and if forgotten, can mitigate viruses or strain, therefore, will be challenging to use a reduced dose to target them [3]. A hub is an integrated site for non-clinical or clinical providers of care [3].

Non-clinical ones may be technological, pharmaceutical or municipalities. Secondly, the technological platform where human-centric system portrays the combination of smart homes where the parameters of health are also part of the engaged sophistications [3]. Many devices may also be in inclusion for a comprehensive and composite healthcare system [3]. Third, 5G and beyond technology platform and the system's performance and access depend on the platform of communication technology upon which the operation of the telehealth care system occurs. Fourth is the technological platform for telemedicine or telehealth (TH) services as every TH service prioritizes call and necessity [3]. The services are inclusive of the procedures of Regular Rehabilitation Program (RRP) [3]. For regular checking of the rehabilitation process, it is a requirement that the individual who seeks rehabilitation always communicates with the physician [3].

Figure 12: The Telemedicine Infrastructure and Integrated Technology-Based Health Applications in Proposition [3]



3.4. The Collaborative Strategies and Socio-Dynamic Cues (SDC) Insights for Assistive Healthcare Technology Applications

The publication answers question RQ2 (i) as in what ways do collaborative strategies and socio-dynamic cues influence assistive healthcare technology applications?

Healthcare assistive technologies have facilitated the more straightforward implementation of various complex and complicated roles in patient care, like the application of electronic health or medical history records through the adoption of digital tools [5]. These tools offer reliable, quick, real-time, and systemic handling of tasks. In healthcare settings, data relay through and thoroughly investigated in the essence of real-time in the inclusion of the acceptable solution and protocols [5]. The enhancement of a good quality of life for chronic patients can be through applying the technology of assistive healthcare, mobile-based healthcare applications, and therapy plans that are customized. The persuasion to maintain the therapy, executing the suggested roles,

and the changes of behaviour can attain various digital equipment. Like the diagnostic sensor that is wireless, whose function is to receive and send repeated data, virtual coaches, application for modifying lifestyle for motivation, and initiate the patient's adherence to the plans of recommended therapy. Similarly, [5] systemically analyzed and reviewed the reliability of information technology for patients' engagement with the processes of healthcare and change of behaviour to conform to the therapy with fruitful results [5].

Also, whereas the review of various research papers, [5] mentions a no change in behaviour, compliance with the care plan and health-related results, and not implementing the theories for specific actions [5]. In the same alignment, the publication mentioned the necessity for analyzing Socio-Dynamic Cues (SDC) variations in a particular group of people globally for their encouragement in the involvement with the plans of treatment while applying them in digital tools medical therapy [5]. Social Dynamics refers to the behaviour of groups that sources from the interactions of individual group members as well to the study of the relationship between individual interactions and group level behaviours [1],[2],[3],[4], [5]. Many software or applications have an adherence to medication, data documentation and diagnostic facilities with lifestyle modification plans. Still, the variance of SDC and cultural specificity is significantly less studied for healthcare assistive technologies. According to [10], there is no clarity about the effectiveness of mobile-Health applications. They evaluated clinical outcomes for diabetic and high blood pressure patients, with staff's engagement [5]. They noticed several inconsistencies in demand, interest and use of the software and the end-user’s needs [5].

Another category of significant factors as mentioned in [5] includes literacy of electronic-Health among the end-users and healthcare practitioners, the adaptation of the technology itself and permission by the applicants, the variance of SDC among cultures or a different group of individuals, choices about the choice of an assistive technology of healthcare. Moreover, the end-user’s analytical skills in differentiating between the right and the wrong consideration, the present information on various applications and the internet [5]. SDC may facilitate a simple implementation of different complex and complicated functions in patients' care and incorporate electronic health or medical history records via the implementation of digital devices and technological tools [5].

3.5 Summary

In general, mainly the third section revolves on the conceptual framework that directs the whole dissertation. The research framework is based on various peer-reviewed published main research contributions, literature study, analysis, and outcomes, strengthening the dissertation. It acts both ways for the literature review and also the conceptual framework of the study. The conceptual framework applies the three published peer-reviewed research articles. It focuses on the benefits of using ICT, the relevance of SDC, the adoption of collaboratives techniques, 5G, and technology-related platform that facilitates conformity to the care plan. Also, section 3 mentions the barriers following wireless communication, the adaptation of technology, and applied devices in terms of the standards, reliability, and security which should be considered before launching out an assistive health care sophistication or device [3],[5],[6].

4. HEALTHCARE TECHNOLOGY BUSINESS MODELS

The section discusses the business model and interlinks to proposed frameworks of assistive digital tools customization by seeing the significance of SDC and collaborative strategies. The approach can influence the implementation of different integrated health-based technology applications and enhance their value and sustainability. Section 4 uses highlights of some of the peer-reviewed published research papers to suggest some of the practical suggestions on business models to fulfil the theme of the dissertation.

4.1. Business Models

The section discusses the need to improvise the business models associated with the integrated technology-based health applications and user specificities for treatment adherence. The chapter revolves around peer-reviewed published research papers shown below:

- A Telemedicine Platform for Disaster Management and Emergency Care [8]
- Literacy and socio-dynamics cues insights decision analytics for care plan adherence [2]
- Framework for Future Telemedicine Planning and Infrastructure using 5G Technology [1]
- Connections of Chronic Diseases and Socio-dynamic cues for Integrating ICT with Care Plan Adherence [4]
- 5G and Telemedicine: A Business Ecosystem Relationship within CONASENSE Paradigm [7]
- Technology-oriented home-based rehabilitation for supporting medication adherence [3]
- Collaborative strategies and Socio-dynamic cues (SDC) insights for assistive healthcare technology applications [5]

Therefore, the chapter revolves around the above peer-reviewed research articles to discuss the business models associated with the integrated technology-based health applications and user specificities for treatment adherence among patients in telemedicine. Thus, responds to research question RQ4; What are some of the improvisations of business models that affect the implementation of integrated technology-based health applications and user specificities for

treatment adherence among patients? Telemedicine refers to a kaleidoscope of the cross, inter, or multi-disciplinary [7]. Telemedicine is an intersection of two explicitly independent areas of science and is inclusive of medicine and telecommunication. Telemedicine remains unique to CONASENSE as most of its employees are in association with to telecommunication paradigm. Communication Technology ranges from Nanoscale Networks to Near-Earth Intra- or intra-planetary communication [7]. No other field other than telemedicine has the possibility of penetrating the CONASENSE domain at every level of this framework. It implies that telemedicine can benefit from the Nanoscale to satellite communications at all levels [7]. For instance, Nanoscale communications can prove beneficial in injectable nabobs that can travel in the blood vessels for pin-point treatments or surgeries. In contrast, Broader medical services can also use the satellite scale [7].

The biosensors use telecommunication to store and transmit parametric data. Server and computer can then collect the transferred data for analysis. This analysis can call appropriate services; for instance, in value Proposition business dimension of telemedicine, the medical service is interlinked with digital/medicinal product business models. Telemedicine in CONASENSE platform perspective links business model seven dimensions to a medical service. These seven dimensions are described here. The value proposition dimension refers to the value that a business model provides to its customers or users. These values can be a product, service, or solution to a problem [7].

In telemedicine, the value propositions are Telehealth, Rehabilitation, Tele pharmacy, Telesurgery, and Telecardiology [7]. The telemedicine business models incept to intervene in telecommunication between the patient and the medical solution [7]. Through telecommunications applications, a patient can facilitate most of the medical needs from remote locations, including rehabilitation, surgery, and monitoring, among others. Telemedicine can be extremely useful in underserved areas and cases of calamities [7]. Another dimension includes users and Customers. Here, customers pay for the values, and users return another value as compensation [7]. In telemedicine, the customers can be hospitals, caregivers, and municipalities. Simultaneously, users may be doctors and end patients who do not pay directly to the telemedicine services [7]. In both cases, the customers or users utilize telecommunications services to benefit their needs, and the corresponding provider uses them for prompt solutions. Networks, also as dimension, correspond

to other businesses' relations to archive values [7]. In Telemedicine, Telecom providers, hospitals, caregivers are the networks that can be associated with the telemedicine process.

Competences dimension corresponds to business competences [7]. In case of telemedicine, all dimensions of CONASENSE shall be the biggest competences besides the medical advancements [7]. Value Chain Function dimension associates with other values that are inevitable to achieve business values. Integration favorable SENSE platform is the most useful function that can be assisted with market analysis and research and developments [7]. Value formula dimension meaning the returns of a business, in terms of telemedicine is the quality enhancements in patients' services. From rehabilitation to surgery, all the possible medical domains are readily achievable due to the CONASENSE paradigm accommodation [7]. Relations dimension relates all other dimensions with each other for seamless business development [7]. Thus, we see that the Telemedicine-CONASENSE planform can be a boon to society [7].

The other ways for improvisation in the business models related to medical/tech digital product development or enhancement of medical service/telemedicine are discussed in the following peer-reviewed published papers below covering the RQ4.

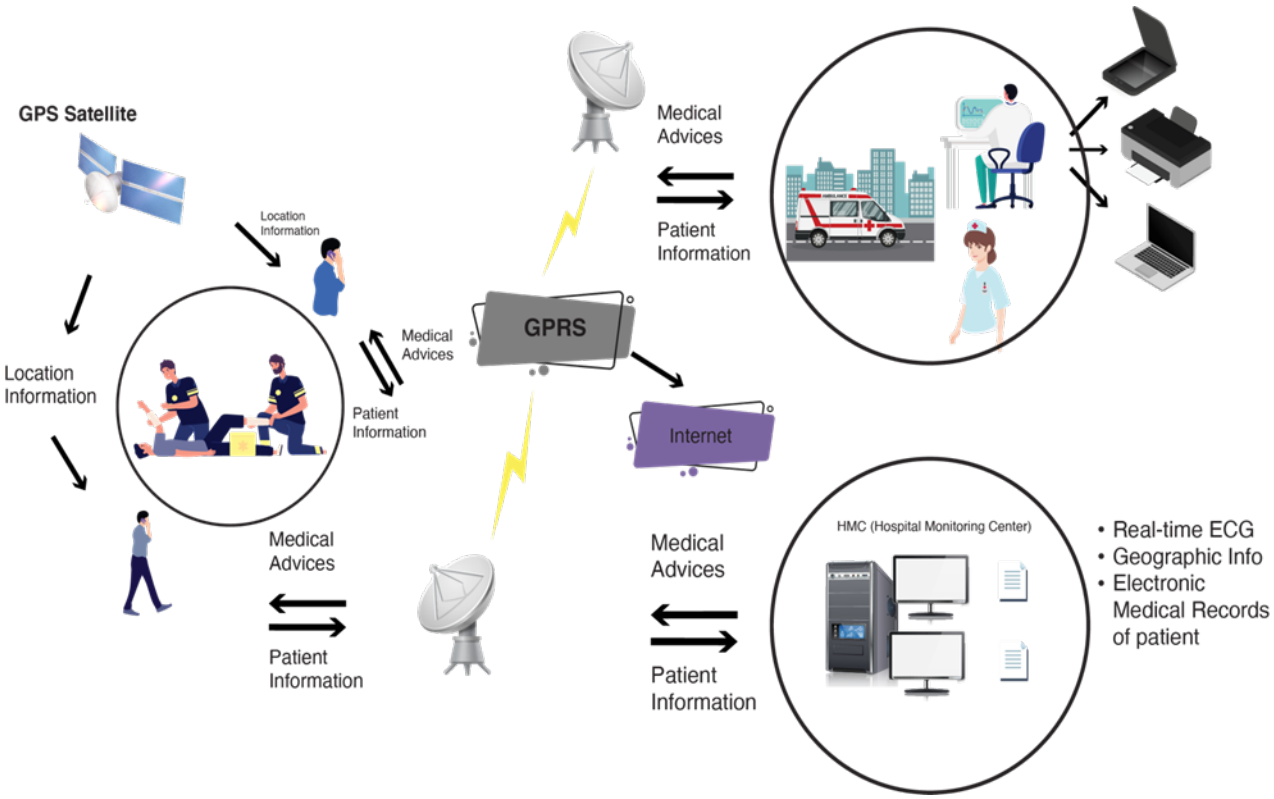
4.2. A Telemedicine Platform for Disaster Management and Emergency Care

In disaster management, the telemedicine systems' designed architecture must conform to an appropriate business model. It will aid successful patients' adherence to integrated technology-based health applications and user specificities for treatment [8]. The adoption of these health-based technologies during disaster management must address reliable business models that consider the factors of economic losses, causalities, and disaster types [8]. As per the reports relayed by the United Nations, a disaster is occasions of disruptions that cause the disorientation of everyday human endeavours. It interferes with economic activities, the technology-based infrastructures of health in telemedicine, and the community's general functionality [8].

The surveillance model emphasizes the need for a business model that enables telemedicine's successful implementation in disaster-prone areas. It addresses disaster types, economic losses and causalities, emergency care, and disaster risk analysis, like those experienced in natural calamities in Belize, Solomon Island, Maldives and Mongolia, between 1980 to 2015 [8]. The model also incorporates emergency care and analysis of disaster risk, both of which

involve the four planning stages such as remission, preparedness, response or action, and the recovery plan [8]. The visualized business model has the telemedicine tools for disaster response, like the indicators of disasters' medical conditions [8]. It also provides disaster response in terms of business model seven dimensions and integrated communication tools (tech, medical, infrastructure and other related industries) along with the application of the surveillance model stages like coordination, compliance, communication, and reconstruction [8], [16]. Communication platform development can enhance technological industries related to medical drug/product, rehabilitation of the infrastructure or victims via integrated collaborative efforts where benefits and risk are shared [8]. The below diagram shows the telemedicine system design architecture, where the business model's seven dimensions can be visualized when interlinked [8].

Figure 13: Telemedicine Systems Design Architecture [8]



4.3. Literacy and socio-dynamics cues insights decision analytics for care plan adherence

As for the Socio-Dynamic Cues (SDC) and consumer-based Business framework for assistive technology promotion and care plan adherence, many patients face the challenge of commitment

to the integrated technology-based care plan interventions [2]. It takes a lot of persuasions for them to conform to these new trends in the sector of healthcare. Social Dynamics are behaviours among groups resulting from the interactions of each group member and to the learning about the relationship between group-level and one-on-one interaction behaviours [1],[2],[3],[4],[5]. The technologies of persuasion can facilitate adherence to the care plan [2]. The adoption of assistive technology in the EU rose from $3.1 billion in 2010 to $4.8 billion in 2011. A triple was expected in 2019 [2]. Reduced adherence to care Plans by the patients are the propellers for digital tools [2]. Therefore, the patients' literacy and compliance towards the integrated technology-based health applications and user specificities for treatment call for the adoption of instrumental business models to popularize these technologies among patients [2].

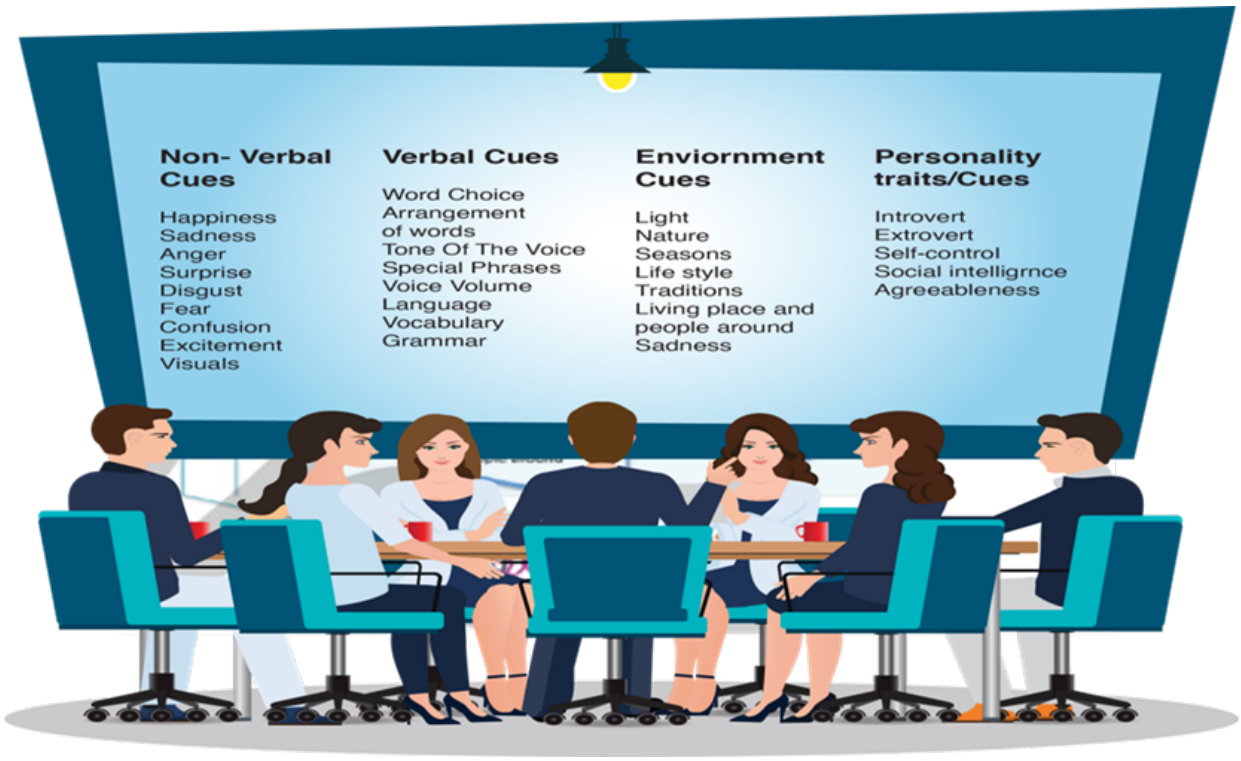
SDC applications for assistive technology and care plan adherence can help a business analyze or navigate the critical factors. Also, what kind of a business model they should conform to, before introducing a single size fit, all solutions technology and concerning that, below points would help them for product sustainability are as follow [2]:

- Does the notion of following emotions, stimulus, and facial gestures, response to a sad or happy face even a strategy of communication to persuade individuals to comply with the healthcare plan change for SDC in various cultures?
- Can SDC weaken or stimulate the persuasion and compliance to a care plan?
- Should a convincing technology be SDC specific? - For improved results.
- If SDC is relevant in making convincing technology, what facial or verbal features of persuasive technology people would need based on SDC between cultures for a long-term chronic disease care plan adherence, particularly for the elderly?

The questions above reveal much of what should be the consideration for a business model that is sustainable in the Health care sector, about adhering to a care plan, particularly in scenarios of the chronic illnesses that need good patient behaviour of sticking to the care plan for their lifetime [2]. There is an availability of a business framework and technology; however, there is a lack of adequate persuasion for patients in using assistive technology and re-merging these specific strategies in SDC [2].

SDC-based assistive technology can offer literacy to patients concerning eHealth literacy necessities about the adherence to care plan [2]. The description of non-verbal and verbal stimuli in the diagram below demonstrates how it is vital to navigating a given area before introducing assistive technology with the belief that it persuades an individual to comply with a healthcare plan [2]. The reward system for adherence with the care plan in assistive technology is executed based on personal traits; therefore, collaborative approach would implement more than one particular strategy [2].

Figure 14: The SDC for Assistive Technology-Based Business Model and its Applications Specific for Different Cultures [2]



The business model's below preliminary framework tends to address every necessary aspect of stakeholders and the essential dimensional elements [2]. The model also addresses the stimuli needed to create and effectively popularize the benefits of SDC for eHealth technology among diverse patients' cultures [2]. Preliminary framework and six dimensions evaluation give insights and ideas for innovation and its linkage with seven-dimensional relations to develop the eHealth business model [2].

Framework results are presumed for the entire health care ecosystem and Business Models based on assistive technology as well municipalities, Government authorities, and related stakeholders by following SDC for creating and capturing new, improved values (optimizing QoL and productivity), socio-economic cost reduction, Prediction and discussions with a collaborative approach to re-design the available service to consumer-based service by changing the behaviour process of consumer and overall cost reduction [2]. The framework will help determine the scientific relevance of SDC and its connection to consumer behavioural change for care plan adherence by launching public and private projects at the local and international level and indulging academia. Students and researchers can use their knowledge in the practical form [2].

Figure 15: Healthcare Technology Application Business Model Framework for Persuasion about the Care Plan and Collaborative Approach [2]

4.4. Framework for Future Telemedicine Planning and Infrastructure using 5G Technology

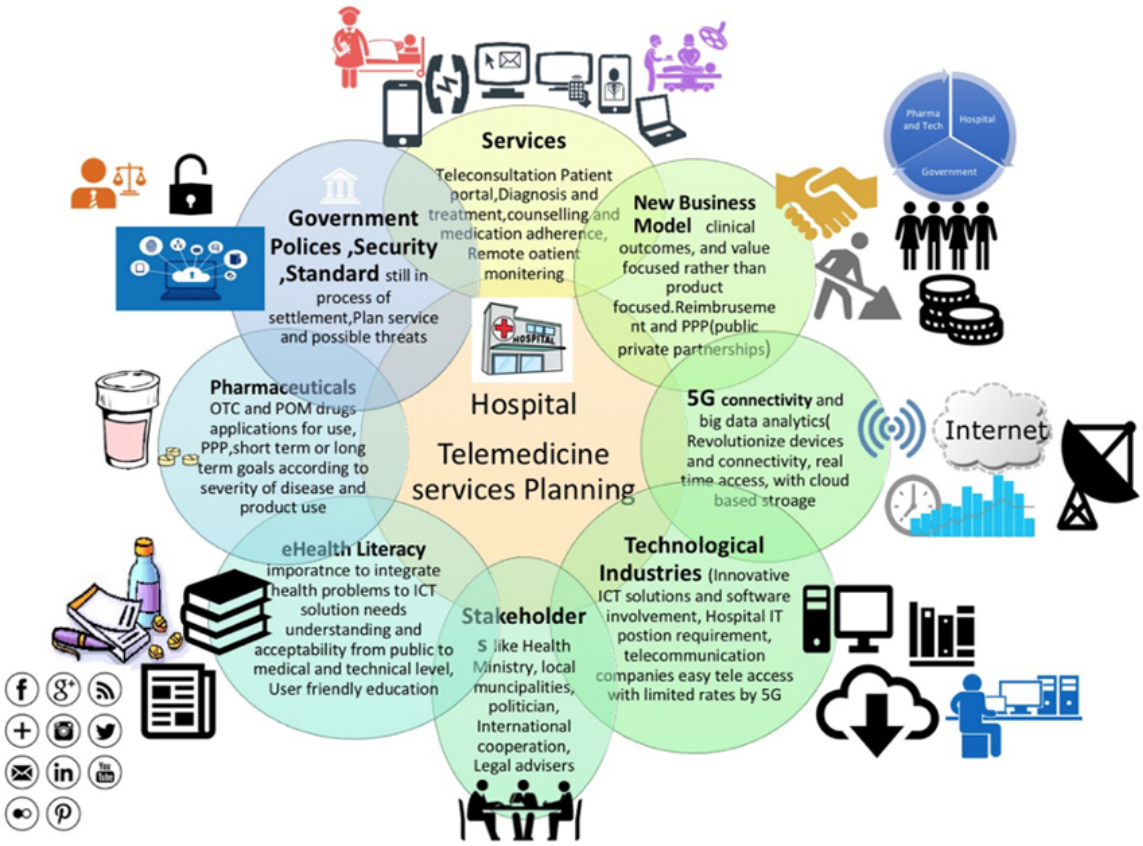
Before considering planning, industries and the area that can support marketing and payments should be under consideration. Long-term disabilities and rehabilitation can encompass potential business models alongside the providers of the opinion that their technical employees and equipment with products, can execute and benefit from the services of telemedicine [1]. Creating a sustainable structure with long-term importance of marketing and business model strategies will maintain the inflow of the system [1]. Private and public partnerships are crucial in the sector of healthcare.

The tech and pharmaceutical industries can invest in telemedicine by seeing the kind of services required [1]. The business alliance can rely on three primary parts: NGOs, R&D, healthcare or educational sectors involved. Second is collaboration; whether short term, middle or long and third introduces supply and demand management by observing the patients' requirements [1]. Long-term partnership poses many risks, but the investment may be fruitful in chronic diseases and remotely-oriented patient monitoring [1]. Policy recommendation needs assistance from all the stakeholders including all types of the industries, for instance; 5G, health authorities and the public to exercise the positive acts through [1]:

- Introduction of different business models in the healthcare ecosystem with pilot actions and modelling approach
- Utilization of acceptable practices in making business models for the continuous and valuable healthcare ecosystem
- Provide the understanding of benchmarking to act innovatively and utilize best practices business models for health care.
- Reimbursement and financing health care sector with acceptable practices
- Legal clearance in a different matter related to personal health data and exchangeable
- data nationally and geographically
- Facilitate industries and markets to come and give solutions for unsorted technical issues.

Telemedicine business models and public-private partnerships are essential both for developed and underdeveloped countries to find a way for payment and revenues [1]. Through this digital eHealth concept, many sectors can provide solutions for emerging countries as well [1]. The proposed escalation model has four necessary vital parts which are giving shape or stability to the skeleton. First, is the government making its policies, defining regulations for best practices. Second is the ICT industries, which are coming with new innovative systems, sensors, and devices for faster access to data and quick response [1]. A Third is a wireless technology such as 5G providing all the data and quick response with real-time and low latency. The Fourth area is the industry itself, such as technology industries, startups, pharmaceutical industries, etc. which will provide investment and practice new ideas and business models to make a sustainable, rewardable eHealth ecosystem [1]. All the systems will coordinate and involve in action and required reactions. A single unit cannot work more efficiently alone. All need to work together to get the maximum benefit. Telemedicine services will be regarded as a healthcare ecosystem, which is central or brainy part of this proposed escalation model [1].

Figure 16: Service Planning for Hospital Telemedicine [1]



4.5. Connections of Chronic Diseases and Socio-dynamic cues for Integrating ICT with Care Plan Adherence

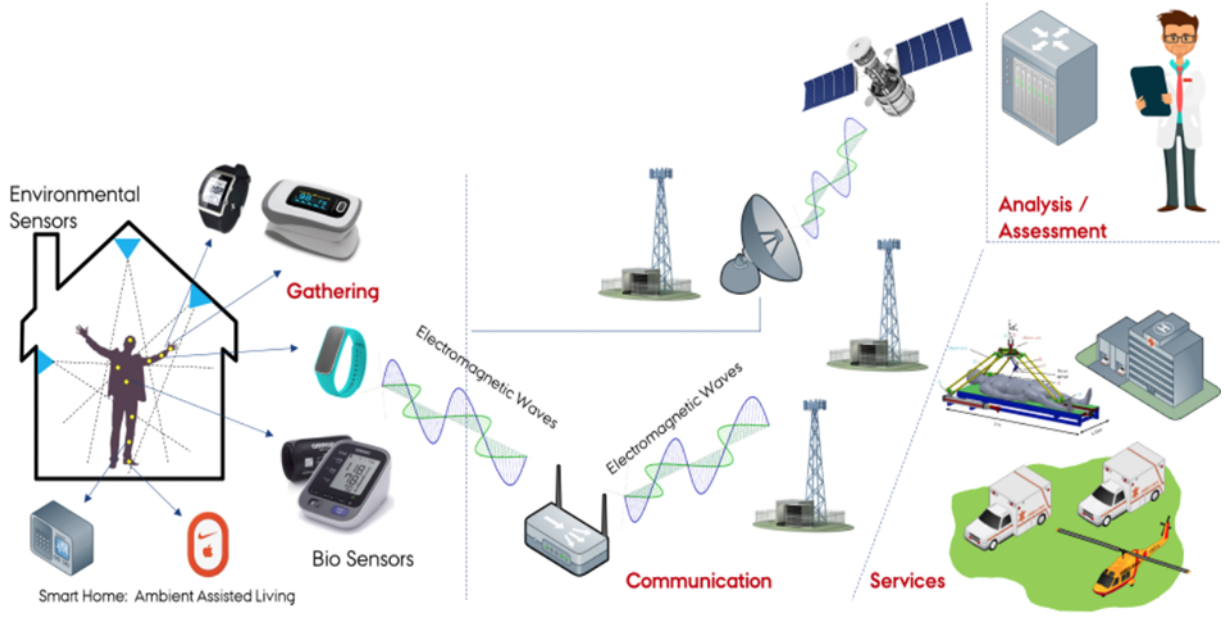
Regarding the connections of chronic diseases and socio-dynamic cues, Denmark has a significant effort on their public-private partnerships regarding technological models of business, municipalities, and healthcare system [4]. Telemedicine market in Europe grew $3.1 billion from 2010 to $4.8 in 2011, and it is expected to triple in 2019 [4]. Information communication technological investments, increasing aged population, and less adherence to the care plan are the telemedicine market's driving forces [4].

Technology is expanded to reduce morbidity, and enhancing patients' motivation with behavioural change is the essential factor in recent research [4]. Many studies with different avatars or robots are investigating that can help in adherence to care plan [4]. Performance of an eHealth system and business model's creation depends on the site where it is going to be implemented, patient relationship, value creation, delivery channels or framework, overall impact and value-based outcomes generation [4]. E-business models, eHealth, and ICT products can accelerate self-management and induce patients' adherence to their care plans [4]. There is the requirement to understand individual willingness, the stakeholders involved, and the post-self-care programs to make the patients independent through their conformity to the care plan [4]. Pharmaceutical companies can furnish a digital remedy with treatment propelled for application [4].

Denmark has put substantial weight on public-private partnership. Businesses in the eHealth industry have an estimated turnover of $680 million. Denmark is one of the front-runners in developing eHealth solutions and has Digital welfare 2016–2020 strategies for caregiving medicine [4]. It is based on telemedicine to reduce expense and increase the patient's safety and convenience at various stages of the hospital, GPs and municipalities [4]. It also provides a better framework for the business community and public-private sector [4]. Data analysis and interpretation models can help to strategize chronic disease connections and optimize adherence to care plan. If one chronic disease is targeted for the care plan and lifestyle modification, it can very likely decrease the probability of other chronic diseases [4]. Data collection in terms of area specificity and SDC can help identify the area-specific diseases and associated diseases that can help make models for helping assistive technology-based business and different stakeholders target

the specific area with high efficiency [4]. The Results produce in multiple scenarios like decreased socio-economic expenditure, several total deaths, increased commitment with care plans worldwide and improved the QoL of the patient [4]. The outcomes can give municipalities, pharma & tech industries insight to seize value or cost-based business models for eHealth applications and assistive technology devices [4]. The findings can help in cost channelization to the added payer by innovative BM integration to adhere to the care plan [4]. The outcomes can give insight to municipalities and service providers about how to plan an eHealth service in the plot of BM for chronic disease adherence to care plan. A device or service is a user-friendly, secure technology platform and requires little eHealth literacy and multiple uses of technological devices [4].

Figure 17: The Paradigm of Telemedicine [7]



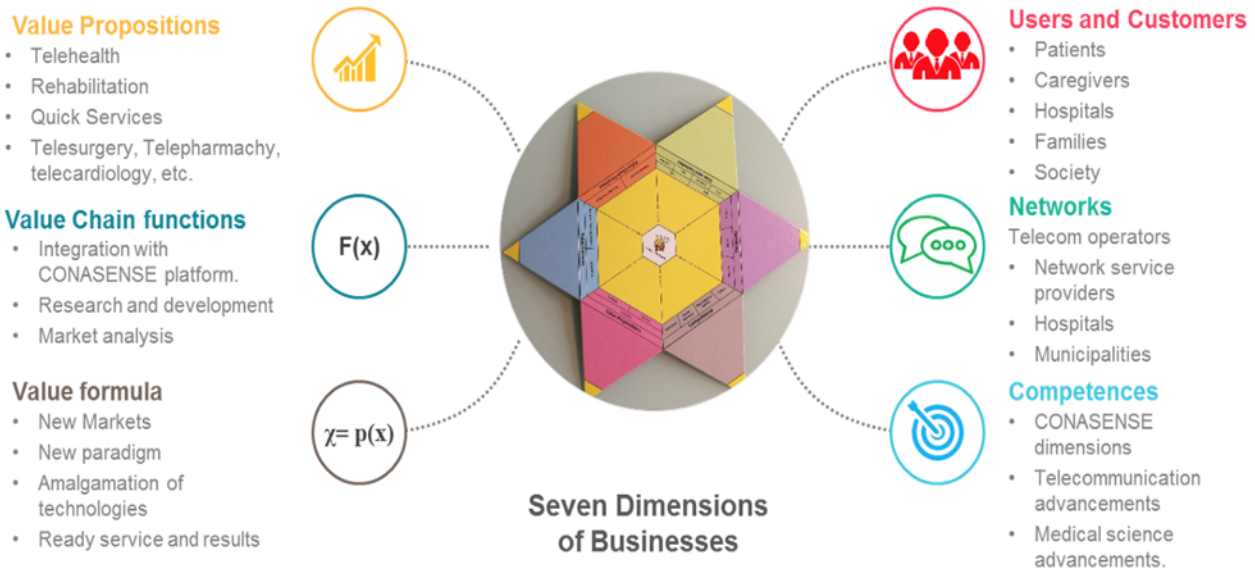
4.6. 5G and Telemedicine: A Business Ecosystem Relationship within CONASENSE Paradigm

Regarding the business model for 5G and Telemedicine, where a business ecosystem relationship within the CONASENSE Paradigm is the dimension that corresponds to the business competencies, the entire dimensions of CONASENSE shall be the most significant competencies besides the medical advancements [7]. The value chain function associates with other values that are inevitable to achieve business values. Integration with the CONASENSE platform is the most

favourable function under assistance with market analysis and research and developments [7]. Also, the value formula, which means the returns of telemedicine, is the quality enhancement in patients' services [7]. As in the currently experienced global pandemic, Covid-19, for instance, the consideration of implementing technology-based healthcare applications should conform to the CONASENSE Paradigm as they will assume the most competent business model for the prevention of the rapidly spreading virus [7].

Here, patients' adherence to these applications will impactfully peg to the fact that the prevention of the spreading virus requires little or, in some occasions, zero efforts towards patients' persuasion for their adherence within the stipulated care plan, as the virus is globally widespread. All the possible medical domains are readily achievable from rehabilitation to surgery due to the CONASENSE paradigm's accommodation [7].

Figure 18: Telemedicine Business Model in Seven Dimensions within the Business Ecosystem [7]



The dimension of relation links all other dimensions with each other for seamless business development [7]. Thus, the Telemedicine-CONASENSE platform can be a boom for society. By introducing human-centric features in the CONASENSE paradigm, a lot can achieve in the ecosystem of business [7].

4.7. Technology-oriented home-based rehabilitation for supporting medication adherence

An estimated 50 percent of aged patients do not conform to the physician's recommendation [3]. About 200.000 premature annual deaths linked to non-adherence to medication in Europe, which costs about EUR 1.25 billion [3]. The United States costs between $100 to $289 billion yearly to the American health care system [3]. Non-adherence to medication results in 125,000 deaths annually in the United States [3]. The non-adherent patients under medication have more significant health expenditures, like $ 3,900 for hypertension and $3,700 for diabetes per year [3]. Only adherence to medication among diabetic patients can save $ 4.7 billion [3]. Adherence to care plan remains part of the European Union research projects H2020 and legislation [3].

Patients need medication adherence to receive the desired effects. The efficacy of treatment relies on the magnitude or concentration of the drug present in the bloodstream that can fabricate the expected outcomes [3]. Therefore, physicians prescribe to a patient the medication after stipulated intervals to regulate the drug's therapeutic impacts. In case the patient doesn't apply the pills, the intended therapeutic effect will not be in achievement [3]. There is the necessity of establishing a platform of technology based on a reminder for medication adherence of aged adults and the patient with dementia, loss of memory, or cognitive deficiencies to evade the toxicity or a lowered impact if the patient does not take or consumes an overdose of the medication [3]. Tuberculosis (TB) needs 6.9 months of treatment, and medication adherence is necessary for scenarios where the non-adherent patient should begin medication from scratch, which is extremely stressful and requires re-scheduling of time mental input [3].

Medication adherence is compulsory in cases of severe or chronic infections, such as HIV, Diabetes, Hypertension, Stroke, and Parkinson's, among others [3]. Patients' low literacy for medication administration & self-management, little knowledge regarding the pathology of the infection, and polypharmacy may result in missing a prescribed dose or otherwise subjects the patients to the frustration of not taking it as the technique of administration seems complex [3]. The literacy can enhance through a technological platform or a virtual coach for self-management and user-friendly guidance effectively and repeatedly [3]. Antibiotics call for medication adherence; if forgotten, it can also secure the strain or viruses, so it will pose a challenge if provided or taken at a low limit of dosages [3]. It is a vital obstruction, mainly in underdeveloped nations

as drug-resistant strains are rising and vulnerable to relapse [3]. These require a specific duration of time, for example, six months or year to see the efficacy of a medication or vaccine to target them to avoid severity and reduce deaths [3].

4.8. Collaborative strategies and Socio-dynamic cues (SDC) insights for assistive healthcare technology applications

There is a necessity for improving the Business model used by adopting different assistive healthcare technology companies to deeply dig into SDC and diversities in the technology applications among various parts of the globe to prevent product failure [5]. A great deal of change in having a comprehensive shift from the contemporary product-based models would turn out vital as abrupt traditional model alterations will disrupt and create financial burden which would not be a healthy or sustainable way [5]. Therefore, a sustainable strategy for a dynamic business model remains a necessity [5].

4.8.1. Business Model Canvas (BMC)

Business Model Canvas is a graphically designed tool by Alexander Osterwalder (The Generation of Business Model) to aid the representation of any business model on a sheet of paper [5]. Business Model Canvas comprises of nine building blocks [5]. It includes key partners, key activities, value proposition, customer relationship, customer segment, essential resources, distribution channel, cost structure, and the revenue stream [5]. To couple the knowledge from the above explanation and the need for integrated technology-based health applications, for instance, data generated from The Business Model Canvas of the Epic Systems Healthcare Technologies presents as below [5]:

Table 7: Components of the Epic Systems Business Model [5]

Building Blocks	Description
Key Partners	With mobile health platform, no other significant Partnerships in Apple, within 2014.
Key Activities	EMR mitigations for healthcare facilities as well as ambulatory clinics. Patient registration and routine organization, care providers inclusive of physicians, nurses, pharmacists, laboratory technologists, emergency personnel, radiologist, and a system of billing for insured individuals.

Value Proposition	EMR or EHR remedies and products, as well as its human resources, are creating the products.
Customer Relationship	As an excellent reputation, Multi Faced System ranks in voting as the top software in a comprehensive suite in the 2015/2016 awards of Best in KLAS, best-selling system of electronic health records.
Customer Segment	An employee from Epic interacts with the customer's devoted personal-assistance during after the sale or hands-on help.
Key Resource	International website and offices without social media platforms or much spending on marketing as clients access Epic Systems' premises.
Distribution Channel	The Centres of Ambulatory surgical operations, Healthcare maintenance organizations (HMOs), and hospital and clinics.
Cost Structure	Customer directly accesses the Epic Systems' premises; therefore, much is spent on EMR and little cash on sales and marketing.
Revenue Team	Epic Systems earns its revenue through a mixture of upfront fees for the implemented software and the progressing upgrade, support, consultation, and service fees.

4.8.2. An Assistive Digital Healthcare Software Business Model Failure: The Danish Hospital Case Presentation

Much focus relays on America's digital health software failure in the Danish healthcare system [5]. Epic Systems, a business that has done many software implementations, explains why The Region Zeeland, Denmark chose the Epic digital health software [5]. Danish health authorities in 2016 spent around 2.8 billion DKK on the Epic software implementations in 18 hospitals in an area with approximately 2.8 million residents [5]. On the 20th of May, Epic became live in the first facility of healthcare [5]. Gert Galster, a doctor and having a PhD in informatics, was trying to convert the software into the workable hospital management system for Copenhagen and the Neighboring regions for three years and 45,000 clinicians in eastern Denmark plunged into the system [5]. However, the problem included translating the medical terms, and relying on the Google translator was necessary [5].

The software design was not easy and hardly coded that it was not very easy to disintegrate [5]. Other differences like C-section are not a medical emergency procedure in the Danish version

[5]. Still, it is in the USA, and language and speech pathologist are absent in Denmark [5]. It was a considerable financial loss [5]. The highlight is that although we as people move through the same diseases, same medical books, and similar diagnoses, the use of IT systems where collaboration is in requirement among users depends on the culture where the particular design and collaboration happens [5]. Nurses in Denmark in an emergency can prescribe medication, and they can explain the reason for that in a later period [5].

In Epic Software, any effort to practice a prohibited role made a rejection [5]. Denmark has a socialized medicine system where you don't need to pay for bills and insurances [5]. However, in the US healthcare sector, the physicians bill the patient very efficiently by bought digital records, and in their system, the value of care comes in the latter part [5]. The physician and nurses in Denmark dispense medication, while in the USA, it is by the pharmacist [5]. The Denmark system is based on trust while it lacks in the USA [5]. In the mid of 2018, a report was published in which it is found that Epic deployment led the 57 percent of patients to wait for more than 30 days just for taking the appointments; however, it was 4 percent where Epic did not deploy [5]. The satisfaction for using the Epic decrease to 12 percent by the physician in Feb 2019 and 60 percent came with a very high level of dissatisfaction [5]. In Copenhagen, 71 physicians signed a petition to remove Epic from the hospital system in 2018. Afzal Chaudhry, the chief information officer of Aden Brooke's Hospital in Cambridge, England, said that they implemented the Epic system successfully in 2015 and encountered very few problems [5]. He also quoted that he visited Copenhagen many times to help Danish for Epic implementation [5]. He also added that you couldn't push people, and for this, you need a mindset of acceptance among the management and a clinical team that allows [5].

4.8.3. The Analysis of Epic Systems Business Model Canvas (BMC) on a BeeStar Business Tool: The Danish Case

BeeStar is a visual tool developed by Prof. Peter Lindgren (Peter, 2018) to describe a business model [5]. BeeStar simplifies the complexities of a business model and illustrates any business model in "As Is" or "To Be" state [5]. In BeeStar, all the business models have seven dimensions [5]. The digital health software failure, Denmark case would be analyzed by disintegrating the BM into the BeeStar to define "As is" and "To be" business model for Epic Systems by taking information through different internet sources as Epic Systems is not being contacted [5].

The analysis has only been done to give some ideas by seeing Danish Case as an example that is implementable and provides values to the business and customer [5]. The "To be" business can be used by any business having the same or similar Business model so that their product remains in the market and not being ended up as a failure product just as happened in the Danish Case [5].

Table 8: The Elaboration of Epic Systems Product Business Model on BeeStar Business Tool [5]

Dimensions	Categories	Business Model Components
User and Customer	B2B B2C	The centres of ambulatory surgical centres, Healthcare maintenance organizations (HMOs), Hospitals and Clinics (Epic Systems). The clinical area includes the district hospitals, rehabilitation centres, local clinics, educational, medical centres, and practice, which are done. Patients quickly access the software and their home care settings through their phones.
Network	Digital Physical Virtual	North Shore (University health system). Premise Health and Mayo Clinic (EHR Intelligence, 2017). New Apple's mHealth application (Apple Partnering with Epic, Mayo on New Health App Platform). Partners Healthcare Offices in the UK, Denmark, Netherlands, United Arab Emirates, Finland, Melbourne, and in many other countries. One of the leading Competencies Technology Human Resource Organizational Culture.
Competences	• Resource • Organizational • Human • Culture • Technology	A member of the leading EHR vendor, Software IT platform for medical records Hospitals and supporting hospital functions Cooperate culture (Epic Decoded: An Inside Look at Life and Corporate Culture at the Health IT World Centre.) EPIC HRMS (provides automation paper-based HR) (EPIC Software Corporation.).
Value Chain Function	• Primary • Function • Secondary • Function	Health Information Technology, electronic health records and medical health records, customer care, training material for installation advisory, consultation, and technical installation support.

	• Cost • Revenue	Research and development, manufacturing, consultation and installation.
Value Proposition	• Product • Service • Process	EHR or EMR Software and education or training material, Installation, applications support functions related hospitals Ecosystem and advisory, and cloud hosting service for customers.

The above categories and Business model dimension components of Epic systems on a BeeStar analyze the digital health software failure case [5]. After studying the Epic Systems BM using BMC and BeeStar as for analysis, it is evident that Epic Systems requires new remedies for the acceptance and adaptation of its technology following the Danish facility's case [5]. The case relays significant concerns and the upgrade of the strategy towards the customer's satisfaction, the variance, and the cultural differences of the Socio-dynamic cues among various people [5].

Also, the implication is that Epic Systems requires some new business model under pre and postmarking of products that can be in addition to the Epic Systems' present portfolio block of channel building and value propositions through the analysis of the current BMC and that of the BeeStar [5]. The post-online research can provide the following recommended mitigations [5]:

4.8.3.1 The Strategy of Post-marketing Surveillance

For a progressive innovation of products, it is necessary to acquire the data after launching the product in the market, a fact that later reveals the problem that should be through the procedure of mitigation [5]. As per the BMC for Epic Systems, the expenditure is lower for marketing the product, thus requiring a dedicated team as the BMC shows only the buying and selling of products between customer and employee, which indicates the reduced availability of reporting following the post-marketing surveillance [5].

4.8.3.2 Customized Product and Customer Satisfaction

Before launching any product, it is a requirement to assess the flexibility to employ various systems, especially software-based healthcare technology [5]. The sales and marketing team can hire individuals with the ability to perceive the demand of customers quickly and later assess the

product's feasibility for the customer's requirement [5]. They should perform a comprehensive customer interview or counselling following the needs and the system regarding its deployment [5]. According to the Danish scenario, the software poses comprehension technicalities and does not comply with the facilities' requirements [5].

A business enterprise should focus on the value creation of the products, besides its missions of revenue generation. The latter is only possible through research on the needs of customers [5].

4.8.3.3 The Availability of Country-specific Data and Collaborative Approach

Epic Systems may also embark on data collection regarding the products before marketing them [5]. The act is possible with data sources being the significant countries or critical partners to boost product consumption, for instance, in health, their specific infrastructure requirements, SDC and cultural values, and sector hierarchy [5]. The strategy will ease the deployment of the products due to its popularity [5]. In Danish's scenario, a Google translator was under adoption to translate many terms from the deployed software, and a lot of processes had invalidities as well as responsibilities and ranks of the hospital's professionals [5].

Since Epic Systems is a vital healthcare technology vendor, these strategies should consider as part of the product's development for the sustenance of their market reputation [5]. A dedicated team can break these terminologies with much ease, the variance of Socio-dynamic cues, cultural and system variation before marketing [5]. The success of a product demonstrates that there is not a single solution for perfection. The employed mitigation should display enough flexibility for acceptance and adoption with customers' desires and grievances [5].

4.9. Summary

In general, the involvement of the integrated technology-based healthcare applications in health encompasses various models of business that impact its influence and admittance among the ailing individuals. For example, telemedicine's field reflects a complete intersection of two independent areas of science and incorporates telecommunication and medicine. There is the necessity to introduce business models regarding the tech industries, pharmaceuticals, and government investments that can aid the affordability of network systems and healthcare devices

for appropriate monitoring and channelling the patients via telemedicine and their national and global provision.

The planning for the adoption and the progressing system interference accountability is significantly vital. Coordination and cooperation in the healthcare ecosystem will boost the human workforce, limited financial burden, and offer more vacancies to the private and public sectors for investment and generation of profits. About communication, real-time and connectivity, 5G will execute a crucial function. The sustainable strategy would involve establishing a business model to cope with and predict the upcoming disruption and offer the opinions on ideal adaptation within the healthcare framework and alterations in the product-related models that exist [1],[2],[3],[4],[5], [7], [8].

5. CONCLUSION AND RECOMMENDATIONS

The section concludes the dissertation topic also suggests various recommendations and future scope for the effectiveness of the research into influencing the adoption of technological strategies in the field of healthcare. It corresponds to the peer-reviewed published research papers 1, 2,3,4,5,6,7,8. It presents the conclusion and recommendations summary of the published papers.

5.1. Conclusion

In essence, there is a need to implement integrated technology-based health applications and patient specificities for adherence to the stipulated treatment plans, mostly for those patients who ail from chronic diseases, and the equivalent influence of the wireless technological tools and 5G to promote the strategy. The engagement of these technologies executes an enormous role concerning the significant boost it replicates on life expectancy and reducing the mortality rates. Chronic infections often require strict adherence to treatment plans, which calls for motivation alongside relaying various forms of concentrations on a particular patient.

The digital tools, wireless communication, and 5G tremendously impact the improvement of the quality of life in scenarios of its appropriate adoption and implementation. The establishment and development of 5G technology is a massive boost towards improving the integrated technology-based health applications due to the advanced popularity regarding the use of smartphones in the daily lives of many individuals. The technology facilitates swift and ready access to the integrated technology-based health applications due to its large bandwidth, which permits the transference of data in their enormous amounts, for instance, as is witnessed in high-definition teleconferencing.

The contemporary technological remedies permit access to healthcare readily and more efficiently. However, there is the urge for continued transition and advancements. Thus, continuous training is needed to ensure that medical practitioners and patients adapt to these technologies to promote adherence in healthcare. There are barriers to adoption in patients and medical practitioners as they may have a varying attitude towards these solutions, their analytical skills, less customized technologies based on SDC, technology acceptance, adaptability, ease, skills to understand with proper implementation and product sustainability. Adherence to integrated heath-based technology remains a capital necessity for chronic treatment among the

patients because they take a long time to treat. The patients who suffer from chronic diseases may also need to stay on medication nearly for the better part of their life if not all of it.

A framework for implementing integrated technology-based healthcare applications is an essential requirement for ensuring continuous literacy among patients and medical practitioners. SDC influence on how, for instance, medical practitioners and patients adopt integrated technology-based healthcare applications. The integrated technology-based healthcare applications prove extremely vital in curbing medical emergencies and calamities or disasters by promoting the ease of accessing or reaching them.

Diverse categories of patients possess different medical demands, and the progressively advancing sophistication exposes constraints along the way. Thus, calls for the switching or the updates of what is in existence among the patients. It, therefore, implies that patients get the coaching progressively regarding the rolled-out adjustments. Training boosts the patients' involvement, which is essential for improving their adaptability to the new advancements. The background and attitude tend to be the primary considerations that influence patients' technological adherence and treatment.

It implies that integrated technology-based health applications should bear designs that propel the rate at which various individuals apply them, a consideration that must incorporate additional features to trigger the entire procedure. The establishments and advancements of these applications deserve the incorporation of medical experts as they are quite familiar with the patient behaviour, unlike in the developers of the software. The integrated technology-based health applications should be acceptable, sustainable, and user friendly so that all stakeholders are satisfied with the system, which will improve effectiveness. It will also allow collaboration and integration with other features in different industries like food and fitness, complementing medical treatment.

It remains significantly vital to develop a framework for the integrated technology-based health application solutions that can aid in the improvement of patients' compliance and conformity to various types of treatment. Inadequate involvement from stakeholders, availability of specialized services, and costly healthcare services tends to be the primary facilitators that push for the necessity of integrated technology-based health applications framework to aid in the entire

procedures pegged to healthcare. A medical framework for treatment should be universally structured to include all integrated technology-based health applications that are important for promoting adherence among patients. The treatment plan adherence reflects a patient's medical recovery response.

The medical treatment plan stipulated by the medical practitioner for patient adherence, dramatically relies on the patient's diagnosis, needs, and body dynamics, such as a disability or cognitive constraints. The treatment plan is inclusive of the patient's treatment, check-ups, and any necessary medical remedies. The primary role of adherence to the medical treatment plan among patients' adherence is the pegs to the patients' quality of life in their encounters of proceeding with the stipulated treatment procedures for preventing the recurrence of the same health complications anytime during treatment. Therefore, patients' adherence to medical treatment plans remains an extremely crucial factor for their recovery and future health status.

5.2. Recommendations and Future Scope

There is an absence of mistrust that the healthcare system's future aligns with the contemporary and the evolving technological platforms. The world gets smarter every day because of the speedy services globally and communication with minimum latency and quick data rates. The models of analysis and interpretation can better aid the research of care plans and may offer up to date treatment protocol for behavioural adjustments. Artificial Intelligence is a stretched type of the integrated technologies which will later lead to the revolutionization of treatment plans that accompany better results.

Various recommendations on medical adherence have been suggested in the dissertation following different section and EU recommendations in general. They are inclusive of coaching the patients based on how to develop profitable decisions following their conformity to the treatment plans stipulated for them by the medical practitioners. The consideration will promote and precipitate the concentration and intensity of the patients' medical adherence. All the medical practitioners, including doctors, nurses, and pharmacists, must be well conversant with all the practices related to the patients' medical adherence. A recommendation made by the EU suggests that every nation should establish strict, workable and realistic policies of medical adherence for

patients. It further recommends that these policies should be aired and made public for general awareness by everybody.

Furthermore, the EU provides a view that to ensure treatment adherence health inequalities need addressing staff competencies and funds availability. Also, the patient-based groups and forums should be under encouragement to motivate the patients regarding every little aspect that proves fruitful for promoting their adherence to the medical treatment plans as organized by the medical practitioners.

Therefore, as in the currently experienced global pandemic, Covid-19, for instance, implementing technology-based healthcare applications should conform to the CONASENSE Paradigm and the other framework recommended in different sections of the dissertation. The most competent business model practice and improvisation are assumed to prevent the rapidly spreading virus and adherence with the care plan. These applications will fruitfully peg to the fact that the prevention of the spreading virus requires little or, in some occasions, zero efforts towards patients' persuasion for their adherence within the stipulated care plan since the virus is globally widespread as a pandemic.

Moreover, network access and coverage are limited or fragmented in remote locations. Infrastructure is and remains fundamental in the development phase in the execution of telemedicine or eHealth care services. Absence of interest by the private organizations because of minimal transparency in the medical services and inadequate managerial supervision on the healthcare ecosystem remains the primary determinants in the reduced affordability of patients for the costly remedies and the deployments of the widely oriented system of health care. The telemedicine services and practice of clinical applications are still expensive because of limited awareness following the proper application of different software and devices, basic and preliminary wireless communication system with reduced bandwidth and interference in the ongoing adopted healthcare ecosystem.

Finally, it is necessary to include government investment, tech industries, and pharmaceuticals to produce affordable devices and systems of the network for proper monitoring and channeling of patients through telemedicine and their national and global supply. It is crucial to plan for the implementation of the ongoing system interference accountability. Coordination

and cooperation in healthcare ecosystems would influence the human workforce, promote reduced financial expenses and offer several opportunities to the private and public sectors to invest and earn many benefits. For communication, real-time, and connectivity, 5G will perform a vital responsibility since standard definition and security still in the line of settlement. Governments, universities, and industries are providing philanthropic inputs for attaining value-oriented eHealth and telemedicine services. However, a lot of research is still required to get the sustainable eHealth ecosystem infrastructure and adherence with the integrated technology-based health applications for treatment adherence.

6. RERERENCE LIST

"6 Prevention of Disability Associated with Chronic Diseases and Aging." Institute of Medicine. 1991. Disability in America: Toward a National Agenda for Prevention. Washington, DC: The National Academies Press. doi: 10.17226/1579.

"eHealth Startup Guide for business success A practical introductory manual on business modelling and routes to market." [Online]. Available: http://webcache.googleusercontent.com/search?q=cache:d7MbQxiXmhwJ:digitalezorg.nl/digitale/uploads/2015/04/RESOURCE-GET-on-Track.pdf+&cd=1&hl=en&ct=clnk&gl=dk

"Non-communicable diseases." [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases

(HLS-EU) Consortium Health Literacy Project European et al., "Health literacy and public health: A systematic review and integration of definitions and models," BMC Public Health, vol. 12, no. 1, Dec. 2012.

"10 Critical Steps for a Successful Telemedicine Program." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:yyvF0He_Ef8J:https://www.amdtelemedicine.com/downloads/10_steps.pdf+&cd=2&hl=en&ct=clnk&gl=dk.

"3 Steps to telemedicine disaster preparedness." [Online]. Available: https://www.beckershospitalreview.com/telehealth/3-steps-to-telemedicine-disaster-preparedness.html.

"A cross-national analysis of eHealth in the European Union: Some policy and research directions," Information & Management, vol. 51, no. 6, pp. 783–797, Sep. 2014.

"A Review of Telemedicine Business Models (PDF Download Available)." [Online]. Available: https://www.researchgate.net/publication/236091643_A_Review_of_Telemedicine_Business_Models?enrichId=rgreq-7c1f9b164bd539aaa9d830207b60cd64-XXX&enrichSource=Y292ZXJQYWdlOzIzNjA5MTY0MztBUzo5OTg0MDkwMjA0MTYxMUAxNDAwODE1MzM0NTc5&el=1_x_3&_esc=publicationCoverPdf.

"Adherence and Concordance." [Online]. Available: http://webcache.googleusercontent.com/search?q=cache:77TxMVrYwUQJ:www.eu-

patient.eu/globalassets/policy/adherence-compliance-concordance/adherence-paper-final-rev_external.pdf+&cd=1&hl=en&ct=clnk&gl=dk.

"Building Value-Based Healthcare Business Models - Health Article - A.T. Kearney | United Kingdom - A.T. Kearney." [Online]. Available: /health/ideas-insights/article/-/asset_publisher/LCcgOeS4t85g/content/building-value-based-healthcare-business-models/10192,http://www.atkearney.co.uk/health/ideas-insights/article/-/asset_publisher/LCcgOeS4t85g/content/building-value-based-healthcare-business-models/10192.

"Business Models for eHealth - Final Report - EUROPEAN INNOVATION PARTNERSHIP - European Commission," EUROPEAN INNOVATION PARTNERSHIP, 14-Jun-2012. [Online]. Available: https://ec.europa.eu/eip/ageing/library/business-models-ehealth-final-report_en

"Business models for eHealth," Digital Single Market. [Online]. Available: https://ec.europa.eu/digital-single- market/en/news/business-models-ehealth.

"Business Models for eHealth." [Online]. Available: http://webcache.googleusercontent.com/search?q=cache:bXo-HkOH7AYJ:ec.europa.eu/information_society/newsroom/cf/dae/document.cfm%3Fdoc_id%3D2891+&cd=1&hl=en&ct=clnk&gl=dk.

"Denmark - a frontrunner in telemedicine in Scandinavia." [Online]. Available: https://www.digst.dk/Servicemenu/English/News/Denmark-a-frontrunner-in-telemedicine-in-Scandinavia.

"Denmark, World Leader in Health IT, Tests New Systems with US Companies," 19-Feb-2014. [Online]. Available: https://www.businesswire.com/news/home/20140219005019/en/Denmark-World-Leader-Health-Tests-New-Systems.

"Denmark: Country Health Profile 2017 - en - OECD." [Online]. Available: http://www.oecd.org/health/denmark-country-health-profile-2017-9789264283343-en.htm. [Accessed: 06-Jun-2019].

"Digital welfare." [Online]. Available: https://admin.en.digst.dk/policy-and-strategy/digital-welfare/.

"Disasters in Europe: more frequent and causing more damage," European Environment Agency. [Online]. Available: https://www.eea.europa.eu/highlights/natural-hazards-and-technological-accidents.

"Drone Delivery Models for Healthcare." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:PmOubpLq_OsJ:https://pdfs.semanticscholar.org/622a/d97506e882bf30ba4dab9c0748ce540ecee3.pdf+&cd=2&hl=en&ct=clnk&gl=dk.

"eHealth Start-up Guide for business success A practical introductory manual on business modeling and routes to market." [Online]. Available: http://webcache.googleusercontent.com/search?q=cache:d7MbQxiXmhwJ:digitalezorg.nl/digitale/uploads/2015/04/RESOURCE-GET-on-Track.pdf+&cd=1&hl=en&ct=clnk&gl=dk

"EMERGENCY MEDICAL RESPONSE." [Online]. Available: http://bcn.boulder.co.us/community/explorer/ep493d4c.htm.

"EPF draft Position paper on eHealth." [Online]. Available: http://webcache.googleusercontent.com/search?q=cache:fxdFgAgbU2YJ:www.eu-patient.eu/contentassets/c8ff38cc3ed24717a8c4a4f6e9106579/ehealth-draft-position-paper-2015_for-consultation.docx+&cd=9&hl=en&ct=clnk&gl=dk.

"EU-funded research projects into technologies for accessibility," Shaping Europe's digital future - European Commission, 13-Dec-2018. [Online]. Available: https://ec.europa.eu/digital-single-market/en/eu-funded-research-projects-technologies-accessibility. [Accessed: 20-Apr-2020].

"European Commission - PRESS RELEASES - Press release - State of the Union 2016: Commission paves the way for more and better internet connectivity for all citizens and businesses." [Online]. Available: http://europa.eu/rapid/press-release_MEMO-16-3009_en.htm.

"European Patient Forum, Patient empowerment campaign, 20-21 May 2015 'http://www.eu-patient.eu/campaign/PatientsprescribE/'

"European Telemedicine Market | Size | Share | Forecast (2017-2022)." [Online]. Available: https://www.mordorintelligence.com/industry-reports/european-telemedicine-market-industry.

"Facts about diabetes in Denmark." [Online]. Available: https://diabetes.dk/diabetesforeningen/in-english/facts-about-diabetes-in-denmark.aspx.

"Governance structures impact on eHealth," Health Policy and Technology, vol. 4, no. 1, pp. 39–46, Mar. 2015.

"Health at a Glance: Europe - Public Health - European Commission," Public Health. [Online]. Available: /health/state/glance_en.

"Home," vCare Project, 04-Jan-2017. [Online]. Available: https://vcare-project.eu/.

"How 5G technology enables the health internet of things." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:95LOIX7Z0d8J:https://www.brookings.edu/wp-content/uploads/2016/07/How-5G-tech-enables-health-iot-west.pdf+&cd=2&hl=en&ct=clnk&gl=dk.

"Human mobility powers wireless communication for disaster relief - The Financial Express." [Online]. Available: https://www.financialexpress.com/industry/technology/human-mobility-powers-wireless-communication-for-disaster-relief/764520/.

"Issue Brief: Medication Adherence and Health IT." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:ibgxffWrzEIJ:https://www.healthit.gov/sites/default/files/medicationadherence_and_hit_issue_brief.pdf+&cd=1&hl=en&ct=clnk&gl=dk.

"Legislative Framework for Telemedicine." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:Mm8eqBF8s-QJ:https://bib.irb.hr/datoteka/366826.Stapic_Vrcek_Hajdin_Legislative_Framework_for_Telemedicine.pdf+&cd=8&hl=en&ct=clnk&gl=dk.

"London hospital pilots Apple Watch for chemo patients," MobiHealthNews, 14-May-2015. [Online]. Available: http://www.mobihealthnews.com/43537/london-hospital-pilots-apple-watch-for-chemo-patients.

"Managing health information during disasters." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:oRlWPNpl1tMJ:https://pdfs.semanticscholar.org/b0f6/e94a0f15168d7d3f72310a3defb03fdda432.pdf+&cd=6&hl=en&ct=clnk&gl=dk.

"Ministry of Finance | Government of Pakistan |." [Online]. Available: http://www.finance.gov.pk/survey_1819.html.

"Municipalities and Regions - Tasks and Financing." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:mdkapqfm6WgJ:https://english.oim.dk/media/16477/municipalities-and-regions-tasks-and-financing-june-2014.pdf+&cd=1&hl=en&ct=clnk&gl=dk.

"NASA Demonstrates Tsunami Prediction System," NASA/JPL. [Online]. Available: http://www.jpl.nasa.gov/news/news.php?feature=2633.

"NATIONAL VISION 2016-2025." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:AXtjPcF7CD8J:https://www.unicef.org/pakistan/media/1276/file/National%2520Vision%25202016-2025.pdf+&cd=2&hl=en&ct=clnk&gl=dk.

"Overview of Natural Disasters and their Impacts in Asia and the Pacific, 1970 - 2014 | United Nations ESCAP." [Online]. Available: http://www.unescap.org/resources/overview-natural-disasters-and-their-impacts-asia-and-pacific-1970-2014.

"Pharmaceutical companies and digital health startups: It's time to get together," MobiHealthNews, 10-Feb-2017. [Online]. Available: http://www.mobihealthnews.com/content/pharmaceutical-companies-and-digital-health-startups-it%E2%80%99s-time-get-together.

"Phases of Disaster: Disaster Preparedness and Economic Recovery," Restore Your Economy.

"Planning for Future Disasters: Telemedicine as a Resource." [Online]. Available: https://reader.elsevier.com/reader/sd/548765331D1EF3A4BB608AF5E3F64B2B78732D29916F1E0255AB5482496C7A60D1F00CD99E4D73D6B3067B5A28ED14D4

"Public Private Partnership Programs:Best Practices." [Online]. Available: http://webcache.googleusercontent.com/search?q=cache:cdnLwN6tth4J:www.healthi

nsightforum.com/HI5%2520Presentations/pdf%2520day%25201/24Apr2015_Partnership%2520Programs%2520Across%2520Emerging%2520Markets_v4.pdf+&cd=8&hl=en&ct=clnk&gl=dk.

"Regions hit by natural disasters to get more support from EU - Consilium." [Online]. Available: http://www.consilium.europa.eu/en/press/press-releases/2017/06/26/eu-support-natural-dissasters/.

"Social dynamics," Wikipedia. 22-Aug-2018.

"Technical paper: Space Applications for Improving Disaster Management | United Nations ESCAP." [Online]. Available: http://www.unescap.org/resources/space-applications-improving-disaster-management.

"Telehealth in Emergency Preparedness and Response." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:jOXmtmgFfHUJ:https://www.healthcareready.org/system/cms/files/1571/files/original/HCR_Telehealth_Brief_SCREEN.pdf+&cd=2&hl=en&ct=clnk&gl=dk.

"The 10 Most Common Natural Disasters in the U.S.," TopTenReviews. [Online]. Available: http://www.toptenreviews.com/services/articles/the-10-most-common-natural-disasters-in-the-u.s./.

"The Ultimate Telemedicine Guide | What Is Telemedicine?," eVisit® Telemedicine Solution. [Online]. Available: https://evisit.com/what-is-telemedicine/.

"Towards a National eHealth/Telehealth Strategy for Pakistan:" [Online]. Available: http://webcache.googleusercontent.com/search?q=cache:HyYaZB6RzkkJ:www.lead.org.pk/lead/Publications/DP%252029-%2520Pakistan%25E2%2580%2599s%2520Experiences%2520in%2520Telehealth%2520The%2520Way%2520Forward%2520for%2520a%2520National%2520TeleheatheHealth%2520Programme.pdf+&cd=1&hl=en&ct=clnk&gl=dk.

"Understanding the Impact of Natural Disasters: Exposure to Direct Damages Across Countries." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:zLY1tJaxuq0J:https://www.eenews.net/assets/2016/11/30/document_cw_01.pdf+&cd=9&hl=en&ct=clnk&gl=dk.

"WHO | Definitions: emergencies," WHO. [Online]. Available: http://www.who.int/hac/about/definitions/en/.

"WHO | Disasters and emergencies," WHO. [Online]. Available: http://www.who.int/surgery/challenges/esc_disasters_emergencies/en/

"WHO | Global diffusion of eHealth: Making universal health coverage achievable," WHO. [Online]. Available: http://www.who.int/goe/publications/global_diffusion/en/.

"WHO | The global burden of disease: 2004 update," WHO. [Online]. Available: http://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/

10 things to know about Epic. (n.d.). Retrieved July 9, 2020, from https://www.beckershospitalreview.com/healthcare-information-technology/10-things-to-know-about-epic.html

5G Radio Access for Ultra-Reliable and Low-Latency Communications,? Ericsson Research Blog, 11-May-2015. .

5G Vision: 100 Billion Connections, 1 ms Latency, and 10 Gbps Throughput.? [Online]. Available: http://www.huawei.com/minisite/5g/en/defining-5g.html. [Accessed: 03- Jun-2016].

5G-PPP: 5G and e-Health.? .

A. Atreja, N. Bellam, and S. R. Levy, "Strategies to Enhance Patient Adherence: Making it Simple," MedGenMed, vol. 7, no. 1, p. 4, Mar. 2005.

A. Tedesco, D. Di Lieto, L. Angrisani, M. Campanile, M. De Falco, and A. Di Lieto? Telemedicine & Broadband, Intechopen, 16-Aug-2013. [Online]. Available: http://cdn.intechopen.com/pdfs/14281/InTech- Telemedicine_broadband.pdf. [Accessed: 03-Jun-2016].

Anonymous, "Overview," Public Health - European Commission, 25-Nov-2016. [Online]. Available: https://ec.europa.eu/health/state/summary_en.

Anwar, S., & Prasad, R. (2020). Connections of Chronic Diseases and Socio-dynamic Cues for Integrating ICT with Care Plan Adherence. Wireless Personal Communications. https://doi.org/10.1007/s11277-020-07299-x

Anwar, S., Prasad, R., & Chowdhry, B. S. (2020). Literacy and Socio-dynamics Cues Insights Decision Analytics for Care Plan Adherence. Wireless Personal Communications. https://doi.org/10.1007/s11277-020-07400-4

Apple Partners With Epic, Mayo on New Health App Platform. (n.d.). Retrieved July 9, 2020, from https://www.beckershospitalreview.com/healthcare-information-technology/apple-partners-with-epic-mayo-on-new-health-app-platform.html

B. J. Fogg, Persuasive Technology: Using Computers to Change What We Think and Do. Elsevier, 2003.

B. J. Wells, K. M. Chagin, A. S. Nowacki, and M. W. Kattan, "Strategies for Handling Missing Data in Electronic Health Record Derived Data," EGEMS (Wash DC), vol. 1, no. 3, Dec. 2013.

B. Skyrms, Social Dynamics. Oxford University Press, 2014.

Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers | Wiley. (n.d.). Wiley.Com. Retrieved July 9, 2020, from https://www.wiley.com/en-dk/Business+Model+Generation%3A+A+Handbook+for+Visionaries%2C+Game+Changers%2C+and+Challengers-p-9780470876411

C. Athanasopoulou et al., "Internet use, eHealth literacy and attitudes toward computer/internet among people with schizophrenia spectrum disorders: a cross-sectional study in two distant European regions," BMC Medical Informatics and Decision Making, vol. 17, p. 136, Sep. 2017.

C. C. Egeland, "Alle medarbejdere på Institut for Folkesundhedsvidenskab," 10-Mar-2008. [Online]. Available: http://forskning.ku.dk/search/?pure=da/publications/denmark-health-system-review(91e7dcc5-f651-4573-a303-ee464eb1290b)/export.html.

C. D. July 31 and 2017Features, "5 industries to gain the most from 5G," IT Pro Portal. [Online]. Available: https://www.itproportal.com/features/5-industries-to-gain-the-most-from-5g/.

C. D. Norman and H. A. Skinner, "eHealth Literacy: Essential Skills for Consumer Health in a Networked World," J Med Internet Res, vol. 8, no. 2, Jun. 2006.

C. Llor et al., "A study of adherence to antibiotic treatment in ambulatory respiratory infections," International Journal of Infectious Diseases, vol. 17, no. 3, pp. e168–e172, Mar. 2013.

C. Rick and P. B. Kritek, Realizing the Future of Nursing: VA Nurses Tell Their Story. Government Printing Office, 2015.

C. Sortsø, A. Green, P. B. Jensen, and M. Emneus, “Societal costs of diabetes mellitus in Denmark,” Diabet. Med., vol. 33, no. 7, pp. 877–885, Jul. 2016.

Choi-Fitzpatrick et al., “Up in the Air: A Global Estimate of Non-Violent Drone Use 2009-2015,” p. 45.

D. Hoy, “Risk Factors for Chronic Disease in Viet Nam: A Review of the Literature,” Prev Chronic Dis, vol. 10, 2013

D. Kellenberg and A. M. Mobarak, “The Economics of Natural Disasters,” Annual Review of Resource Economics, vol. 3, no. 1, pp. 297–312, Oct. 2011.

D. Lake et al., “Internet of Things: Architectural Framework for eHealth Security,” Journal of ICT Standardization, vol. 1, no. 3, pp. 301–328, 2014.

D. S. Kayange, ?Telemedicine Available Bandwidth Estimation Simulation Model for Effective E-Health Services: Categories, Requirements and Network Application,? Acad. Res. Int., vol. 5, no. 5, pp. 11?20, Sep. 2014.

Dongseo University, N. Thiranant, H. Lee, and Dongseo University, “A Design of Security Framework for eHealth Authentication System using QR Code,” 2013, pp. 32–35.

E. B. G.-D. A. Pirvu and R. Snyder, “E.U. way ahead of the game on telehealth | Lexology.” [Online]. Available: https://www.lexology.com/library/detail.aspx?g=e1259fba-9e68-4751-9450-9dfea92d7df6.

E. Meyer, The Culture Map (INTL ED): Decoding How People Think, Lead, and Get Things Done Across Cultures. Hachette UK, 2016.

EHRIntelligence. (2017, May 16). Epic EHR Interoperability at Center of New Partnership. EHRIntelligence. https://ehrintelligence.com/news/epic-ehr-interoperability-at-center-of-new-partnership

Epic decoded: An inside look at life and corporate culture at the center of the health IT world. (n.d.). Retrieved July 9, 2020, from https://www.beckershospitalreview.com/healthcare-information-technology/epic-decoded-an-inside-look-at-life-and-corporate-culture-at-the-center-of-the-health-it-world.html

EPIC Software Corporation. (n.d.). Retrieved July 9, 2020, from http://www.epic-soft.com/epic-hrms.php

Epic Systems. (2016, August 22). Cleverism. https://www.cleverism.com/company/epic-systems/

European Telemedicine Market | Size | Share | Forecast (2017-2022).” [Online]. Available: https://www.mordorintelligence.com/industry-reports/european-telemedicine-market-industry.

F. Chiti, R. Fantacci, L. Maccari, D. Marabissi, and D. Tarchi, “A broadband wireless communications system for emergency management,” IEEE Wireless Communications, vol. 15, no. 3, pp. 8–14, Jun. 2008.

F. Falcini and G. Rinaldi, “Medical Records, eHealth and Health IT: What Are the Key Points for the Organizational Benefits and for the Improvements of the Modern Local Health Organisations?,” in New Perspectives in Medical Records, Springer, Cham, 2017, pp. 129–140.

G. C. Doolittle and R. J. Spaulding, “Defining the needs of a telemedicine service,” J Telemed Telecare, vol. 12, no. 6, pp. 276–284, 2006.

H. K. Koh et al., “New Federal Policy Initiatives To Boost Health Literacy Can Help The Nation Move Beyond The Cycle Of Costly ‘Crisis Care,’” Health Affairs, vol. 31, no. 2, pp. 434–443, Feb. 2012.

History of Epic Systems Corporation – FundingUniverse. (n.d.). Retrieved July 9, 2020, from http://www.fundinguniverse.com/company-histories/epic-systems-corporation-history/http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2006:146:0001:0003:EN:PDFhttp://pages/hit-consultant-llc/302199219847409. (2012, May 20).

I. U. Din, M. C. Xue, Abdullah, S. Ali, T. Shah, and A. Ilyas, “Role of information & communication technology (ICT) and e-governance in health sector of Pakistan: A case study of Peshawar,” Cogent Social Sciences, vol. 3, no. 1, p. 1308051, Jan. 2017.

J. Bernard and J. D. Linkous, ?Core Operational Guidelines for Telehealth Services Involving Provider-Patient Interactions.? [Online]. Available:

http://www.americantelemed.org/docs/default- source/standards/core-operational-guidelines-for-telehealth- services.pdf?sfvrsn=6. [Accessed: 03-Jun-2016].

J. A. Kim, “Telehealth in the Developing World,” Healthc Inform Res, vol. 16, no. 2, pp. 140–141, Jun. 2010

J. A. Zubairi and S. Idwan, “Smart algorithms for patient assignment in disasters,” ICT Express, Jun. 2017.

J. Best, ?The race to 5G: Inside the fight for the future of mobile as we know it,? TechRepublic. [Online]. Available: http://www.techrepublic.com/article/does-the-world-really-need-5g/. [Accessed: 03-Jun-2016].

J. E. W. C. van Gemert-Pijnen et al., “A holistic framework to improve the uptake and impact of eHealth technologies,” J. Med. Internet Res., vol. 13, no. 4, p. e111, Dec. 2011.

J. H. CNN, “In the future, drones could save your life,” CNN. [Online]. Available: https://www.cnn.com/2017/10/09/health/ambulance-drone-teching-care-of-your-health/index.html.

Jensen, S. M. (n.d.). Learnings from the implementation of Epic Benefits , issues , causes and recommendations.

Jr, H. M. K. (2015). Becoming the Best: Build a World-Class Organization Through Values-Based Leadership. John Wiley & Sons.

K. Khosla, “The Best MedTech Startups in Europe.” [Online]. Available: https://www.valuer.ai/blog/the-best-medtech-startups-in-europe. [Accessed: 20-Apr-2020].

K. Kvarnström, M. Airaksinen, and H. Liira, “Barriers and facilitators to medication adherence: a qualitative study with general practitioners,” BMJ Open, vol. 8, no. 1, p. e015332, Jan. 2018.

L. Skär and S. Söderberg, “The importance of ethical aspects when implementing eHealth services in healthcare: A discussion paper,” J Adv Nurs, vol. 74, no. 5, pp. 1043–1050, May 2018.

Lala M. Purnima, Kumar, Ambuj, “Heterodox Networks An Innovative and Alternate Approach to Future Wireless Communication, Role of ICT for Multi-disciplinary Applications in 2030. Vol. 47. River Publishers, 2016.

Ligthart, Leo P., and Ramjee Prasad, eds. Communications, Navigation, Sensing and Services (CONASENSE). River Publishers, 2013.

Lindgren, Peter, et al. "Open business model innovation in healthcare sector." Journal of Multi Business Model Innovation and Technology 1.1 (2012): 23-52.

Lost in translation: Epic goes to Denmark—POLITICOBack ButtonSearch IconFilter IconArrow. (n.d.). Retrieved July 8, 2020, from https://www.politico.com/story/2019/06/06/epic-denmark-health-1510223

M. Erdelj, E. Natalizio, K. R. Chowdhury, and I. F. Akyildiz, “Help from the Sky: Leveraging UAVs for Disaster Management,” IEEE Pervasive Computing, vol. 16, no. 1, pp. 24–32, Jan. 2017.

M. Hertzum and G. Ellingsen, “The implementation of an electronic health record: Comparing preparations for Epic in Norway with experiences from the UK and Denmark,” International Journal of Medical Informatics, vol. 129, pp. 312–317, Sep. 2019, doi: 10.1016/j.ijmedinf.2019.06.026.

M. Olejaz, A. Juul Nielsen, A. Rudkjøbing, H. Okkels Birk, A. Krasnik, and C. Hernández-Quevedo, “Denmark health system review,” Health Syst Transit, vol. 14, no. 2, pp. i–xxii, 1–192, 2012.

M. R. Vicente and G. Madden, “Assessing eHealth skills across Europeans,” Health Policy and Technology, vol. 6, no. 2, pp. 161–168, Jun. 2017.

M. Raza, M. H. Le, N. Aslam, C. H. Le, N. T. Le, and T. L. Le, “Telehealth Technology: Potentials, Challenges and Research Directions for Developing Countries,” in 6th International Conference on the Development of Biomedical Engineering in Vietnam (BME6), 2017, pp. 523–528.

M. Ullah, M. Fiedler, and K. Wac, “On the ambiguity of Quality of Service and Quality of Experience requirements for eHealth services,” 2012, pp. 1–4.

M. ur Rahman, S. Rahman, S. Mansoor, V. Deep, and M. Aashkaar, “Implementation of ICT and Wireless Sensor Networks for Earthquake Alert and Disaster Management in Earthquake Prone Areas,” Procedia Computer Science, vol. 85, pp. 92–99, Jan. 2016.

Mobile devices in healthcare come with pros and cons,? SearchHealthIT. [Online]. Available: http://searchhealthit.techtarget.com/tip/Mobile- devices-in-healthcare-come-with-pros-and-cons. [Accessed: 03-Jun- 2016].

N. Halwas, L. Griebel, and J. Huebner, “eHealth literacy, Internet and eHealth service usage: a survey among cancer patients and their relatives,” J. Cancer Res. Clin. Oncol., vol. 143, no. 11, pp. 2291–2299, Nov. 2017

N. Jafari, A. Shahsanai, M. Memarzadeh, and A. Loghmani, “Prevention of communicable diseases after disaster: A review,” J Res Med Sci, vol. 16, no. 7, pp. 956–962, Jul. 2011.

N.-C. Chi, O. Sparks, S.-Y. Lin, A. Lazar, H. J. Thompson, and G. Demiris, “Pilot testing a digital pet avatar for older adults,” Geriatr. Nurs. N. Y. N, May 2017.

O. Khazan, “A Drone to Save the World,” The Atlantic, 04-Apr-2016.

P. Lindgren (2016) “The Business Model Ecosystem” Journal of Multi Business Model Innovation and Technology River Publishers

P. Tropea *et al.*, “Rehabilitation, the Great Absentee of Virtual Coaching in Medical Care: Scoping Review,” *J Med Internet Res*, vol. 21, no. 10, Oct. 2019, doi: 10.2196/12805.

Partners Healthcare Considers Epic Systems for EHR. https://hitconsultant.net/2012/05/20/partners-healthcare-considers-epic-systems-for-integrated-statewide-system/

Peter, L. (2018). The Multi Business Model Innovation Approach. River Publishers.

Policy - European Commission.? [Online]. Available: http://ec.europa.eu/health/ageing/policy/index_en.htm. [Accessed: 03- Jun-2016].

R. Finkel (PharmD.), M. A. Clark, and L. X. Cubeddu, Pharmacology. Lippincott Williams & Wilkins, 2009.

R. J. Cipolle, L. Strand, and P. Morley, Pharmaceutical Care Practice: The Patient-Centered Approach to Medication Management, Third Edition. McGraw Hill Professional, 2012.

R. Lawler, “Therapy-By-Text Startup Talkspace Raises $9.5M Led By Spark Capital,” TechCrunch. .

R. Walker, Clinical Pharmacy and Therapeutics E-Book. Elsevier Health Sciences, 2011

S. Ajami and P. Lamoochi, “Use of telemedicine in disaster and remote places,” J Educ Health Promot, vol. 3, May 2014.

S. AlDossary, M. G. Martin-Khan, N. K. Bradford, N. R. Armfield, and A. C. Smith, “The Development of a Telemedicine Planning Framework Based on Needs Assessment,” J Med Syst, vol. 41, no. 5, p. 74, May 2017.

S. Al-Lawati, “A report on patient non-adherence in Ireland.,” Pfizer Healthcare Ireland; Irish Pharmacy Union; Irish Patients’ Association, Dublin, Report, Mar. 2014.

S. Anwar and R. Prasad, “Framework for Future Telemedicine Planning and Infrastructure using 5G Technology,” Wireless Pers Commun, vol. 100, no. 1, pp. 193–208, May 2018.

S. Anwar, “5G and Telemedicine: A Business Ecosystem Relationship within CONASENSE Paradigm,” Conasense Book, pp. 41–57, 2018.

S. Anwar, “5G, an approach towards future telemedicine,” 2016.National Danish Database, River Publisher

S. Anwar, “Smart Pharma: Towards Efficient Healthcare Ecosystem,” Lecture Notes of the Institute for Computer Sciences, Social-informatics and Telecommunications Engineering, 2017.

S. Chen, A. Cheng, and K. Mehta, A Review of Telemedicine Business Models, vol. 19. 2013.

S. Chung, B. K. Park, and E.-S. Nahm, “The Korean eHealth Literacy Scale (K-eHEALS): Reliability and Validity Testing in Younger Adults Recruited Online,” Journal of Medical Internet Research, vol. 20, no. 4, p. e138, 2018.

S. Emery, Telemedicine in Hospitals: Issues in Implementation. Routledge, 2015.

S. L. Kota, K. Pahlavan, and P. A. Lepp,,nen, Broadband Satellite Communications for Internet Access. Springer Science & Business Media, 2011.

S. Latif, J. Qadir, S. Farooq, and M. A. Imran, “How 5G (and concomitant technologies) will revolutionize healthcare,” arXiv:1708.08746 [cs], Aug. 2017.

S. Yan, S. Zhang, Y. Tong, X. Yin, Z. Lu, and Y. Gong, “Nonadherence to Antituberculosis Medications: The Impact of Stigma and Depressive Symptoms,” The American Journal of Tropical Medicine and Hygiene, vol. 98, no. 1, pp. 262–265, Jan. 2018.

Sawesi, S., Rashrash, M., Phalakornkule, K., Carpenter, J. S., & Jones, J. F. (2016). The Impact of Information Technology on Patient Engagement and Health Behavior Change: A Systematic Review of the Literature. JMIR Medical Informatics, 4(1), e1. https://doi.org/10.2196/medinform.4514

Singh, K., Kumar, A., Anwar, S., & Gupta, S. N. (2019). Technology oriented value propositions for Bluetown Case. 2019 22nd International Symposium on Wireless Personal Multimedia Communications (WPMC), 1–5. https://doi.org/10.1109/WPMC48795.2019.9096206

Skyrms, B. (2014). Social Dynamics. Oxford University Press.

Social dynamics. (2020). In Wikipedia. https://en.wikipedia.org/w/index.php?title=Social_dynamics&oldid=964929325

T. I. Pathirana and C. A. Jackson, “Socioeconomic status and multimorbidity: a systematic review and meta-analysis,” Australian and New Zealand Journal of Public Health, vol. 42, no. 2, pp. 186–194, 2018.

T. Kaltenbach, “The impact of E-health on the pharmaceutical industry,” International Journal of Healthcare Management, vol. 7, no. 4, pp. 223–225, Oct.2014.

Thies, K., Anderson, D., & Cramer, B. (2017). Lack of Adoption of a Mobile App to Support Patient Self-Management of Diabetes and Hypertension in a Federally Qualified Health Center: Interview Analysis of Staff and Patients in a Failed Randomized Trial. JMIR Human Factors, 4(4), e24. https://doi.org/10.2196/humanfactors.7709trinoma,

U. D. H. S. Marketing Public Affairs and, “Telemedicine Saves Patients Time, Money.” [Online]. Available: https://www.ucdmc.ucdavis.edu/publish/news/newsroom/11887.

V. Oleshchuk and R. Fensli, ?Remote Patient Monitoring Within a Future 5G Infrastructure,? Wirel. Pers. Commun., vol. 57, no. 3, pp. 431?439, Jul. 2010.

W. H. Organization (WHO), “Health Literacy. The Solid Facts,” 01-Jul-2013. [Online]. Available:http://publichealthwell.ie/search-results/health-literacy-solid-facts?&content=resource&member=572160&catalogue=none&collection=none&tokens complete=true

W. Xiang, G. Wang, M. Pickering, and Y. Zhang, “Big video data for light-field-based 3D telemedicine,” IEEE Network, vol. 30, no. 3, pp. 30–38, May 2016.

W. Xiong, A. Bair, C. Sandrock, S. Wang, J. Siddiqui, and N. Hupert, “Implementing Telemedicine in Medical Emergency Response: Concept of Operation for a Regional Telemedicine Hub,” J Med Syst, vol. 36, no. 3, pp. 1651–1660, Jun. 2012.

Wang, Yapeng, and Ramjee Prasad. "Network Neutrality for CONASENSE Innovation Era." Role of Ict for Multi-disciplinary Applications in 2030. River Publishers, 2016. 167-184.

What is Epic Systems? - Definition from WhatIs.com. (n.d.). SearchHealthIT. Retrieved July 9, 2020, from https://searchhealthit.techtarget.com/definition/Epic-Systems-Corp

What is the minimum amount of bandwidth required for a video call? Do you have high resolutionvideo? [Online].Available: http://support.oovoo.com/link/portal/3908/4244/Article/1503/What-is- the-minimum-amount-of-bandwidth-required-for-a-video-call-Do-you- have-high-resolution-video. [Accessed: 03-Jun-2016].

X. Zhang, P. Yu, J. Yan, and I. Ton A M Spil, “Using diffusion of innovation theory to understand the factors impacting patient acceptance and use of consumer e-health innovations: a case study in a primary care clinic,” BMC Health Serv Res, vol. 15, p. 71, Feb. 2015.

Y. Smith, ?A Brief History of NASA?s Contributions to Telemedicine,? NASA, 16-Aug-2013. [Online]. Available: http://www.nasa.gov/content/a-brief-history-of-nasa-s-contributions-to- telemedicine. [Accessed: 03-Jun-2016].

Y.1541ÿ:ÿNetwork performance objectives for IP-based services.? [Online]. Available: https://www.itu.int/rec/T-REC-Y.1541-201112- I/en. [Accessed: 03-Jun-2016].

7. APPENDIX

The following section presents the published and accepted research peer-reviewed articles.

7.1 Peer-reviewed Published Research Papers (attached at the bottom)

The following subsection introduces the peer-reviewed published eight research articles presented in the dissertation.

7.1.1 Framework for Future Telemedicine Planning and Infrastructure using 5G Technology.

7.1.2 Literacy and Socio-dynamics Cues Insights Decision Analytics for Care Plan Adherence.

7.1.3 Technology-oriented home-based rehabilitation for supporting medication adherence.

7.1.4 Connections of Chronic Diseases and Socio-dynamic Cues for Integrating ICT with Care Plan Adherence.

7.1.5 Collaborative Strategies and Socio-dynamic cues (SDC) Insights for Assistive Healthcare Technology Applications.

7.1.6 5G, an approach towards future telemedicine.

7.1.7 5G and Telemedicine: A Business Ecosystem Relationship within CONASENSE Paradigm.

7.1.8 A Telemedicine Platform for Disaster Management and Emergency Care.

7.2 Co-authors statements

The following subsection introduces the co-author statements for the peer-reviewed published eight research articles presented in the dissertation.

7.2.1 Co-Author Statement 1: Framework for Future Telemedicine Planning and Infrastructure using 5G Technology.

AARHUS BSS SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Declaration of co-authorship*

Full name of the PhD student: Sadia Anwar

This declaration concerns the following article/manuscript:

Title:	Framework for Future Telemedicine Planning and Infrastructure using 5G Technology
Authors:	Sadia Anwar, Ramjee Prasad

The article/manuscript is: Published

If published, state full reference: S. Anwar and R. Prasad, "Framework for Future Telemedicine Planning and Infrastructure using 5G Technology," Wireless Pers Commun, vol. 100, no. 1, pp. 193–208, May 2018, doi: 10.1007/s11277-018-5622-8.

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

Sadia Anwar has contributed to the elements of this article/manuscript as follows:

A. Has essentially done all the work
B. Major contribution
C. Equal contribution
D. Minor contribution
E. Not relevant

Element	Extent (A-E)
1. Formulation/identification of the scientific problem	B
2. Planning of the experiments/methodology design and development	A
3. Involvement in the experimental work/clinical studies/data collection	A
4. Interpretation of the results	B
5. Writing of the first draft of the manuscript	A
6. Finalization of the manuscript and submission	A

Signatures of the co-authors

Date	Name	Signature
31-08-2020	Ramjee Prasad	

In case of further co-authors please attach appendix

Date: 31-08-2020

Sadia Anwar

Signature of the PhD student

*As per policy the co-author statement will be published with the dissertation.

7.2.2 Co-Author Statement 2: Literacy and Socio-dynamics Cues Insights Decision Analytics for Care Plan Adherence.

AARHUS BSS SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Declaration of co-authorship*

Full name of the PhD student: Sadia Anwar

This declaration concerns the following article/manuscript:

Title:	Literacy and socio-dynamics cues insights decision analytics for care plan adherence
Authors:	Sadia Anwar, Ramjee Prasad, Bhawani S. Chowdhry

The article/manuscript is: Published

If published, state full reference: S. Anwar, R. Prasad, and B. S. Chowdhry, "Literacy and Socio-dynamics Cues Insights Decision Analytics for Care Plan Adherence," Wireless Pers Commun, vol. 113, no. 3, pp. 1597–1613, Aug. 2020, doi: 10.1007/s11277-020-07400-4.

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

Sadia Anwar has contributed to the elements of this article/manuscript as follows:

A. Has essentially done all the work
B. Major contribution
C. Equal contribution
D. Minor contribution
E. Not relevant

Element	Extent (A-E)
1. Formulation/identification of the scientific problem	B
2. Planning of the experiments/methodology design and development	B
3. Involvement in the experimental work/clinical studies/data collection	A
4. Interpretation of the results	B
5. Writing of the first draft of the manuscript	A
6. Finalization of the manuscript and submission	A

Signatures of the co-authors

Date	Name	Signature
31-08-2020	Ramjee Prasad	
31-08-2020	Bhawani S. Chowdhry	

In case of further co-authors please attach appendix

Date: 31-08-2020

Sadia Anwar

Signature of the PhD student

*As per policy the co-author statement will be published with the dissertation.

7.2.3 Co-Author Statement 3: Technology-oriented home-based rehabilitation for supporting medication adherence.

AARHUS BSS SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Declaration of co-authorship*

Full name of the PhD student: Sadia Anwar

This declaration concerns the following article/manuscript:

Title:	Technology-oriented home-based rehabilitation for supporting medication adherence
Authors:	Sadia Anwar, Ambuj Kumar, Ramjee Prasad

The article/manuscript is: Published

If published, state full reference: S. Anwar, A. Kumar, and R. Prasad, "Technology-oriented home-based rehabilitation for supporting medication adherence," in 2018 21st International Symposium on Wireless Personal Multimedia Communications (WPMC), Nov. 2018, pp. 525–529, doi: 10.1109/WPMC.2018.8712931.

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

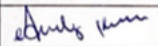
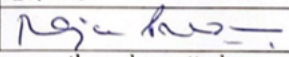
No ☒ Yes ☐ If yes, give details:

Sadia Anwar has contributed to the elements of this article/manuscript as follows:

A. Has essentially done all the work
B. Major contribution
C. Equal contribution
D. Minor contribution
E. Not relevant

Element	Extent (A-E)
1. Formulation/identification of the scientific problem	B
2. Planning of the experiments/methodology design and development	A
3. Involvement in the experimental work/clinical studies/data collection	B
4. Interpretation of the results	B
5. Writing of the first draft of the manuscript	A
6. Finalization of the manuscript and submission	B

Signatures of the co-authors

Date	Name	Signature
31-08-2020	Ambuj Kumar	
31-08-2020	Ramjee Prasad	

In case of further co-authors please attach appendix

Date: 31-08-2020

Sadia Anwar

Signature of the PhD student

*As per policy the co-author statement will be published with the dissertation.

7.2.4 Co-Author Statement 4: Connections of Chronic Diseases and Socio-dynamic Cues for Integrating ICT with Care Plan Adherence.

AARHUS BSS SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Declaration of co-authorship*

Full name of the PhD student: Sadia Anwar

This declaration concerns the following article/manuscript:

Title:	Connections of Chronic Diseases and Socio-dynamic cues for Integrating ICT with Care Plan Adherence
Authors:	Sadia Anwar, Ramjee Prasad

The article/manuscript is: Published

If published, state full reference: S. Anwar and R. Prasad, "Connections of Chronic Diseases and Socio-dynamic Cues for Integrating ICT with Care Plan Adherence," Wireless Pers Commun, vol. 113, no. 3, pp. 1567–1578, Aug. 2020, doi: 10.1007/s11277-020-07299-x.

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

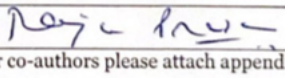
No ☒ Yes ☐ If yes, give details:

Sadia Anwar has contributed to the elements of this article/manuscript as follows:

A. Has essentially done all the work
B. Major contribution
C. Equal contribution
D. Minor contribution
E. Not relevant

Element	Extent (A-E)
1. Formulation/identification of the scientific problem	A
2. Planning of the experiments/methodology design and development	B
3. Involvement in the experimental work/clinical studies/data collection	A
4. Interpretation of the results	B
5. Writing of the first draft of the manuscript	A
6. Finalization of the manuscript and submission	B

Signatures of the co-authors

Date	Name	Signature
31-08-2020	Ramjee Prasad	

In case of further co-authors please attach appendix

Date: 31-08-2020

Sadia Anwar

Signature of the PhD student

*As per policy the co-author statement will be published with the dissertation.

7.2.5 Co-Author Statement 5: Collaborative Strategies and Socio-dynamic cues (SDC) Insights for Assistive Healthcare Technology Applications.

AARHUS BSS SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Declaration of co-authorship*

Full name of the PhD student: Sadia Anwar

This declaration concerns the following article/manuscript:

Title:	Collaborative strategies and Socio-dynamic cues (SDC) insights for assistive healthcare technology applications
Authors:	Sadia Anwar, Peter Lindgren, Ramjee Prasad

The article/manuscript is: Published

If published, state full reference: S. Anwar, P. Lindgren, and R. Prasad, "Collaborative Strategies and Socio-dynamic cues (SDC) Insights for Assistive Healthcare Technology Applications," Journal of Mobile Multimedia, pp. 205-224-205–224, Feb. 2021, doi: 10.13052/jmm1550-4646.171311.

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

Sadia Anwar has contributed to the elements of this article/manuscript as follows:

A. Has essentially done all the work
B. Major contribution
C. Equal contribution
D. Minor contribution
E. Not relevant

Element	Extent (A-E)
1. Formulation/identification of the scientific problem	B
2. Planning of the experiments/methodology design and development	A
3. Involvement in the experimental work/clinical studies/data collection	A
4. Interpretation of the results	A
5. Writing of the first draft of the manuscript	A
6. Finalization of the manuscript and submission	B

Signatures of the co-authors

Date	Name	Signature
30-04-2021	Peter Lindgren	
30-04-2021	Ramjee Prasad	

In case of further co-authors please attach appendix

Date: 30-04-2021

Sadia Anwar
Signature of the PhD student

*As per policy the co-author statement will be published with the dissertation.

7.2.6 Co-Author Statement 6: 5G, an approach towards future telemedicine.

AARHUS BSS SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Declaration of co-authorship*

Full name of the PhD student: Sadia Anwar

This declaration concerns the following article/manuscript:

Title:	5G, an approach towards future telemedicine
Authors:	Sadia Anwar, Ambuj Kumar, Ramjee Prasad, Bhawani S. Chowdhry

The article/manuscript is: Published

If published, state full reference: S. Anwar, "5G, an approach towards future telemedicine," Proceedings of the Global WirelessSummit2016,2016.
https://www.riverpublishers.com/book_details.php?book_id=462

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

Sadia Anwar has contributed to the elements of this article/manuscript as follows:

A. Has essentially done all the work
B. Major contribution
C. Equal contribution
D. Minor contribution
E. Not relevant

Element	Extent (A-E)
1. Formulation/identification of the scientific problem	B
2. Planning of the experiments/methodology design and development	A
3. Involvement in the experimental work/clinical studies/data collection	A
4. Interpretation of the results	B
5. Writing of the first draft of the manuscript	A
6. Finalization of the manuscript and submission	C

Signatures of the co-authors

Date	Name	Signature
31-08-2020	Ambuj Kumar	
31-08-2020	Ramjee Prasad	
31-08-2020	Bhawani S. Chowdhry	

In case of further co-authors please attach appendix

Date: 31-08-2020

Sadia Anwar

Signature of the PhD student

*As per policy the co-author statement will be published with the dissertation.

7.2.7 Co-Author Statement 7: 5G and Telemedicine: A Business Ecosystem Relationship within CONASENSE Paradigm.

AARHUS BSS SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Declaration of co-authorship*

Full name of the PhD student: Sadia Anwar

This declaration concerns the following article/manuscript:

Title:	5G and Telemedicine: A Business Ecosystem Relationship within CONASENSE Paradigm
Authors:	Ambuj Kumar, Sadia Anwar, Ramjee Prasad

The article/manuscript is: Published

If published, state full reference: R. Prasad and L. P. Ligthart, Towards Future Technologies for Business Ecosystem Innovation. River Publishers, 2018. Link: https://books.google.dk/books?id=xDFuDwAAQBAJ&lpg=PA41&dq=5G%20and%20Telemedicine%3A%20A%20Business%20Ecosystem%20Relationship%20within%20CONASENSE%20Paradigm&pg=PA41#v=onepage&q=5G%20and%20Telemedicine:%20A%20Business%20Ecosystem%20Relatio&f=false

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

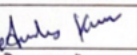
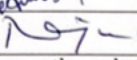
No ☒ Yes ☐ If yes, give details:

Sadia Anwar has contributed to the elements of this article/manuscript as follows:

A. Has essentially done all the work
B. Major contribution
C. Equal contribution
D. Minor contribution
E. Not relevant

Element	Extent (A-E)
1. Formulation/identification of the scientific problem	B
2. Planning of the experiments/methodology design and development	A
3. Involvement in the experimental work/clinical studies/data collection	A
4. Interpretation of the results	B
5. Writing of the first draft of the manuscript	A
6. Finalization of the manuscript and submission	C

Signatures of the co-authors

Date	Name	Signature
31-08-2020	Ambuj Kumar	
31-08-2020	Ramjee Prasad	

In case of further co-authors please attach appendix

Date: 31-08-2020

Sadia Anwar

Signature of the PhD student

*As per policy the co-author statement will be published with the dissertation.

7.2.8 Co-Author Statement 8: A Telemedicine Platform for Disaster Management and Emergency Care.

AARHUS BSS SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Declaration of co-authorship*

Full name of the PhD student: Sadia Anwar

This declaration concerns the following article/manuscript:

Title:	A Telemedicine Platform for Disaster Management and Emergency Care
Authors:	Sadia Anwar, Ramjee Prasad, Bhawani Shankar Chowdhary, M.R. Anjum

The article/manuscript is: Published

If published, state full reference: S. Anwar, R. Prasad, B. S. Chowdhary, and M. R. Anjum, "A Telemedicine Platform for Disaster Management and Emergency Care," Wireless Pers Commun, vol. 106, no. 1, pp. 191–204, May 2019, doi: 10.1007/s11277-019-06273-6.

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

Sadia Anwar has contributed to the elements of this article/manuscript as follows:

A. Has essentially done all the work
B. Major contribution
C. Equal contribution
D. Minor contribution
E. Not relevant

Element	Extent (A-E)
1. Formulation/identification of the scientific problem	B
2. Planning of the experiments/methodology design and development	A
3. Involvement in the experimental work/clinical studies/data collection	A
4. Interpretation of the results	B
5. Writing of the first draft of the manuscript	A
6. Finalization of the manuscript and submission	C

Signatures of the co-authors

Date	Name	Signature
31-08-2020	Ramjee Prasad	
31-08-2020	Bhawani Shankar Chowdhary	
31-08-2020	M.R. Anjum	

In case of further co-authors please attach appendix

Date: 31-08-2020

Sadia Anwar

Signature of the PhD student

*As per policy the co-author statement will be published with the dissertation.

Wireless Pers Commun (2018) 100:193–208
https://doi.org/10.1007/s11277-018-5622-8

Framework for Future Telemedicine Planning and Infrastructure using 5G Technology

Sadia Anwar[1] · **Ramjee Prasad**[1]

Published online: 13 March 2018

Abstract Current and upcoming Information and Communication Technology solutions for quick access to the healthcare system are promising as well as very challenging. On the one hand, these solutions are providing solutions for healthcare ecosystem according to patient-specific needs and demands, but on the other hand, adoption of technology is moving through evolution and some part revolution. In consequence of continuous transition, people are not getting used to of these endless variations in technological solutions, and they have concerns that these deployed technologies will change after some period. Seeing this situation, we recommend continuous eHealth literacy is need of this transition era and development of new business models to increase involvement, motivation and revenue generation. People from medical and technical background have a different attitude for work, which can cause difficulty in solving medical related problems and adaptation of new technologies. Therefore, it is essential to involve medical experts when developing telemedicine service from technological point of view. Consequently, we recommend that there is a need to sketch a framework and plan before introducing any telemedicine service. The telemedicine services should be user- friendly and have the ability to integrate all stakeholders to pursue a system which is sustainable and acceptable for all. A framework which is proactive, open in various dimensions with flexibility, gives chances to industries for public–private partnership and practice value-based business models.

Keywords Telemedicine · eHealth ecosystem · eHealth literacy · 5G · Framework · Planning · Sustainable business models

✉ Sadia Anwar
sadia@btech.au.dk

Ramjee Prasad
ramjee@btech.au.dk

[1] Department of Business Development and Technology, Aarhus University, Herning, Denmark

1 Introduction

With the use of ICT solutions, such as future wireless communication technologies (5G) and Big Data analytics, healthcare sector can be more efficient and improvised. The efficiency can be achieved both economically by an introduction of technology-based business models and qualitatively through reliable communication technologies. The success of a health care system can base on three fundamental pillars of technologies. (a) Communication technology (b) Big data analytics (c) Health Care: Medical and Medicines. That is why a cross-disciplinary approach is a prerequisite for future telemedicine services.

It is essential to understand what are the needs of a healthcare ecosystem concerning ICT solutions. What kind of telemedicine services we can integrate by using 5G technology. Standards for telemedicine are still in early stage, and available security frameworks are not enough for telemedicine services before we see any promising features of the 5G technology. Health-care is a vast area itself. There has not been much research done to conclude what parts of healthcare sector needs or can work more efficiently by using 5G and Big Data.

Framework importance for telemedicine services arises due to three factors; one is the economic factor as health services are in general costly, second is the availability of some specialized services internationally, the third element is the availability of specialized services to remote areas within a particular country, less involvement of the stakeholders and industries. It is important to recognize that how we can meet these demands of accessibility by introducing a basic framework or sketch to identify and provide possible solutions.

Coming innovative technologies requires understanding and acceptance at first place that these are going to revolutionize our healthcare system. Transitional phase means that technology is still emerging and causing less engagement and understanding for the people where it is going to be deployed. These people feel pressure or burden in understanding as technology is not their primary field or area. What is important here is to make a plan or use a bottom-up approach which means to consider the deficient areas of eHealth sector rather than to integrate new technologies with newly formed telemedicine services. Before introducing any service, planning with a basic understanding, assessment regarding cost and affordability, associated deficiencies or defects and benefits are essential parts to be considered to avoid future anomalies [1].

This paper discusses what could be the realistic planning for future infrastructure of telemedicine and 5G technology. This article has nine sections. Planning of a telemedicine service and many frameworks have been discussed considering problematic areas and future possibilities with a proposed telemedicine framework and lastly conclusions.

2 Planning of Services Considering Supply and Demand

Supply and demand for telemedicine services are one of the most significant challenges especially in the areas where access to hospitals is limited. Current practices and ongoing research are still in the line of progression. There are still not good solutions available to fill the gap between supply and demand. Strategic plans are needed as telemedicine integrate two professions, e.g., medical and technical areas. There is a need to understand

what are the clinical requirements and how latest technologies more practically provide solutions to the problems related to supply and demand.

2.1 Data Analysis

Qualitative and quantitative data of a particular area can be collected to see what kind of patients are existing with needs. Susceptibility to diseases and treatment satisfaction based questionnaires can help to formulate what kind of telemedicine services are needed. We cannot use one telemedicine service universally as different areas of the countries may have different conditions and disabilities related to environmental factors and genetic susceptibility. Before supply of any telemedicine service, there is a need to consider the first disease affected people, and their collected data can be beneficial after that there is a need to search for non-clinical care providers like politicians, the ministry of health, medical team and related stakeholders. Before making a plan, all constraints should be considered [2]. UC medicine school in California has conducted a study on March 21, 2017, regarding the use of video conference with patients and physicians and they have checked their data for the last 18 years. It showed that treated patients saved 9 years of travel time and US dollar three million traveling expenses [3]. Access to high-quality video conference using 5G will give a considerable edge compare to the existing wireless technologies.

Many variables for supply and demand have been discussed in recent researches with needs and access theories. But there is a need to think another way around that how supply and demand can be accomplished and what are the other factors that can contribute and these will be discussed later in the paper [4].

2.2 Acceptability of Innovative Technologies

Acceptability of a new technology or innovation begins when people are more accepting and have knowledge related to a particular area with understanding. Variables that should be analyzed before considering supply and demand, for example, behavioral or attitude variable of people regarding new innovative and current technologies, hospital variable for instance what kind of services available with the grant, physician number, diseases addressed and size of the hospital. Market variable concerning competition with supply and demand based on the patient needs are also critical variables to be noticed. These three variables can be utilized to see supply and demand in a particular area with mental susceptibility, hospital occupancy, and industries involvement for initiation of telemedicine services [5].

In Scandinavia, Denmark is where the eHealth solutions are in progress at a higher rate. Denmark has strong collaboration among municipalities and surrounding regions which is less seen in other European countries. Denmark has formulated a Digital Welfare Strategy for 2013-2020. It also has unique telemedicine projects for example for COPD (Chronic Obstructive Pulmonary Disease). This project shows that telemedicine is a multidimensional approach which requires participation and understanding at all levels. Collaboration is vital to see the solution for patient problems regarding supply and demand [6].

3 Sustainable Infrastructure as Part of Planning

Sustainable infrastructure during a transition phase of innovative technologies is difficult to maintain. Accomplishment or sustainable telemedicine services depend on many sectors. These sectors, if integrated with proper connections, can provide a framework in which we can assimilate medical or clinical structure.

More than 75% telemedicine services designed for the care providers fail because of practical instability. Successful business models are needed to generate value for the involved companies and the treated patients [7]. There are many business models which have been discussed in many research articles. However, for a successful business model concerning telemedicine, there is a need to define whether it's a revenue model, a cost-saving model or a strategic model. There should be a clear objective and set goals for what we are going to achieve with proper measurement to see if it meets the expectation as part of planning. Senior managerial staff is required to develop a sustainable business model for eHealth [8].

3.1 eHealth Literacy

Technological eHealth literacy is basically to acquire, understand and integrate health information to technical or ICT solutions to solve health-related problems and issues. These are essential skills to treat patient anomalies and dealing patient empowerment due to innovative technologies in coming future. In America and Canada, more than 40% adult people have very baseline literacy for social participation. User-friendly ICT solutions are required at all levels of sustainability of health solutions in developed and underdeveloped countries primarily for the telemedicine services in distant areas where a physician is not available [9].

Deployment of solutions related to technologies for sustainability is difficult when these come to a complex organization, for example, tertiary hospitals and eHealth ecosystem in developed countries. Current ICT solutions are very good theoretically, but practically these offer multiple problems and require engagement or involvement of different sectors. Patient empowerment is the following challenge in developed countries which needs the participation of varying industry at all levels [10].

Consultation at all levels is necessary to understand what are the requirements and practicality of ICT solutions. One thing which should be focused that clinician should come forward because solutions are available for fast healthcare ecosystem and there is a need how to guide these solutions for expected benefits. Physicians have in-depth knowledge of the health issues and diseases. They can better guide the requirements which need faster solutions. They can discuss what the current problems and disparities are. ICT solutions will be then aligned accordingly. There is a need that physician should understand and accept the technological platform and be open. Integration with the innovative solutions and technologies are the future success of the hospital. Realization of patient empowerment at pharmaceutical industries and physician level is vital with a recognition that technology is the crucial connecting area for future best practices.

A study has been conducted on 170 patients in Peshawar, Pakistan about ICT solution and e-governance at Government and private hospitals level. Statistical analysis has been utilized to visualize the data. A very few number of people and physician know about ICT solutions and e-governance. Policies and infrastructure, are very disruptive. In case of natural disasters and floods and because of inappropriate infrastructure, the situation could

be worse. The Study was conducted to see awareness, usage of technology, required facilities availability and Government policies. Sustainability needs more attention in underdeveloped countries, as an example Africa, India, and Pakistan [11].

eHealth literacy to understand ICT and eHealth solutions in underdeveloped countries where poverty is at a high level, and people are less educated, and these solutions can put more harm than benefit. There is a need for better understanding in developed and underdeveloped countries to get the benefit of any technology. Community programs and physician technician meetings before planning of telemedicine or ICT service at all levels is essential to understand each other.

The Concept of blended staff for multipurpose tasks like ICT position intermediate care provider is critical. These people will be responsible for integrating technical and medical assistance and able to locate faster solutions for current disparities as it is hard for a medical doctor to understand technical areas and same is with the pure technical person. In this case, we need integrated assistance which could be in the form of ICT positions in eHealth ecosystem as part of planning [12].

3.2 Standard and Laws for Security

Constitution or laws are needed for defining standards and security issues for sustainability. Security problems can harm care plan for the patient and destroy trust. Patient and physician relationship needs privacy. Sometimes, there is a requirement of customized strategies according to the need of patients. Planning is the key factor before starting the service. For very critical and emergency situations like risky pregnancy, chemotherapy and surgical procedures are very demanding, and telemedicine at some point is not the solution if the remote staff is not well trained in the medical or technical area especially to handle security issues.

Planning for each deployed device with its interaction with other devices and connection should be considered. Security rupture in medical devices or sensor especially M2 M communication are of many types, like data attack, hacking communication connection nodes, and by this one can quickly locate the position and misinterprets the whole care plan. It will lead to the physical assault or other harms. It is imperative to consider security aspects as part of planning [13].

QR code which is two-dimensional barcode matrix is utilized nowadays in different applications and websites like secure authentication to avoid hacker attacks. It is one-time password authentication, and after logout, a person should again scan this QR code. Password and login are assigned to medical staff for using a particular device, and in case of attack, additional QR code requirement secure the system in the precise way [14].

There are many differences between international to national and then local laws. Telemedicine is a broader term and services can be provided through globally. For a collaborative project between Europe and US, rules and standard guidelines for telemedicine are comfortable as in US federal states govern it, but in case of Europe union, any law or regulations cannot be implemented without permission or consultation from the member countries [15].

Information transmission by using IP address protocol as well as low bandwidth should consider as this is acceptable to hacking attacks if the local or publically available internet provides the teleconsultancy.

There are no unanimous laws and guidelines for the telemedicine services worldwide. ICT professional can provide a good source of security information before implementation of any telemedicine services, and technical staff can tell about what are the possible

available solutions for secure network, with these available standards for telemedicine must be seen as part of the planning of a framework.

3.3 Telemedicine Services Reimbursement and Solid Financial Plan

Currently, telemedicine services are expensive. Reimbursement or indemnity needs attention, e.g., in teleconsultation, innovative business models can help if some sponsorships provide services. Proper knowledge about the technological infrastructure available at the site recommended for telemedicine service should consider the business model before giving any service. For building telemedicine service in particular area revenue generation or payments should be considered before planning of telemedicine services.

29 states of Colombia have passed parity laws for the reimbursement of telemedicine services via private payers. Patients directly pay their charges through online service. The insurance does not cover it. Before planning of a telemedicine service, it is essential to have a solid financial plan. Payment models can be changed flexibly [16].

In EU Directive (Article 3(d) of Directive 2011/24/EU) allows reimbursement of cross-border telemedicine if the patient resides in an EU country. However, in Germany, compensation is only through the health insurers otherwise patient have to pay by his pocket while in France some telehealth services are paid as well as in UK and Sweden [17].

3.4 Customized Telemedicine Services Planning

Customized services and 3D telemedicine planning services considering patient needs, genetics, metabolism and disease situation, personalized services are in progress with individual plans. In chronic disabilities and long-term diseases, telemedicine and home care rehabilitation are the ultimate solutions for patients. Patients cannot be hospitalized for a lifetime as it will be costly.

2D video conference has been used in the hospitals and connected care centers. New 3D video conferencing is now the future development which is not utilized widely. This technology will cover the gap inherit from 2D technology. Light–Field displays (LF) can be used efficiently in the teleconsultation and surgery. For quick decision making and as sitting remotely or at a distance require intelligent decision-making data and algorithms. Analysis of big data LFV is difficult with video compression although standards are defined but still not wholly applicable to address the issue for example progression challenges like how to analyze and understand 3D enormous information in one platform and make decisions. But this 3D technology provides more extensive and open knowledge as compared to 2D conferencing [18].

4 Planning Business Models for Telemedicine Services and Marketing

Before considering planning, industries and the sector that can support with payments and marketing should be considered. Rehabilitation and long-term disabilities can involve potential business models with providers of the view that their equipment and technical staff with products can handle and benefit from telemedicine services.

To create a sustainable structure with long-term benefits marketing and business model ideas will keep the system inflow.

4.1 Public Private Partnership and Revenue Generation

Denmark is one of the highest telehealth users in all of Europe. Denmark is looking for the public–private partnership, and many hospitals are working to explore new markets, and available solutions like Living Lab Denmark is a successful public–private partnership program where Danes and Multinational companies testing their products for the elderly population and with different care centers in 22 municipalities in the southern region of Denmark. The government of Denmark is taking many initiatives and collaboration with American companies to seek new solutions and invest in new business models for the health sector and to meet the needs of the patients. Denmark is going to make 16 new hospitals in which eight hospitals will be with complete IT state of the art structure. This innovative and unique IT equipped hospitals will decrease the number of beds to 20% and length of stay in hospital from 5 to 3 days. Dollar 7 billion money is allocated for this task for the next 10 years. Many projects related to telehealth have been established. US Epic company recently got the opportunity to invest USD 1 billion in building IT infrastructure in two of the central region of Denmark [19].

Talkspace, a software company, is connecting licensed physician to the patients through unlimited messages and provides virtual connections. They are using data analysis to find out right practitioner for the patient and provide service for 25 dollars per week and has raised Dollars 9.5 million led by spark capital [20].

London Kings college hospital is using wearable Apple watch for chemotherapy to see medication adherence and therapy. This clinic is piloting an application from Medopad, a tablet-based mobile application technology company. This company has done a collaboration with England and China in the health sector and has raised 2.8 million dollars from 2011. Apple watch will be likely to save one pill cost of chemotherapy which is dollar 1575 to dollar 78 per patient [21].

Public and private partnerships are vital in the healthcare sector. Pharmaceutical industries and tech industries can take part and can-do investments by seeing what kind of telemedicine services are needed. This partnership depends on three primary factors what kind of stakeholders likely NGOs, R&D, educational or healthcare sector are involved, second what kind of collaboration like is it short term, middle or long term, third is the supply and demand management, by seeing needs of the patients. Long-term partnership is risky, but this investment would be very beneficial in case of chronic diseases and remote patient monitoring [22].

4.2 Medication Therapy Adherence and Value-Based Business Models

Applications can be installed with the prescribed medication for therapy adherence and remote patient monitoring as part of telemedicine service like Novartis has proposed home-based telehealth application for patient adherence and remote patient monitoring. These eHealth digital solutions can provide new business models for pharma and practice new services aligned with telemedicine as part of planning to develop a framework for future telemedicine. Neurometrix Quell is working for digital pain management, WellDocs for digital diabetes and asthma therapy through digital therapy inhalers applications [23].

Telemedicine business models and public–private partnership is essential both for developed as well as underdeveloped countries to find a way for payment and revenues. Many sectors through this digital eHealth concept can be involved to provide solutions for the emerging countries as well.

Myca Nutrition is a web, and mobile video platform in Canada established in 2007 and is providing consultation on nutrition, and this online system is saving most of the physician cost. Doctors are charging approximately dollars 20 a month for five patients and approx., 89 dollars for 100 patients while the patient is giving 12 dollars per month. Arizona telemedicine in the US is a teleconsultation for dollars 5000 per year. Tective Telemedicine is working for mental health in Netherland with euro 200 per patient profit. These are the digital eHealth or telemedicine business models that can be utilized as part of planning before the introduction of telemedicine service in developed countries.

In underdeveloped countries like Pakistan Telenor, a telecommunication company is providing TeleDoctor services for 24 h a day in case of secondary medical advice. They are receiving around 10 thousand calls per day and charging 8PKR (0.08 USD). India, Apollo is providing Telemedicine services for rural areas. Teleconsultation cost varies from dollar 20 to dollar 30 with a net profit of dollar 10 per patient. In China Pla Telemedicine is providing teleconsultation, saving time and reducing the cost for patients as well as getting revenue, are the examples for business models which can be considered before introducing telemedicine service [24].

There is a need to introduce Government investment, pharmaceutical and tech industries which can make affordable devices and networking system for proper channelizing of health care services and their provision nationally and globally. This factor will overall enhance value-based Healthcare business models and give more opportunities to the public and private sector to invest and get the benefits. Pfizer in the UK is pursuing integrated care programs for health care system. This model is based on rewards to clinical as well as economic outcomes instead to only pay for the products. These programs reduce cost and reimbursement is basically through health insurance companies or local health authorities per patient basis, and this example can be seen in UK, Germany, and Switzerland [25].

5 Sustainable eHealth Business Models, Policies, European Commission and 5G

Policy recommendation requires help from all stakeholders, industries, and technology, e.g., 5G health authorities and the public to pursue the good practices [26].

- Introduction of different business models in healthcare ecosystem with pilot actions and modelling approach
- Utilization of good practices in making business models for continuous and valuable healthcare ecosystem
- Provide the understanding of benchmarking so that every industry act innovatively and utilize best practices business models for health care.
- Reimbursement and financing health care sector with good practices
- Legal clearance in different matter related to personal health data and exchangeable data nationally and geographically
- Facilitate industries and market to come and give solutions for unsorted technical issues.

EU is moving ahead to use 5G for better internet access for citizen and business models because 315 million population in Europe is using the internet and use of IOT has been raised and continuously growing. They have made a plan for 2025 where it is decided to

change 100 Mbps to Gbps. All communication and remote monitoring in case of telemedicine services will be revolutionized [27].

6 5G Solution for Healthcare

5G will revolutionize connected services and devices by improving reliability, connectivity, and cloud-based storage. This technology will provide a base architecture for the assimilation of virtual devices in the health sector with a broad capability of computing intelligence with more speed and a big range of bandwidth. The more advanced form for the previous generation has amalgamate nature and combing all previous generations, sensors and wireless technology devices, the wavelength in millimeters, Wi-Fi. 5G is combining or connecting virtual systems to cloud with artificial intelligence and helping in the derivation of the different models of computing [28].

In 2020, 50 billion devices will be connected to 212 billion sensors when this 44 zettabytes (ZB) will be accessible. 5G will develop an ecosystem where all the devices and system are connected. The speed of the internet will make many innovative applications of the healthcare system, and rehabilitation enable. Immersive data traffic and system configuration will help in the process of decision making and location access. Rehabilitation by utilizing virtual coaching with real-time will be possible. Data analytics and algorithm will help in faster treatment and quick decisions. This cloud architecture and central data network will provide new opportunities for new business models with a customized approach. Internet-based services will give more opportunities to start-ups. Clinical trials and cost for human will be decreased in computational and digital structures as 5G will allow making intelligent networks and data analytics possible [29].

7 5G Health Sector, Future Society, Marketing and Economy

Due to digitalization and the faster speed internet healthcare area is continuously developing in the technological point of view as it is of course need of the time. More and more industries will involve that have not any medical background but can make a structure or provide a basement for the flow of medical information by utilizing 5G technology. American firms are putting more investments dollar 232 billion for ICT environment, and this will grow to dollars 357 by 2019.

Imaging and diagnostic are enhanced nationally as well as internationally. Cancer detection remotely can be done through the 5G connection of wearable sensor and devices to monitor baby respiratory patterns through android applications.

All the medical industries are now interested in transferring their medical devices into real-time connected devices. It will provide setup for the establishment of new business models focusing customized solutions. Through modified business models and more involvement of people from different professions can provide help to connect biological system to virtualized system and ultimate quick access without doing significant procedures, developing of ICT software, reducing clinical trials in the augmented and virtual reality way.

5G equipped technology is going to open and invest in new business models with healthcare sector with reliable solutions. By this method, pharmaceutical industries and medical device industries will be able to help in standardization and enhance their role

from manufacturing of products to value-based business models. Wearable devices, sensors, technology architecture, software, different drug delivery systems, diagnostic and imaging devices will give chances for industries to introduce business models to connect different system as one ecosystem.

To create value and to develop sustainable healthcare ecosystem business models are necessary, and 5G can help to make this approach accurate [30].

7.1 Current Threats in the Ongoing Health Care System and Medical Team

- Patient personal data is mostly stored in one place in the form of repository, only exchanged with the authenticated users. But most of the time this data remains at one location as hospitals and doctors are not connected sufficiently.
- Fair utilization of incentives for the healthcare sector and access to eHealth system at all levels from city to rural areas should be without discrimination.
- Less availability and insufficient training of the medical staff and patient can put more problems. As both come from different fields or areas and they need an understanding of each other [31].
- Rehabilitation is difficulty in hospitals for the long term in case of chronic diseases. Solutions should be like that patient can get care at their home doorstep with convenience. Which is difficult because of expenses and medical teams are not technically aware of any difficulties if arise at the level of devices which can put more harm than benefit.
- More practical and intelligent medical care system is still not available, and poor practices have been seen in data analysis and handling [32].
- Less integrated and more paralyzed structure of health care, problems in information system especially in the underdeveloped country where infrastructure is not adequately built [33].
- Connectivity issues with real-time and bandwidth problems and by this access in case of medical images or transfer of big data in telesurgery creating hindrance due to end to end latency. Latency beyond 200 ms effects surgeons and it is difficult for surgeons to operate [34].

Intelligent medical team with having the realization of patient condition and technological infrastructure of the area is critical. The Accomplishment of any telemedicine service depends on cast or crew as these are the people going to handle or initiate particular telemedicine service.

8 Framework for Future Telemedicine Planning and Involved Infrastructure

The Principal approach here is “escalation” that every working facility or sphere are interconnected and overlap to make the backbone of the skeleton of the healthcare ecosystem. This overlapped skeleton will help in the understanding of every linked unit and its importance before starting of any telemedicine or eHealth service. If one unit change because of the requirement of the innovative technologies, other will begin to strategize plans accordingly to keep all the units in stable and sustainable position.

8.1 Escalation Model

This escalation model has four necessary vital parts which are giving shape or stability to the skeleton. First is the government making their policies, defining regulations for best practices. Second is the ICT industries, which are coming with new innovative systems, sensors, and devices for faster access to data and quick response. A Third is a wireless technology such as 5G providing all the data and quick response with real-time and low latency. The Fourth area is the industry itself, for example, technology industries, startups, pharmaceutical industries, etc. which will provide investment and will practice new ideas and business models to make a sustainable, rewardable eHealth ecosystem. All the systems will coordinate and involve in action and required reactions. A Single unit cannot work more efficiently alone. All need to work together to get the maximum benefit. In case of telemedicine services, it will be regarded as healthcare ecosystem which is central or brainy part of this proposed escalation model (Fig. 1).

8.2 Productivity Determination for Launching a Particular Telemedicine Service

Many measures and unit by unit determine this escalation productivity, for example, future wireless communication technologies like 5G with reliability and faster speed to predict the productivity of the individual attached unit, use of all resources and financial assistance by the involvement of public–private sector partnerships. Satisfaction reviews or trust level measurement including questionnaire from consumer involvement which are getting eHealth services at remote places. For chronic diseases or disability, Government policies flexibility and current security standards, eHealth literacy, education programs and campaigns. Non-clinical care providers like the involvement of NGOs, Media and municipalities, Technological industries providing medical and technical devices and solution for a particular telemedicine service.

This escalation approach requires that every connected system or a subsystem or unit have a proper description or knowledge of each performed the task in providing and dealing telemedicine or medical emergency care with the overall goal to decrease the burden on hospital and connected units. In this way, every individual will be treated on a priority basis rather than to get treatment on selection basis. There will be more revenue and investment would be available. This escalation model system will help in connecting of different units of health care system as well and in case of any change because of transition and innovation; it will give us the systematic way to absorb and come back accordingly. This approach will help to maintain the overall goal of this escalation and sustainable infrastructure.

Outcomes regarding patient satisfaction and trust will come from the coordination of all the overlapped units. Since any unit in this escalation is not alone, there is coordination so the burden will be shared and revenue will be divided to all the units concerning less pressure and with more investments. For achieving a big target, it is required to put multiple, and differential efforts as this approach will make the system more secured and harmonized (Fig. 2).

$$C * \frac{\sum Si}{\sum Pi} \tag{1}$$

Pressure sharing formula is described in Eq. (1). By this, we can also see what the problem areas in the ongoing telemedicine services are and where are the holes or gaps to be filled

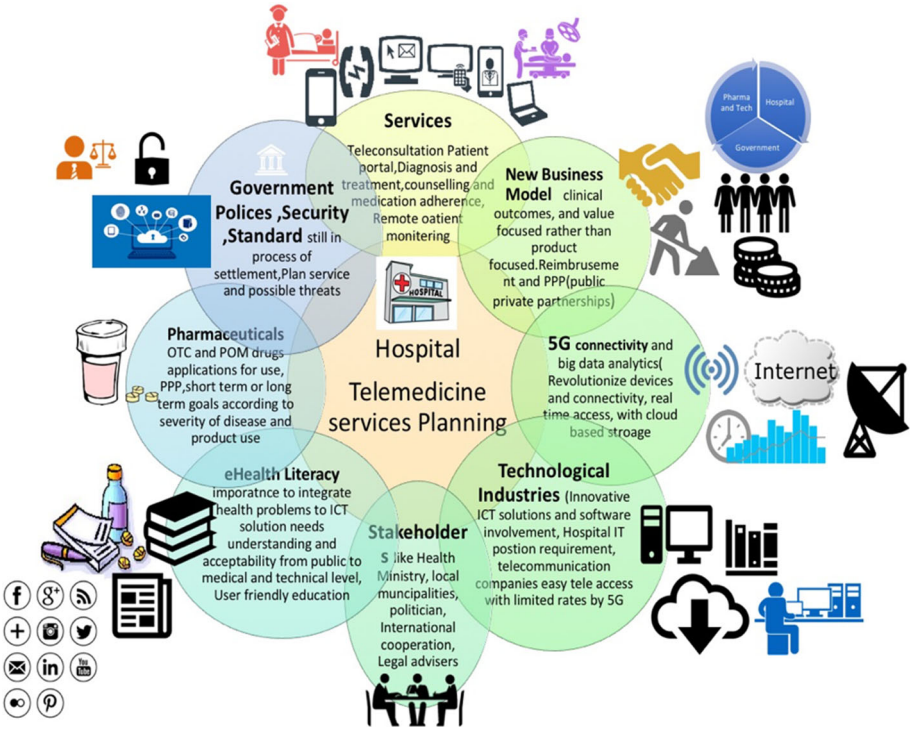


Fig. 1 Planning before starting of any telemedicine service has been shown in this escalation model diagram with a future framework and importance of each connected unit as part of healthcare ecosystem

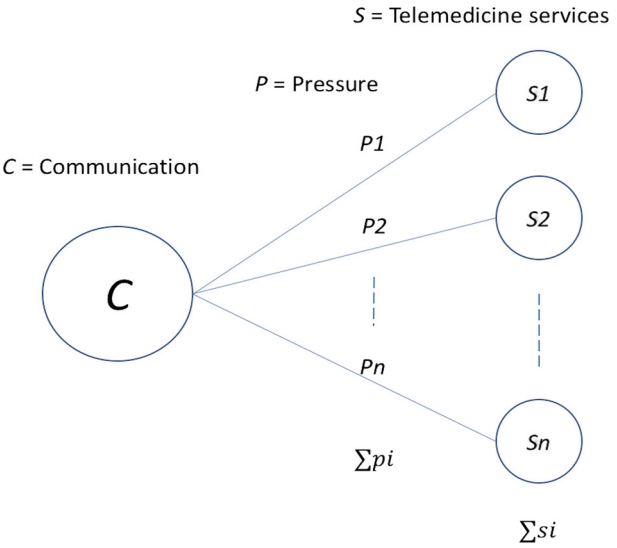


Fig. 2 This mathematical modeling approach describes pressure sharing between all the overlapped units. Communication factor will play a significant role in the orientation of a particular plan for eHealth ongoing, and future-oriented services

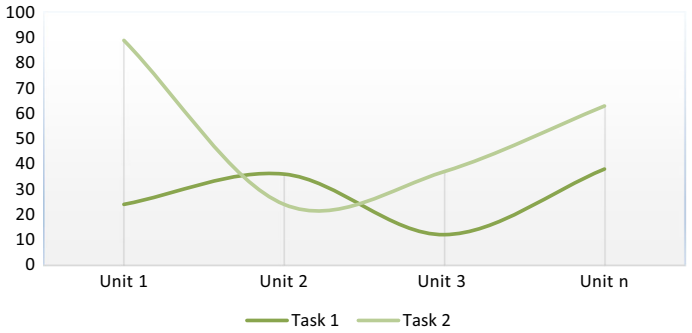


Fig. 3 Productivity achieved regarding specified points

up in case of remote patient monitoring or eHealth overall services for the public. Issues related to connectivity and real-time access in this escalation that will be solved with 5G technology in coming days as there is a need of high definition breakage free wireless communication that can fill up the gaps of space (which means less occupancy of patients) and time factor (response is quick). Patient and physician can communicate data from different attached sensors, exoskeletons and robotics to see patient movements. Smart pharmaceutical devices which are providing dose tailored on suggestive and maintained therapy on a signaling pathway by the physician in real time with no delay especially for remote areas as part of escalation model.

It is a basic framework to consider before implementation of any telemedicine or eHealth service as this model still needs more exploration in cooperation and coordination point of view.

Productivity can be measured by yearly data analysis of performed tasks by each overlapped unit. By this measurement, we can see what the problem areas that are creating hindrance in the efficiency of a particular task are and accordingly we can improvise (Fig. 3).

8.3 Performed Tasks Analysis

This productivity measurement can analyze many factors like there is any communication gap, proper task handling, understanding with the medical area, technology utilized, available resources use, commercialization and marketing, value-based business model creation, motivation level, etc.

This productivity measurement will help to find out efficiency, engagement, and service experiencing patient satisfaction. Productivity points will be assigned to the units after data analysis of performed tasks. The Yearly report will make the framework more applicable and accountable for sustainable infrastructure. The Provided study will set future more stable structure and sustainable healthcare ecosystem with stable telemedicine services.

9 Conclusions

Network coverage and access are limited or fragmented in distance areas. Infrastructure is fundamental and still in the stage of development to carry out eHealth care or telemedicine services. Lack of interest by the private sector due to less transparency in the medical

services and inadequate managerial supervision on the healthcare ecosystem are the leading factors in less affordability of patients for expensive solutions and deployments of the vastly oriented health care system. The Practice of clinical applications and telemedicine services are still not affordable due to less awareness about proper utilization of different devices and software, basic and preliminary system of wireless communication with less bandwidth and disruption in the ongoing implemented healthcare ecosystem.

There is a need to introduce government investment, pharmaceutical and tech industries which can make affordable devices and networking system for proper channelizing and monitoring of patients through telemedicine services and their provision nationally and globally. Planning for the implementation and ongoing system disruption accountability is very important. Cooperation and coordination in healthcare ecosystem will enhance human workforce, less financial burden and give more opportunities to the public and private sector to invest and get the benefits. For communication, connectivity and real-time, 5G will play an essential part. Security and standard definition are still in the line of settlement. Universities, governments, and industries are putting philanthropic efforts for establishing value-based telemedicine and eHealth services, but there is still more research needed to get the sustainable infrastructure for eHealth ecosystem.

References

1. Doolittle, G. C., & Spaulding, R. J. (2006). Defining the needs of a telemedicine service. *Journal of Telemedicine and Telecare, 12*(6), 276–284.
2. AlDossary, S., Martin-Khan, M. G., Bradford, N. K., Armfield, N. R., & Smith, A. C. (2017). The development of a telemedicine planning framework based on needs assessment. *Journal of Medical Systems, 41*(5), 74.
3. *U. D. H. S. marketing public affairs and, "Telemedicine saves patients time, money" (Online).* Available https://www.ucdmc.ucdavis.edu/publish/news/newsroom/11887.
4. AlDossary, S., Martin-Khan, M. G., Bradford, N. K., Armfield, N. R., & Smith, A. C. (2017). The development of a telemedicine planning framework based on needs assessment. *Journal of Medical Systems, 41*(5), 74.
5. Emery, S. (2015). *Telemedicine in hospitals: Issues in implementation*. London: Routledge.
6. Denmark—A frontrunner in telemedicine in Scandinavia (online). Available https://www.digst.dk/Servicemenu/English/News/Denmark-a-frontrunner-in-telemedicine-in-Scandinavia.
7. Chen, S., Cheng, A., & Mehta, K. (2013). A review of telemedicine business models. *Telemedicine and e-Health, 19,* 287–297.
8. *10 Critical Steps for a Successful Telemedicine Program (Online)*. https://webcache.googleusercontent.com/search?q=cache:yyvF0He_Ef8J:https://www.amdtelemedicine.com/downloads/10_steps.pdf+&cd=2&hl=en&ct=clnk&gl=dk.
9. Norman, C. D., & Skinner, H. A. (2006). eHealth literacy: Essential skills for consumer health in a networked world. *J Med Internet Res, 8*(2), 8.
10. Falcini, F., & Rinaldi, G. (2017). *Medical records, eHealth and health IT: What are the key points for the organizational benefits and for the improvements of the modern local health organisations?* (pp. 129–140)., New perspectives in medical records Cham: Springer.
11. Din, I. U., Xue, M. C., Abdullah, S., Ali, T. Shah, & Ilyas, A. (2017). Role of information & communication technology (ICT) and e-governance in health sector of Pakistan: A case study of Peshawar. *Cogent Social Sciences, 3*(1), 1308051.
12. Rick, C., & Kritek, P. B. (2014). Realizing the future of nursing: VA nurses tell their story. Government Printing Office.
13. Lake, D., et al. (2014). Internet of things: architectural framework for ehealth security. *Journal of ICT Standardization, 1*(3), 301–328.
14. Thiranant, N., & Lee, H. (2013). A design of security framework for eHealth authentication system using QR Code. *Advanced Science and Technology Letters, 38,* 32–35.

15. *Legislative Framework for Telemedicine (Online)*. Available: https://webcache.googleusercontent.com/search?q=cache:Mm8eqBF8s-QJ:https://bib.irb.hr/datoteka/366826.Stapic_Vrcek_Hajdin_Legislative_Framework_for_Telemedicine.pdf+&cd=8&hl=en&ct=clnk&gl=dk.
16. *The ultimate telemedicine guide|What is telemedicine? eVisit® Telemedicine Solution (online)*. Available: https://evisit.com/what-is-telemedicine/.
17. Pirvu, E. B. G.-D. A., & Snyder, R. E.U. *Way ahead of the game on telehealth|Lexology (online)*. Available: https://www.lexology.com/library/detail.aspx?g=e1259fba-9e68-4751-9450-9dfea92d7df6.
18. Xiang, W., Wang, G., Pickering, M., & Zhang, Y. (2016). Big video data for light-field-based 3D telemedicine. *IEEE Network, 30*(3), 30–38.
19. *Denmark, world leader in health IT, tests new systems with US companies, 19 February, 2014 (Online)*. Available https://www.businesswire.com/news/home/20140219005019/en/Denmark-World-Leader-Health-Tests-New-Systems.
20. Lawler, R. Therapy-by-text startup talkspace raises $9.5 M led by spark capital. *TechCrunch*.
21. London hospital pilots Apple Watch for chemo patients. *MobiHealthNews*, 14 May, 2015 (Online). Available http://www.mobihealthnews.com/43537/london-hospital-pilots-apple-watch-for-chemo-patients.
22. *Public Private Partnership Programs:Best Practices (Online)*. Available http://webcache.googleusercontent.com/search?q=cache:cdnLwN6tth4J:www.healthinsightforum.com/HI5%2520Presentations/pdf%2520day%25201/24Apr2015_Partnership%2520Programs%2520Across%2520Emerging%2520Markets_v4.pdf+&cd=8&hl=en&ct=clnk&gl=dk.
23. Pharmaceutical companies and digital health startups: It's time to get together. *MobiHealthNews*, 10 Februrary, 2017 (Online). Available: http://www.mobihealthnews.com/content/pharmaceutical-companies-and-digital-health-startups-it%E2%80%99s-time-get-together.
24. A Review of Telemedicine Business Models (PDF Download Available) (Online). Available: https://www.researchgate.net/publication/236091643_A_Review_of_Telemedicine_Business_Models?enrichId=rgreq-7c1f9b164bd539aaa9d830207b60cd64-XXX&enrichSource=Y292ZXJQYWdlOzIzNjA5MTY0MztBUzo5OTg0MDkwMjA0MTYxMUAxNDAwODE1MzM0NTc5&el=1_x_3&_esc=publicationCoverPdf.
25. *Building value-based healthcare business models—Health article—A.T. Kearney|Middle East—A.T. Kearney (online)*. Available http://www.health/ideas-insights/article/-/asset_publisher/LCcgOeS4t85g/content/building-value-based-healthcare-business-models/10192, http://www.atkearney.co.uk/health/ideas-insights/article/-/asset_publisher/LCcgOeS4t85g/content/building-value-based-healthcare-business-models/10192.
26. *Business models for eHealth (online)*. Available: http://webcache.googleusercontent.com/search?q=cache:bXo-HkOH7AYJ:ec.europa.eu/information_society/newsroom/cf/dae/document.cfm%3Fdoc_id%3D2891+&cd=1&hl=en&ct=clnk&gl=dk.
27. *European Commission—PRESS RELEASES—Press release—State of the Union 2016: Commission paves the way for more and better internet connectivity for all citizens and businesses (online)*. Available: http://europa.eu/rapid/press-release_MEMO-16-3009_en.htm.
28. Latif, S., Qadir, J., Farooq, S. & Imran, M. A. (2017). *How 5G (and concomitant technologies) will revolutionize healthcare*. arXiv:1708.08746 (cs).
29. *How 5G technology enables the health internet of things (online)*. https://webcache.googleusercontent.com/search?q=cache:95LOIX7Z0d8J:https://www.brookings.edu/wp-content/uploads/2016/07/How-5G-tech-enables-health-iot-west.pdf+&cd=2&hl=en&ct=clnk&gl=dk.
30. C. D. July 31 and 2017Features. *5 industries to gain the most from 5G, IT Pro Portal (online)*. Available https://www.itproportal.com/features/5-industries-to-gain-the-most-from-5g/.
31. (HLS-EU) Consortium Health Literacy Project European et al. (2012). Health literacy and public health: A systematic review and integration of definitions and models. *BMC Public Health, 12*(1), 12.
32. Wells, B. J., Chagin, K. M., Nowacki, A. S. & Kattan, M. W. (2013). Strategies for handling missing data in electronic health record derived data. *EGEMS (Wash DC), 1*(3), 1–3.
33. Raza, M., Le, M. H., Aslam, N., Le, C. H., Le, N. T., & Le, T. L. (2017) Telehealth Technology: Potentials, Challenges and Research Directions for Developing Countries. In *6th International Conference on the Development of Biomedical Engineering in Vietnam (BME6)* (pp. 523–528).
34. Ullah, M., Fiedler, M., and Wac, K. (2012) *On the ambiguity of quality of service and quality of experience requirements for eHealth services* (pp. 1–4).

Sadia Anwar received her degree in doctor of Pharmacy in 2011 form Government College University, Pakistan. She had worked for 3 years as a community pharmacist and she also worked as a Clinical and Drug information consultant. She came to Denmark in December 2015 and started working as a Guest Researcher at CTiF in the department of electronic systems, Aalborg University under "IICT Endowment Fund for Sustainable Development Scheme" under the supervision of Professor Ramjee Prasad. She worked for Interdisciplinary area specifically more focused in 4 sections: medicine, Telecommunication, Big data and economics. She joined Aarhus University in 2016 and now working there as Research Assistant. Her research is based on interdisciplinary area of Medicines, ICT, and Business Development. She is also Working in vCare project (Virtual Coaching Activities for Rehabilitation in Elderly)—EU Horizon 2020 Research and Innovation funding programme.

Dr. Ramjee Prasad is a Professor of Future Technologies for Business Ecosystem Innovation (FT4BI) in the Department of Business Development and Technology, Aarhus University, Denmark. He is the Founder President of the CTIF Global Capsule (CGC). He is also the Founder Chairman of the Global ICT Standardization Forum for India, established in 2009. GISFI has the purpose of increasing of the collaboration between European, Indian, Japanese, North-American and other worldwide standardization activities in the area of Information and Communication Technology (ICT) and related application areas. He has been honored by the University of Rome "Tor Vergata", Italy as a Distinguished Professor of the Department of Clinical Sciences and Translational Medicine on March 15, 2016. He is Honorary Professor of University of Cape Town, South Africa, and University of KwaZulu-Natal, South Africa. He has received Ridderkorset af Dannebrogordenen (Knight of the Dannenberg) in 2010 from the Danish Queen for the internationalization of top-class telecommunication research and education. He has received several international awards such as: IEEE Communications Society Wireless Communications Technical Committee Recognition Award in 2003 for making contribution in the field of "Personal, Wireless and Mobile Systems and Networks", Telenor's Research Award in 2005 for impressive merits, both academic and organizational within the field of wireless and personal communication, 2014 IEEE AESS Outstanding Organizational Leadership Award for: "Organizational Leadership in developing and globalizing the CTIF (Center for TeleInFrastruktur) Research Network", and so on. He has been Project Coordinator of several EC projects namely, MAGNET, MAGNET Beyond, eWALL and so on. He has published more than 30 books, 1000 plus journal and conference publications, more than 15 patents, over 100 PhD Graduates and larger number of Masters (over 250). Several of his students are today worldwide telecommunication leaders themselves. Under his leadership, magnitudes of close collaborations are being established among premier universities across the globe. The collaborations are regulated by guidelines of the Memorandum of Understanding (MoU) between the collaborating universities.

Wireless Personal Communications (2020) 113:1597–1613
https://doi.org/10.1007/s11277-020-07400-4

Literacy and Socio-dynamics Cues Insights Decision Analytics for Care Plan Adherence

Sadia Anwar[1] · Ramjee Prasad[1] · Bhawani Shankar Chowdhry[2]

Published online: 22 April 2020

Abstract
Literacy is a tool to analyze a problem in different scenarios. A skill that can give a person/business/stakeholders insight to differentiate and explain and how to follow a particular protocol. In the healthcare ecosystem, eHealth literacy is very critical for the promotion of a product/service when it comes to the patient for following or selection of a care plan or doctor level for communication at patient level as well as at a technological level. Young people are more familiar with digital tools. When it comes to an older population, we observe resistance because of weak cognitive skills or suspicious behaviour towards technologies that exist and culture variance. Different stakeholders should consider the level of literacy, deep dig into technological advancement while making policies for the Health care ecosystem and cultural aspects for technological promotion to ensure eHealth solutions to be followed. A business model should be improvised concerning eHealth literacy and culture literacy in different countries in the health care sector for the promotion of a particular assistive technology product/device/service. This paper highlights the various essential aspects concerning eHealth literacy, cultural influences its importance while following a specific plan of care and its adherence at the patient as well as the policy-making level for the healthcare ecosystem.

Keywords Analytical decision making · Consumer-directed health · Health literacy scale · Chronic diseases · Therapy optimization · The global governing body · Business model for promotional strategies · Socio-dynamic cues · Cultural variance

✉ Sadia Anwar
Sadia@btech.au.dk

Ramjee Prasad
Ramjee@btech.au.dk

Bhawani Shankar Chowdhry
bhawani.chowdhry@faculty.muet.edu.pk

[1] CGC, Aarhus University, Herning, Denmark

[2] Mehran University of Engineering and Technology, Jamshoro, Pakistan

1 Introduction

According to the World Health Organization (WHO), eHealth literacy is the skill to understand, review and evaluate health-related medical information through digital or electronic sources and applying that redundant information in a way to solve a health problem [1].

eHealth solutions are considered for making a sustainable healthcare ecosystem. eHealth applications can be used for the provision and exchange of medical information at the physician, patient or state level as well as to improve the management structure of the Healthcare ecosystem [2].

Treatment of the disease is easier if the literacy scale of the subjected patient is significant. With that, therapy optimization is notably more practical for the patient that has a satisfactory response towards technology and skill of decision making. Recent advancements in technology persuade patients' decision making through various motivational applications/assistive technological devices or virtual coaching that can mould or change the decision-making of a particular patient. Many variables can limit a person's ability to be analytical in decision making, and that ability can be analyzed by perceiving the encircling environment. A considerable amount of information sources is web-based that anyone can access by the use of the internet. eHealth literacy can also help to compare two sources of information and its reliability, especially in a big or complex society [3].

People with a low level of eHealth literacy can exaggerate the disease condition if they don't know how to wisely use an application/assistive technology or access the information. eHealth application can provide preventive measures to prohibit a condition, diet plans, medication adherence, daily motivation lessons, daily goals or plan-making, about sleep cycle, physical activity, obesity and vital signs. Some applications give information about toxicity management if a person inhales or consumes a substance which is not good for the body. These eHealth applications are the immediate services before access to an actual medical practitioner. eHealth literacy is a broader term and gives a person hints to understand his conditions as some problems are not easy to identify so a person can itself verify many facts. It can also provide a vision for the assistive technology-based business models. Young people are more active in the usage of eHealth applications with better understanding and decision making [4]. Different diseases can also hinder the ability to understand and investigate, for example, people with cognitive impairment, having Schizophrenia or mental illness [5].

Analytical training is required for ICT application deployment and proper usage. There are many obstacles which are responsible for rationalization and adaptation of a technological solution, i.e., unavailability of analytical tools or applications, many legal and political barriers, technological barriers, confidence, trust, culture variance and awareness between patient and physician.

This paper discusses the impact of literacy in the healthcare ecosystem as well as its impact on technology-based businesses with possible solutions and a framework. This article has seven sections. Section 1: is the introduction Sect. 2: depicts the need of analytical mindset Sect. 3: put lights on the cultural impact on eHealth technology devices Sect. 4: provides international policies, promotional strategies and its implications for care plan adherence Sect. 5: comes with a business model example and description of the socio-dynamic cues importance, culture variance, directions and applications. Lastly, Sect. 6: formulates the conclusions and future scope.

2 The Need for an Analytical Mindset

eHealth literacy is an essential skill set, especially in the present digital era to leverage health information available online to improve health outcomes [6].

The core skills/analytics are like traditional health information, scientific media and computer literacy, and after that its analysis and use for acquiring the confidence to adopt/follow the particular eHealth device/care therapy. eHealth refers to help of electronic resources for the development of the health care system, and it will be productive only if people will understand about their applications, like how, when and why to employ these resources/devices/services, what are their specifications and what variety of skills are needed to use them. When it comes to consumer-directed eHealth, it requires the ability to try to find, integrate and apply what is needed in electronic environments for solving a health problem.

For calculating the eHealth literacy of a population, various iterations are made in "literacy scales". These scales calculate understanding of a population about eHealth and its products. Within a clinical environment, eHealth literacy has the potential to serve as a mechanism of identifying the real customer who can benefit from eHealth applications. Norman and Skinner in 2006 developed an 8-item self-report eHealth literacy scale to measure eHealth skills, i.e. "eHealth Literacy Scale" (eHEALS). In eHEALS, the first subscale covered self-perceived competence in obtaining health information online, and the second subscale is the information appraisal of health data on the internet. Further research is needed to examine the applicability of the eHEALS to different populations and setting areas while exploring the relationship between eHealth literacy and health care outcomes [7].

eHEALS consistently captures the eHealth literacy concept in repeated administrations, showing a promising tool for evaluating consumer comfort and skill in using information technology for health. The objective of the study eHealth literacy scale was to psychometrically evaluate the properties of the eHEALS within a population context [8].

The use of eHealth services/devices in the healthcare ecosystem means to support self-care, facilitate the use of healthcare services, make caretakers and professionals more available and compensate for the daily living activities for people living with chronic illnesses. Hospitals and healthcare centres are often not the primary settings for care, as people with chronic illnesses are usually discharged from hospitals earlier and are less well than previously reported; thereby, they are often in need of support and care in their own home. Chronic illness sustains for a lifetime. Different healthcare facilities need eHealth services in the form of technical solutions/devices to give patients the best care (WHO 2011). Health information accessibility, such as electronic patient records, became more readily accessible to both patients and healthcare persons. Health systems usually operate as if all patients have health literacy skills and can be advocates for themselves. It neglects many other aspects that will be discussed in the latter part of the paper. However, a wide gap often separates what providers intend to convey in written and oral communication/eHealth applications and what patients understand. Moreover, as our world population becomes more diverse concerning age, culture, and language, that gap threatens to widen and intensify health disparities. The eHealth systems demand patients handle and perform several levels of abilities like providing the consent, recognition and implementing the obtained learning to numerous situations of life and With that communicating with the health care specialists. The patient has to prove that he can achieve vital levels of health education [9].

Many eHealth technologies like assistive devices are not thriving in the realization of sustainable innovations in health care practices. One of the reasons for this is the current development of eHealth technology usually ignores the interdependencies between technology, human characteristics, and the socio-economic environment and ending in a technology application/device that has a flat influence in health care practices. Introducing eHealth technologies into the health care system expects careful coordination and communication between healthcare professionals, patients, informal caregivers, end-users, and others. To prove the outcomes of eHealth technologies soundly, a new way of thinking is needed about how technology can be used to innovate health care. It also requires new concepts and tools to develop and execute eHealth technologies in practice [10].

To overcome all those obstacles that come among eHealth configuration and implementation, a new method is required for the improvement of eHealth technologies that have limited impact on the complexity of the healthcare ecosystem, individual patient practices and relevant stakeholders.

3 Cultural Influence/Variance and eHealth Technology Adaptation

Cultural boundaries are a major cause of discrepant views of reality. eHealth applications/devices must use approaches that acknowledge and account for the views and values of the individual related to different cultures, not only in defining the nature of a patient's problems but also in explaining solutions [11].

Technological experts should be motivated for the particular care of the patients that must be culturally very responsive. Because the provider's ascendancy can serve to impede rather than improve communications between consultant and patient. Inability to recognize the issue as mentioned above can limit the practitioner's potential to analyze the patient's views and role in the illness process. If the problem-oriented methodology is used suitably, one has to account for the patient's perspective and formulate a care strategy that accounts for the multifaceted interactions between medical, social, psychiatric, and different population issues.

Although culture and language are vital blocks to obtaining suitable eHealth services, however, some additional factors cannot be parted like socio-economic situation, and geographical orientation perilous issues must be taken into account when planning for technologically enabled rural/remote health care service. In undeveloped countries, for example, in Pakistan, there has always been strong cultural influences, with people coming from different backgrounds and tribes. The cultural policy document like in underdeveloped country Pakistan (2009) outlines protection for groups and individuals with a distinct language, script or culture (Article 28) and the discouragement of regional, racial, tribal, sectarian and provincial prejudices (Article 33) where every second province and districts are distinct from each other. And this impact over the world as in Europe, the principles are moderately different. European Union has offered their wisdom and expertise in eHealth policies implementation (2004) [12].

The EU holds twenty-seven nations (26 now after Brexit) of different countries that have a shared vision for the stable eHealth policies, good quality and fair access; and that is "patient-centred and responsive to individual need. In eHealth, during teleconsultation, the cultural norms and values have to be carefully observed, especially when we are dealing with teleconsultation across cultural boundaries and consultations with rural respondents in conferring reproductive health issues. With that, Rural/remote areas have also increased

barriers to culturally appropriate healthcare by eHealth applications/devices following the expansion in amounts of the distinction in socio-economic status, boost insignificant ethnic minorities, geographical orientation and cultural variance in metropolitan and rural areas of a particular country.

3.1 Social Influence and Law Fairness Regarding eHealth Literacy for Technological Devices/Tools

The socially deprived communities are those who hold no or little entrance to primary care, especially in underdeveloped countries Because they are socioeconomically disadvantaged or they live in rural/remote/inaccessible areas, so they disproportionately carry the burden of more chronic conditions. They often have less education, lack means of transportation to a primary health care facility, experience difficulties with language barriers and cultural beliefs, and have limited financial resources or health insurance. A Study and Report on the use of eHealth Tools for Chronic Disease Care among these areas more likely to engage in high-risk health behaviours that can increase their chances of developing chronic situations, such as alcohol and tobacco use, lack of physical activity, obesity, and poor diet. The adequate control of smoking, hypertension and cholesterol alone would reduce annual healthcare costs by as much as $30 billion, 38 and as many as one-third of cancer deaths in 2011 were related to the inadequate control of risk factors and could have been reduced or prevented [12].

In most developing countries, citizens expect equal primary health services in both rural and urban areas. It is only possible when it's mentioned in the law. The use of eHealth within or between institutions involves several factors that require proper planning, supported by well-defined policies, rules, standards or guidelines at the institutional, jurisdictional and global levels. Absence of these policies may lead to several problems during the cycle of eHealth planning, that may lead to failures in achieving the intended goals, or inadvertent widening of gaps in health status and knowledge levels between different sectors of the population and increasing rather than decreasing health inequity also termed as 'Digital Divide' [12].

Inadequate communication about the electronic appointment service to the patients and the patients characteristic that itself causes the limitations are like less analytical understanding for the use of any health application provided at the internet even use of the basics of the computer. The other factors could be no access to the internet at home. These characteristics and factors contribute to the less socio-economic status of the patient [13].

The purpose of the eHealth applications/devices is to monitor the inaccessible patients with medical conditions diagnosed using a centralized system, which interacts with patients to get their data and monitor. eHealth based Patient monitoring systems are capable of receiving and storing patient data analytics and may include a medicine dosage algorithm for using the stored patient data to generate medicine dosage recommendations to a patient. Patient data is gathered and then analyzed to obtain patient data to identify medical conditions of each respective patient.

3.2 Challenges Acquired and Lack of Availability of the Data

Most importantly, when new technologies are introduced, their acceptance becomes a challenge, for them to be authentic and applicable in ethical values. With the introduction of the electronic patient record, for analysis which has been limited to date. It is critical to

use the information systems for planning patient and health information to become readily available to both patients and healthcare personnel, which suggests that ethical issues should be noted. Patients must have access to their health records, that gives them more belief in using eHealth service and might improve their ability to participate in planning and analytical decision-making for their care, which was previously tricky while using a paper-based patient record. These kinds of challenges occur in many dimensions of eHealth innovations.

According to Ekendahl (2012), there is no denying that patients should have access to their patient records. Still, the discussion should focus on what information should be shared and under what conditions. If the patient record becomes an eHealth service via the internet, the question is instead whether the information has been disclosed following the Publicity and Privacy Act and if the patient is protected as an individual [14].

A chronic disease that is a significant health problem in the world as chronic disease often reduces the lifespan of those who suffer, for example, diabetes mellitus. Management of Diabetes includes monitoring a patient's blood glucose for abnormalities; monitoring preventative health behaviours such as weight control and fat intake, and monitoring adherence to scheduled insulin regimens. As the control of blood glucose may expect that patients measure their blood sugar 2–3 times per day, record the data, use some calculations to adjust their insulin dosage, and frequently transfer the data to a physician or nurse to evaluate their progress. Unfortunately, this does not happen in the current system because care providers do not have that much time to check data and prescribe patients for what is required. Health information systems currently used in Pakistan and many underdeveloped countries are fragmented and vertical. They respond to or serve primarily the health programs that created them. Consequently, health indicator data collected through various systems sometimes give conflicting results. Some percentage of the total budget is spent on prevention and public health. Health budget by federal and provincial governments during 2018–2019 (July–Mar) is Rs 203.74 billion [15].

The increasing rate of chronic diseases such as diabetes, hypertension, trauma, heart disease, and CVD estimates > half of the entire full growth of healthcare expenses. Prevention services such as screening and disease management that address populations at-risk, along with primary prevention with an emphasis on improving the environments where people live, work, play, and go to school, are receiving more attention and helping to reduce the costs on the health care system.

Demographic Health or the Social and Living measurement Surveys cannot fully compensate for the lack of reliable ongoing monitoring data. Furthermore, even these surveys require ability, resource allocation, and health care delivery system; however, it is impractical because it lacks accuracy, quality, reliability and absence of linkages with decision-makers. Though research is conducted in Pakistan, it is carried out in silos, does not have relevance to local issues, and quality is often compromised because of capacity and resources. There is a disconnect between researchers, implementers and policymakers. Evidence to policy link hence is weak [16].

4 Policies at the National and International Platform Regarding eHealth Awareness

Local health authorities considerably create current eHealth policy development, federal and provincial legislative organizations. A policy can also be exploited for the Government's obligation to implement a proper structure to fulfil the particular operations such as funding, law, or specialized plans for eHealth.

4.1 European Union

The first eHealth action plan was launched by the European Commission (EC) in 2004 and with that EC asked for solidarity on this action plan by member States to work together on eHealth. Since the launch of the 2004 Action Plan, several challenges remain that were hindering the EU from reaching their goal. These challenges are the digital divide between the member states, significant variations in terms of the level of eHealth integration between countries, differences between healthcare systems and legal hurdles associated with interoperable systems for cross-border health information exchange. To overcome these challenges, the European Union commission launched a second eHealth plane at the end of 2011. The new eHealth Action Plan 2012–2020 followed a public consultation with experts across the eHealth stakeholder community. This Plan included recommendations by the eHealth Task Force and a review of the evidence [17].

The EU Task Force on eHealth, a group assigned to estimate the role of information and communication technology and ways that can enhance the means of reform in the healthcare ecosystem. The group would consist of eHealth leading countries and regions which can provide leadership and inspiration for other countries. The countries who could take on leadership roles include Denmark, Sweden, Estonia and Spain. Of these countries, Denmark is widely regarded as the frontrunner in terms of countrywide eHealth usage. Denmark has a high level of eHealth deployment and usage amongst general practices, hospitals and patients. Denmark′s high eHealth usage can be attributed to a combination of many efforts like Health information exchange efforts led by the organization "MedCom". Agreements for the mandatory adoption of electronic health records in the primary and secondary care sector as well as the national IT strategies created to encourage eHealth implementation across the Danish health sector [18].

A Report that has inquired about the eHealth policy from 2004 represented the data for the 112 countries out of 192, member states of the World Health Organization (WHO) regarding the perspectives of the national policy that involves the information, e-Health and e-policies. They have shown that 72 countries (63%) have reported launching e-Health policies at the end of 2005 and the number is going to be improved at the end of 2008 to 95 countries that value 85%. But many member states of the WHO did not react to the study, and it is assumed that they might be having e-Health policy in place sometime soon. The 27 member states of the European Union announced to compose a roadmap at the end of 2006 and the remaining countries agreed to study into the clear roadmaps for the e-Health policies. But the report pointed out that there was not a piece of clear evidence about the plans or roadmap is being developed or not [19].

In 2015, an investigation by the global Observatory eHealth (GOe) depicted that it is instantly and in the mainstream to promote the health system with an excellent information system. All of the 194 member states of the World Health Organization had been assessed

for the deployment of the public eHealth policies. The results have determined that 125 nations did eHealth policy deployment with the statement that the eHealth policy is now becoming very mandatory as the standard. Over half of the countries (n = 73; 58%) indicated in the report that they have put in eHealth strategies. Nearly all of those plans (n = 64; 91%) have the policy objectives that eHealth can offer to the Universal Health Coverage (UHC) [18].

In countries like Pakistan, the promotional vision for Innovative technologies will be incorporated to provide speedy and reliant information to support evidence-based decision making at the district level through the District Health Information System (DHIS). Platforms at a provincial and national level for transforming evidence into policy advice will be encouraged, including dedicated units at federal and provincial levels (HPSIU and HSRUs/PSPU). Governments will be developing consistency across health information systems. They will be spending in key missing areas for watching the Sustainable Development Goals (SDGs) as well as national health objectives, and the information that comes from the critical events, for example, births and deaths. The national health vision calls for a transition from medical research to national health research prioritizing areas as per local requirements. A central hub for information repository, standardization and quality will be developed at a national level with the assistance of the provinces. It will serve to promote evidence-based decision making, policy formulation and health systems research. It is strengthening information systems at national, provincial and district levels eventually leading to a productive, integrated disease surveillance and response system, with a particular focus on Early Warning System.

4.2 Promotional Strategies at International Scenario

Promoting e-health strategies on an international level includes appointing an e-health governing body and linking foreign aid to e-health. There is a critical need for a global governing body to oversee e-health activities. The global authority e-health would be instrumental in defining matters such as standards of practice regulation and funding. The agenda of this organization should include training as a priority. Overseas development assistance scheme must consist of e-health as an integral part of the development and promotion of e-health generally [20].

Disease prevention and health care advancement have been a great interest among authorities like policymakers, researchers, and consultants in recent decades. Demographers have documented a significant result for disease prevention and health promotion. The revolution in lifestyle and health care in this century has made a remarkable success. Firstly the change in public health occurred when fundamental principles of public health were introduced in society to improve the quality of the health care system. This regime of change depends on factors like the age structure of society as a result of enhanced average life expectancy and acute disease, and these two joined in chronic disease as a focus of public health devotion.

Chronic disease and its related spiking situations, however, have not been responsive to the traditional public health involvements. The stopping challenge of managing a chronic disease brought time for another revolution in public health, which focuses on behaviour and lifestyle modification as the main factors of health promotion and disease prevention.

The education is needed for the public how lifestyle changes, policies on socio-economic status stability and education opportunity can modify the ageing process and also a person's whole lifestyle [21, 22].

The occurrence of most chronic health problems varies in a population. These conditions are ranked according to their prevalence in the total population. But only observations cannot track the parallel changes in health status and quality of life of people with chronic disease; there must be a system that monitors this too. So national and provincial governments need to initiate such health care programs that motivate and build the trust of the public suffering from these conditions. They should be refined in such a way that the functional limitation and disability resulting from these chronic diseases can be measured and changes can be monitored over time.

5 Socio-dynamic Cues (SDC) and Consumer-Based Business Framework for Assistive Technology Promotion and Care Plan Adherence

Patients face a challenge to adhere to a care plan as it claims to persuade them to develop new healthy habits or lifestyle modification. Social Dynamics refers to the behaviour of groups that results from the interactions of individual group members as well as to the study of the relationship between one-on-one interactions and group level behaviours [23, 24]. Persuasive technologies can stimulate adherence to the care plan [25, 26]. The use of assistive technology in the EU grew from $3.1 billion in 2010 to $4.8 billion in 2011, and it is expected to be tripled in 2019. Less adherence to care Plan are the driving forces for the digital tools [27–30]. Persuasion may diversify from culture to culture. Dr BJ Fogg from Stanford University exhibits how websites, software applications and mobile devices can be used to change peoples' behaviours. In 2003, Fogg defined seven persuasive tools that can persuade people to change behaviour to follow the care plan. With this, he also mentioned how physical cues could be helpful to predict adherence (Book Persuasive Technology, 2003). We are more easily persuaded by those who we view as similar to us. It is another powerful persuasion principle highlighted by Fogg. However, at the time of his writing, that's only available for the enterprise companies and notable brands [31].

Erin Mayer, a professor at INSEAD, one of the world's leading international business schools, illustrates how various cultures perceive the world and how one can respond to a particular behaviour. Also, perception about a specific observation or information, upgrades, downgrades and the philosophy of interpretation may diversify and could be taken oppositely [32].

Cultural mapping (Eight scales that map the world's cultures) can be helpful in persuasive technology-based device development for adherence with the care plan.

We can also choose what kind of a business model would suit best for a particular scenario, or the involvement can make a multi-business model approach where you connect with different vibrant people who are progressive in a specific area and channelize the cost and value as multi-business model innovation/ecosystem [33] and this of various stakeholders.

The primary author worked with an EU project vCare (Virtual coaching activities for rehabilitation in elderly) where the primary task is to develop a virtual coach that can make older adults independent after coming from hospitals and rehabilitation centres. The care is focused in the home care setting area, and patients own comfort zone. The literature findings were conducted from > 250 papers about the use and development of the virtual coach that can better suit the requirement of the patients, guide them with some decision-making abilities and for medication adherence [34, 35]. Out of > 250 papers, 20 were selected that

were very close to the scope of the project. The planned targeted chronic diseases were four, and a consortium of European countries divided one of the chronic diseases. These chronic diseases were ischemic heart disease, congestive heart failure, stroke and Parkinson's disease.

The main research questions that highlighted in this article concerning SDC for assistive technology and care plan adherence that can help a business to navigate or analyze and what kind of a business model they should follow before the introduction of a one size fit all solutions technology are as follows:

- Does the perception about a stimulus, emotions, facial gestures, response to a happy or sad face even a way of communication to persuade people to adhere with the care plan vary for SDC in different cultures?
- Can SDC stimulate/weaken the persuasion and adherence to a care plan?
- Should a persuasive technology be SDC specific? - for getting better results.
- If SDC is relevant in making persuasive technology then what verbal or facial features of persuasive technology people would require based on SDC between cultures for a long-term chronic disease care plan adherence especially for the elderly

The above questions open a lot to figure out what we should consider for a sustainable business model in the Health care sector for following a care plan especially in case of the chronic diseases that require steadfast patient behaviour to stick with the care plan for a lifetime. Technology and business framework is available, but the missing thing to persuade a consumer for assistive technology and to recombine these approaches that are specific to the SDC. SDC based assistive technology can better literate a patient seeing eHealth literacy requirements about care plan adherence.

SDC stated in Dr Fogg's book illustrates a general view. The article research demonstrates that any applications or software have language facilities, but cultural specificity has not been highlighted for persuasive technologies. If we look into different cultures, physical cues could be several, especially the SDC mentioned in Fogg's book. Cultural variation has been discussed in various research articles and books in general, but needs in terms of care plan adherence have not been described.

This research article is about the analysis and navigation and what the researcher has observed outside the scope of the EU Project and developed its report. The researcher has analyzed that the assistive technology for care plan adherence and the cultural specific SDC for consumer decision making is less investigated and should be researched more in making persuasive technology for better consumer outcomes and improved quality of life for patients as well as for sustainable business modelling.

Culture is the driving factor for the success of a particular business model. All sectors from the Government to the public and private sector must come forward to innovate a specific technology that can solve the issues regarding health in a particular society. Assistive technology-based business models cannot be a success if we are excluding the SDC and cultural influences.

The situation becomes critical in underdeveloped countries where the necessary facilities are not available to develop a technology-based healthcare ecosystem. It also shows that eHealth based business models should make a product for the needs of a particular community with promotional activities aligned with the local Government policies.

Local Government and local hospital staff can help in providing information about cultural variation and available resources. At the same time, the business can make a product according to the provided information and literate the local people for the use of the

assistive technology device with hospital staff and Government authorities. eHealth literacy if visualized in the global scenario where we have different countries, different age groups and cultures and that can make a more significant impact if these are studied in detail for the implementation of a particular eHealth based assistive technology product. Policies should be made at a local level to see how people perceive the specific technology. In developed countries, the younger population is more aware of eHealth literacy and use of assistive technologies. Still, values may vary when it comes to the older generation to follow the care plan.

The same above question analysis and navigation and improvisation with little innovation can help in figuring out what is best suitable for them and for the local businesses and startups to flourish and produce the customer-based solutions.

A preliminary proposal for the SDC based business model for assistive technologies is depicted below. The business model could be based on value (increase quality of life and productivity) or cost (Socio-economic cost reduction for municipalities and Government as well as revenue generation and savings). The below model depicts both the values proposition and cost reduction as well as revenue attainment. Business model analysis or evaluation has been shown in six dimensions like value proposition, user and customer, networks, competencies, value chain functions and value formula. The disintegration into six dimensions clarifies as well as it gives ideas for which area a business, even municipalities or Government has to work with or target. The preliminary framework is more focused on the joint collaborative effort that can provide more promising results (Fig. 1).

Preliminary framework and six dimensions evaluation give insights and ideas for innovation. Framework results are presumed for the entire health care ecosystem and Business Models based on assistive technology as well municipalities, Government authorities and related stakeholders by following SDC for creating and capturing new, improved values (optimizing QoL and productivity) socio-economic cost reduction, Prediction and

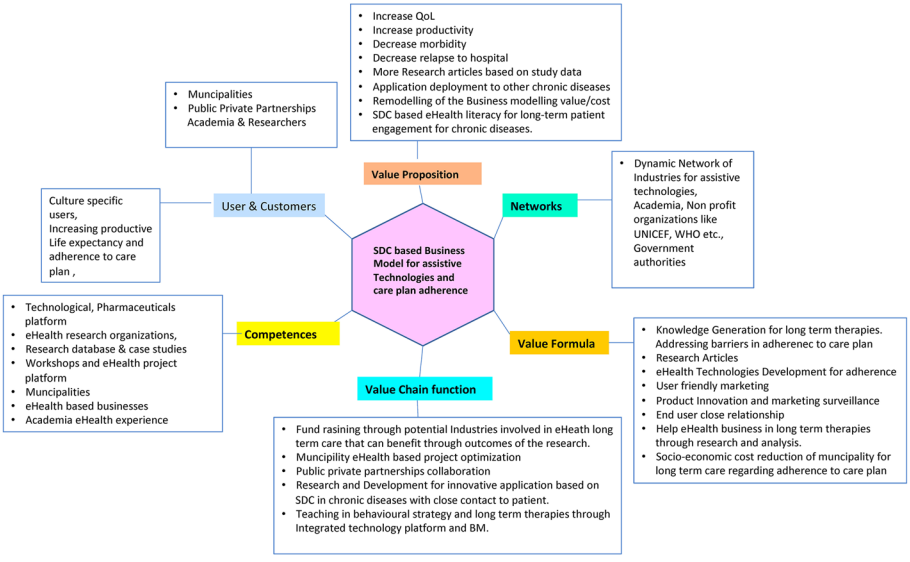


Fig. 1 Describes the importance of SDC and stakeholders involvement for a sustainable business paradigm and collaborative effort for assistive technology to persuade users/consumers to adhere to the care plan in 6 dimensions

discussions with a collaborative approach to remould the available service to consumer-based service by changing the behaviour process of consumer and overall cost reduction.

The framework will help to find out the scientific relevance of SDC and its connection to the behavioural change of consumer for care plan adherence by launching public and private projects at the local and international level and indulging academia so that students and researchers can use their knowledge in practical form. It will improve data collection and associated results. This will also give opportunities to researchers and job creation. The outcomes can help in cost channelization to the added payer as many stakeholders and sectors are involved, even research-based pharmaceutical industries will cooperate for medical devices innovation/assistive technology devices through broad data collection.

Adherence to care Plan can be increased with assistive technology, and the use of Assistive technology increases if the technology is SDC specific, then results could be more promising in guiding and iterating users/consumers. Content of the Non-verbal stimuli is similar all around the world as we all are human beings with the same body structure and same reactions; however, context or how a person perceives can vary between different cultures. Non-verbal stimuli for Assistive technology-based devices can predict the behaviour, attitudes and optimize the therapy by instructing in that particular period by knowing that the effectiveness can be more if the consumer follows.

Verbal stimuli vary between different cultures and vary widely. One solution for all problems will be irrelevant in this scenario, and that's why many assistive devices come and frequently go. Why because it's not very explicitly made for a particular area of the world. Vocabulary, grammar and language facilities are available. Still, the association can be increased with the choice of words and tone of the voice, unique phrases that can calm or motivate a person are still in the research phase, and that can deliberately affect the care plan adherence. Since Verbal stimuli differ between different areas or cultures of the world and as a solution, we can get the insight after living or collaborating between various stakeholders to choose what is best for the consumer for successful assistive technology launch.

The third stimuli; the response of the consumer to the environmental stimuli is very similar all around the world like light brightness, and dim light is associated with an increase of enthusiasm and depression. Also, hot and cold weather affects moods, different seasons and habits also can come along with the environment. If people are around bad food or junk chances are more to adopt the same eating habits, and even your relationship making is widely affected by the environment. Response to the environment is almost similar, but culture-specific areas may vary a bit, and joint effort from all the stakeholders can help while putting diet plan, healthy lifestyle modification. The environment can differ from one culture to culture as well.

The fourth one stimuli are personality traits that can vary even in the same culture as well as worldwide like the biology of a human being (inheritance, genes, body metabolism, receptors and immune system) can vary with that thought process/analytics of decision making. The above three stimuli can also affect and change personality Life experiences shape you and different socio-economic status as well. That is why a customized approach came into the market which is specific to the needs of the individual, and inner personality dimension to follow the inner self and change even though the above three stimuli are affecting. Many companies perform personality tests because they want to know what is best for the employee as well as for the company, so tasks are given accordingly for the best of the employee as well as the business (Fig. 2).

The above stimuli description shows how it is essential to navigating a particular area before the introduction of assistive technology with a view that it can persuade a person to follow a care plan. Reward system for adherence with the care plan in assistive technology

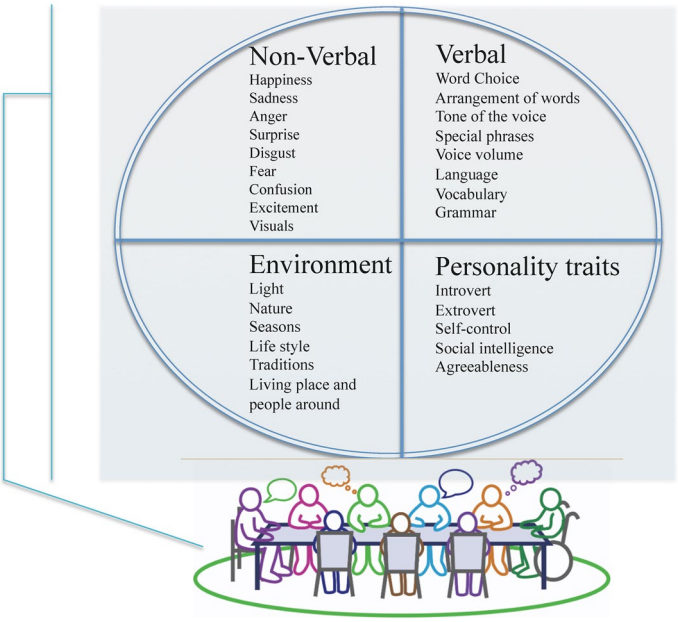


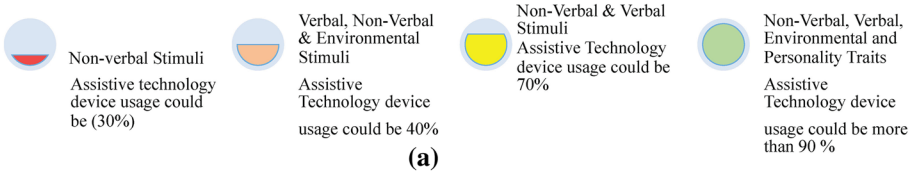
Fig. 2 Describes stimuli and SDC for Assistive technology business model specific for different cultures and its need while making or suggesting a particular eHealth business model

should be based on personality traits; then chances are more than a particular strategy will be followed. For personality traits, stakeholders can help only by defining the culture-specific traits for persuasion, a person's family can also play a part, and the actual targeted consumer itself as well (Fig. 3).

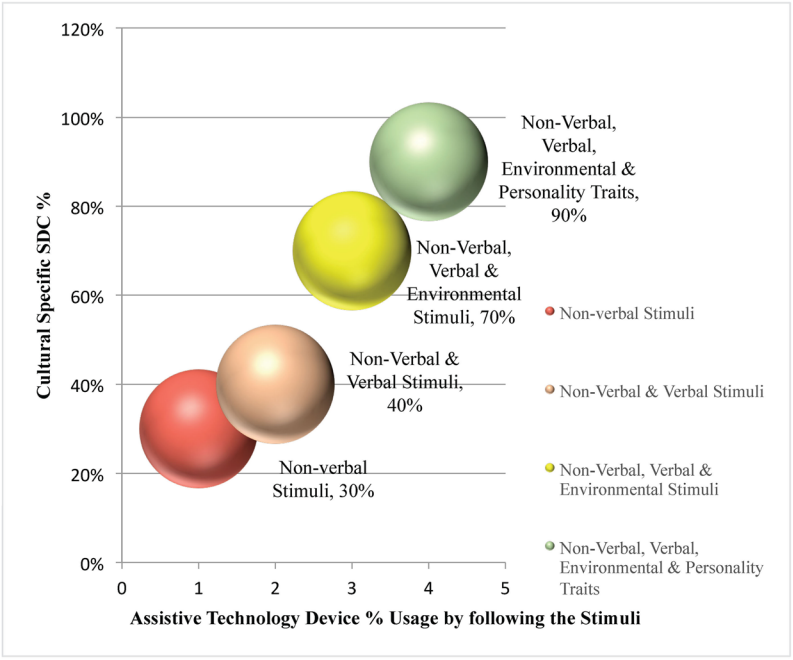
The above discussion shows that many cultural, as well as the above stimuli, should be evaluated before moving towards a particular business model for sustainability where the initial effort is that people would like the product and adhere to the care plan. It also shows how important it is to collaborate with different stakeholders to make a customer-specific product, especially in the world where choices are high. Assistive technology devices in care plan adherence need to be consumer-focused to develop a healthy relationship between product and consumer for revenue attainment, cost reduction for different stakeholders to reduce the socio-economic stress, eHealth literacy, innovation and creation to achieve the value by increasing quality of life of the patient/consumer.

6 Conclusions with Future Scope

Socio dynamic cues, eHealth literacy, decision analytics, technological trust can play a vital role in care plan adherence. It requires an analytical mindset at a business level as well as at the stakeholders level to analyze what could be the best solution for adherence and how technology-based services/devices should be used for ultimate benefit. There is a need for policies amendments not only at the national but also at the international scenario and current business models. One best approved technology-based product/device/service may not be the best solution for a particular community. Many variables that have been



(a)



(b)

Fig. 3 The **a**, **b** shows the assumed percentage if followed and the chances of success for assistive technology related to SDC specificity

described above should be considered. The above-mentioned small analysis/evaluation needs more detailed research and methodologies to get a definitive conclusion. However, there is a need for a joint effort from public, different stakeholders, academia and industries to analyze these factors in detail for making the best eHealth/assistive technology-based product for care plan adherence which is easy to use not only for the customer but also for the clinical staff with the best possible understanding.

References

1. Norman, C. D., & Skinner, H. A. (2006). eHealth literacy: Essential skills for consumer health in a networked world. *Journal of Medical Internet Research, 8*(2), e9.
2. EPF draft position paper on eHealth. http://webcache.googleusercontent.com/search?q=cache:fxdFgAgbU2YJ:www.eu-patient.eu/contentassets/c8ff38cc3ed24717a8c4a4f6e9106579/ehealth-draft-position-paper-2015_for-consultation.docx+&cd=9&hl=en&ct=clnk&gl=dk.

3. W. H. Organization (WHO). (2013). *Health literacy. The solid facts*. http://publichealthwell.ie/search-results/health-literacy-solid-facts?&content=resource&member=572160&catalogue=none&collection=none&tokenscomplete=true.
4. Halwas, N., Griebel, L., & Huebner, J. (2017). eHealth literacy, Internet and eHealth service usage: A survey among cancer patients and their relatives. *Journal of Cancer Research and Clinical Oncology, 143*(11), 2291–2299.
5. Athanasopoulou, C., et al. (2017). Internet use, eHealth literacy and attitudes toward computer/internet among people with schizophrenia spectrum disorders: A cross-sectional study in two distant European regions. *BMC Medical Informatics and Decision Making, 17,* 136.
6. Chung, S., Park, B. K., & Nahm, E.-S. (2018). The Korean eHealth Literacy Scale (K-eHEALS): Reliability and validity testing in younger adults recruited online. *Journal of Medical Internet Research, 20*(4), e138.
7. Vicente, M. R., & Madden, G. (2017). Assessing eHealth skills across Europeans. *Health Policy and Technology, 6*(2), 161–168.
8. Norman, C. D., & Skinner, H. A. (2006). eHEALS: The eHealth literacy scale. *Journal of Medical Internet Research, 8*(4), e27.
9. Koh, H. K., et al. (2012). New federal policy initiatives to boost health literacy can help the nation move beyond the cycle of costly 'crisis care'. *Health Affairs, 31*(2), 434–443.
10. van Gemert-Pijnen, J. E. W. C., et al. (2011). A holistic framework to improve the uptake and impact of eHealth technologies. *Journal of Medical Internet Research, 13*(4), e111.
11. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2006:146:0001:0003:EN:PDF.
12. Towards a National eHealth/Telehealth Strategy for Pakistan. http://webcache.googleusercontent.com/search?q=cache:HyYaZB6RzkkJ:www.lead.org.pk/lead/Publications/DP%252029-%2520Pakistan%25E2%2580%2599s%2520Experiences%2520in%2520Telehealth%2520The%2520Way%2520Forward%2520for%2520a%2520National%2520TelehealtheHealth%2520Programme.pdf+&cd=1&hl=en&ct=clnk&gl=dk.
13. Zhang, X., Yu, P., Yan, J., Ton, I., & Spil, A. M. (2015). Using diffusion of innovation theory to understand the factors impacting patient acceptance and use of consumer e-health innovations: A case study in a primary care clinic. *BMC Health Services Research, 15,* 71.
14. Skär, L., & Söderberg, S. (2018). The importance of ethical aspects when implementing eHealth services in healthcare: A discussion paper. *Journal of Advanced Nursing, 74*(5), 1043–1050.
15. Ministry of Finance | Government of Pakistan. http://www.finance.gov.pk/survey_1819.html.
16. NATIONAL VISION 2016–2025. https://webcache.googleusercontent.com/search?q=cache:AXtjPcF7CD8J:https://www.unicef.org/pakistan/media/1276/file/National%2520Vision%25202016-2025.pdf+&cd=2&hl=en&ct=clnk&gl=dk.
17. Kierkegaard, P. (2015). Governance structures impact on eHealth. *Health Policy and Technology, 4*(1), 39–46.
18. WHO. *Global diffusion of eHealth: Making universal health coverage achievable*. WHO. http://www.who.int/goe/publications/global_diffusion/en/.
19. Currie, W. L., & Seddon, J. J. (2014). A cross-national analysis of eHealth in the European Union: Some policy and research directions. *Information and Management, 51*(6), 783–797.
20. Kim, J. A. (2010). Telehealth in the developing world. *Healthcare Informatics Research, 16*(2), 140–141.
21. 6 Prevention of Disability Associated with Chronic Diseases and Aging, & Institute of Medicine. (1991). *Disability in America: Toward a national agenda for prevention*. Washington, DC: The National Academies Press. https://doi.org/10.17226/1579.
22. Anwar, S., & Prasad, R. (2018). Framework for future telemedicine planning and infrastructure using 5G technology. *Wireless Personal Communications, 100*(1), 193–208.
23. Social dynamics. Wikipedia (22-Aug-2018).
24. Skyrms, B. (2014). *Social dynamics*. Oxford: Oxford University Press.
25. eHealth Startup Guide for business success A practical introductory manual on business modeling and routes to market. http://webcache.googleusercontent.com/search?q=cache:d7MbQxiXmhwJ:digitalezorg.nl/digitale/uploads/2015/04/RESOURCE-GET-on-Track.pdf+&cd=1&hl=en&ct=clnk&gl=dk.
26. Business Models for eHealth—Final Report—European Innovation Partnership—European Commission. European Innovation Partnership (14-June-2012). https://ec.europa.eu/eip/ageing/library/business-models-ehealth-final-report_en.
27. European Telemedicine Market | Size | Share | Forecast. (2017–2022). https://www.mordorintelligence.com/industry-reports/european-telemedicine-market-industry.
28. Anwar, S. (2018). 5G and telemedicine: A business ecosystem relationship within CONASENSE paradigm (pp. 41–57). Conasense Book.

29. Anwar, S. (2017). Smart pharma: Towards efficient healthcare ecosystem. In O. Fratu, N. Militaru, & S. Halunga (Eds.), *Lecture notes of the institute for computer sciences, social-informatics and telecommunications engineering*. Cham: Springer.
30. Anwar, S. (2016). *5G, an approach towards future telemedicine*. Aarhus: National Danish Database, River Publisher.
31. Fogg, B. J. (2003). *Persuasive technology: Using computers to change what we think and do*. Amsterdam: Elsevier.
32. Meyer, E. (2016). *The culture map (INTL ED): Decoding how people think, lead, and get things done across cultures*. Hachette: PublicAffairs.
33. Lindgren, P. (2016). The business model ecosystem. *Journal of Multi Business Model Innovation and Technology, 4*(2), 1–50.
34. Home. vCare project. (04-Jan-2017). https://vcare-project.eu/.
35. Tropea, P., et al. (2019). Rehabilitation, the great absentee of virtual coaching in medical care: Scoping review. *Journal of Medical Internet Research*. https://doi.org/10.2196/12805.

Sadia Anwar received her degree in Doctor of Pharmacy in 2011 form Government College University, Pakistan. Currently, she is working as a Research Assistant in Skagen Uddannelses- og Udviklingscenter where she is deploying her skills and experience for SET II Project for ports. She is also jointly collaborating with research groups CGC (CTIF global Capsule) and CET (Center for Energy Technology) in Aarhus University, Denmark. She had worked for three years as a community pharmacist. She also served as a Hospital Pharmacist and Drug information consultant. She arrived in Denmark, December 2015 and started working as a Guest Researcher at CTiF in the department of electronic systems, Aalborg University under the supervision of Professor Ramjee Prasad. She served for Interdisciplinary area specifically more focused in 4 sections: Medicine, Telecommunication, Big data and economics. She joined Aarhus University in December 2016 in Department of Business Development and Technology as Research Scientist for 7 months. She worked as a Research Assistant in the same department from October 2017 to September 2019. Her research interests were based on the interdisciplinary area of health care technology. She worked with a EU project vCare (Virtual Coaching Activities for Rehabilitation in Elderly)—EU Horizon 2020 Research and Innovation funding programme. She was also involved in administrative and managerial tasks. She has produced many research articles for the International conferences and Journals as an Author and co-Author. She also has been part of three EU Horizon H2020 projects proposals preparation and submission process.

Dr. Ramjee Prasad is a Professor of Future Technologies for Business Ecosystem Innovation (FT4BI) in the Department of Business Development and Technology, Aarhus University, Denmark. He is the Founder President of the CTIF Global Capsule (CGC). He is also the Founder Chairman of the Global ICT Standardization Forum for India, established in 2009. GISFI has the purpose of increasing the collaboration between European, Indian, Japanese, North-American and other worldwide standardization activities in the area of Information and Communication Technology (ICT) and related application areas. The University of Rome "Tor Vergata", Italy as a Distinguished Professor of the Department of Clinical Sciences and Translational Medicine honoured him on March 15, 2016. He is Honorary Professor of University of Cape Town, South Africa, and University of KwaZulu-Natal, South Africa. He received Ridderkorset af Dannebrogordenen (Knight of the Dannenberg) in 2010 from the Danish Queen for the internationalization of top-class telecommunication research and education. He has received several international awards such as IEEE

Communications Society Wireless Communications Technical Committee Recognition Award in 2003 for making contribution in the field of "Personal, Wireless and Mobile Systems and Networks", Telenor's Research Award in 2005 for impressive merits, both academic and organizational within the area of wireless and personal communication, 2014 IEEE AESS Outstanding Organizational Leadership Award for: "Organizational Leadership in developing and globalizing the CTIF (Center for TeleInFrastruktur) Research Network", and so on. He has been Project Coordinator of several EC projects, namely, MAGNET, MAGNET Beyond, eWALL, and so on. He has published more than 30 books, 1000 plus journal and conference publications, more than 15 patents, over 100 PhD Graduates and a more significant number of Masters (over 250). Several of his students are today worldwide telecommunication leaders themselves. Under his leadership, magnitudes of close collaborations are being established among premier universities across the globe. The collaborations are regulated by guidelines of the Memorandum of Understanding (MoU) between the collaborating universities.

Prof. Dr. Bhawani Shankar Chowdhry is the Distinguished National Professor and the former Dean Faculty of Electrical Electronics and Computer Engineering at Mehran University of Engineering and Technology, Jamshoro, Pakistan. He did his PhD from renowned School of Electronics and Computer Science, University of Southampton, UK in 1990. He is having teaching, research and administration experience of more than 35 years. He has the honour of being one of the editor of several books "Wireless Networks, Information Processing and Systems", CCIS 20, "Emerging Trends and Applications in Information Communication Technologies", CCIS 281, "Wireless Sensor Networks for Developing Countries", CCIS 366, "Communication Technologies, Information Security and Sustainable Development", CCIS 414, published by Springer Verlag, Germany. He has also been serving as a Guest Editor for special issue "Wireless Personal Communications" Springer International Journal. He has produced more than 13 PhDs and supervised more than 50 MPhil/Masters Thesis in the area of ICT. His list of research publication crosses to over 60 in national and international journals, IEEE and ACM proceedings. Also, he has Chaired Technical Sessions in USA, UK, China, UAE, Italy, Sweden, Finland, Switzerland, Pakistan, Denmark, Spain and Belgium. He is member of various professional bodies including: Chairman IEEE Karachi Section, Region10 Asia/Pacific, Fellow IEP, Fellow IEEEP, Senior Member, IEEE Inc. (USA), SM ACM Inc. (USA). He is a Lead person for four European Commission Erasmus Mundus exchange programs "Mobility for Life", "STRoNG-TiES" (Strengthening Training and Research through Networking and Globalisation of Teaching In Engineering Studies), INTACT (It's Time for CollaboratioNTowArds Close CooperaTion), LEADERS (Leading mobility between Europe and Asia in Developing Engineering educations and ReSearch), and Stearing Committee Member CENTRAL (Capacity building and ExchaNge towards attaining Technological Research and modernizing Academic Learning).

Technology-oriented home-based rehabilitation for supporting medication adherence

Sadia Anwar
Department of Business Development and Technology
Aarhus University
Herning, Denmark
sadia@btech.au.dk

Ambuj Kumar
Department of Business Development and Technology
Aarhus University
Herning, Denmark
ambuj@btech.au.dk

Ramjee Prasad
Department of Business Development and Technology
Aarhus University
Herning, Denmark
ramjee@btech.au.dk

***Abstract*—Technology transition and current innovative medical solutions have decreased the mortality rate and at the same time increased the life expectancy. The increasing number of the aged population and progression in chronic disease therapy will require a long-term patient commitment to the medication and care plan. There is a need to strengthen a sustainable technology platform to adhere patient to medication to augment the quality of life (QoL) of the patient with reducing health economics.**

Keywords— Telemedicine, Healthcare ecosystem, Medication Adherence, Chronic disease, Technology-oriented value-based platform, Health Economics

I. INTRODUCTION

In medicines, Adherence "the extent to which patient`s behavior matches the agreed recommendations from the prescriber" [1]. Whereas a Care Plan is medical advice based on the patient's unique body dynamics, needs and diagnostics by the healthcare provider. It involves treatment, interventions and an agenda for the next follow-up evaluation [2]. The purpose of adherence to care plan is to reduce the relapse of patients to the hospital and to improve the quality of life (QoL) of the patients. Chronic diseases require steadfast patient behavior for adherence to the care plan. Adherence to care plan reduces medical team effort (appointments, assessment, hospital space, future relapse, inappropriate reimbursement, & payments) and improves patient outcomes, i.e., improved QoL with a minor cost. Causes of non-adherence to care plan could be internal like age, culture, attitude, and motivation, relationship with the health care team, family, etc. Additional factors like complicated care plan, eHealth education, affordability, adaptability of new technology and less believe in the care plan for outcomes.

Inappropriate adherence to medication especially when prescribed by the physician in severe conditions is imperative. There are several noncommunicable, immune system compromising and infectious diseases which require persistence to follow up the care plan. If the patient doesn't follow the prescribed medication, many strains or viruses stimulate or start to develop resistance. Non- adherence can decrease the quality of life (QoL). It can also put economic pressure on the pocket of the patient as well on the entire healthcare ecosystem. Massive surgeries or accidents need to follow up the care plan to bypass severity and improve the healing process of the affected area. Chronic diseases require more determined push from the patient to follow the medication plan since the patient have to follow the assigned care plan for a lifetime. Adherence to medication is regarded as a compelling effort.

This paper discusses what could be the value proposition technology-oriented platform to ensure medication adherence. This article has five sections which define the user requirements, need for a multidisciplinary approach, a case study. A technology-oriented value-based platform to optimize medication adherence is proposed and lastly conclusions.

II. MEDICATION ADHERENCE USER REQUIREMENTS

Approximately 50 percent of the ageing patients do not follow physician recommendation. Around 200.000 premature annual deaths are linked to medication non-adherence in Europe, and it cost around EUR 1.25 billion. In united states, it cost between $100 to $289 billion a year to the American health care system [3]. Non-adherence to medication leads to 125,000 deaths annually in the United States. The non-adherent patients with medication have more significant health cost, e.g. $3,700 for diabetes and $ 3,900 for hypertension per year. Adherence to medication alone with diabetes patient could save $ 4.7 billion [4]. Adherence to care plan is part of the Europe Union research projects H2020 and legislation [5]. Fig. 1 shows the situations that need a close adherence and constant care, and also, this figure shows kind of adherences required for patients' well being.

A. User Requirements (see fig. 1):

1) The user requires medication adherence to get the wanted effects. The efficacy of treatment depends on the amount or concentration of the drug available in the bloodstream that can fabricate the desired effect. So, the physician prescribes to take medication after a listed interval to control the therapeutic level of the drug. If Patient doesn't take the pill, the required therapeutic effect cannot be achieved [6].

2) It is essential to establish a technology platform based on a reminder for medication adherence for older adults and the patient having dementia, memory loss or cognitive problems to avoid the toxicity or reduced effect if the patient doesn't take or overtake the medication.

3) Tuberculosis (TB) requires 6.9 months of treatment, and medication adherence is essential in case of non-adherence patient have to start the medication again from the beginning which is very stressful and require re-scheduling of time and mental effort. Medication adherence is mandatory in case of severe or chronic diseases

like HIV, Diabetes, Hypertension, Parkinson and stroke etc. [7].

4) Patient lower literacy for medication administration & self-management, less knowledge about the pathology of the disease and polypharmacy can lead to dose missing or maybe frustrate patient not to take it at all if the method of administration is complicated. Literacy can be improved by a technological platform or a virtual coach for self-management and user-friendly guidance repeatedly and effectively [8].

5) Antibiotics require medication adherence if forgotten can mitigate strain or viruses so it will be challenging to target them by a reduced dose. It is also a very significant obstacle especially in underdeveloped countries since drug-resistant strain is kept arising and vulnerable with the passage of time and to attack them requires time maybe 6 months or year to produce a medication or vaccine that can target them and avoid deaths [9].

B. Discussion

To analyze the socio-economic cost of Diabetes patients in Denmark. Patients involved in the National database of 2011 (N= 318 729). Diabetes cost had been counted as the difference between the cost of diabetes patients and the expected cost, from the annual consumption of the diabetes-free population. The estimated cost for diabetes was 4.27 billion EUR in 2011 corresponding to 14,349 EUR per patient per year as a result. Two-fold higher use of healthcare resources was found for the patient with diabetes as compared to the diabetes-free population. Cost is determined for different components.

A steep increase was seen for complicated diabetes patient as compared to non-complicated. An estimate of 6,992 EUR per person was estimated if we exclude potential confounders [11]. It clearly describes that medication non-adherence has profound effects on the budget of the patient as well as health care system.

Table 1: Healthcare budget

Cost million EUR	Components
732	Primary or secondary care
153	Pharmaceutical drugs
851	Nursing Service
1.77	Productivity lost
761	Additional factor cost

III. THE INTEGRATED APPROACH

Clinical and non-clinical care providers lead to the development of a framework or protocol for execution of a plan with shared benefits, and that could be value or cost-based. Value concern the increased quality of life of the patient (QoL), resources generation for cost reduction and new business models that can pay and generate the value of a particular telemedicine service.

A. Human Involvement

The framework of a specific service of telemedicine includes "remote site" that receive care (consumer or patient) and a "hub site" that delivers the care. A hub site is integrated clinical or non-clinical care providers. Non-clinical care providers could be technological, pharmaceutical or municipalities.

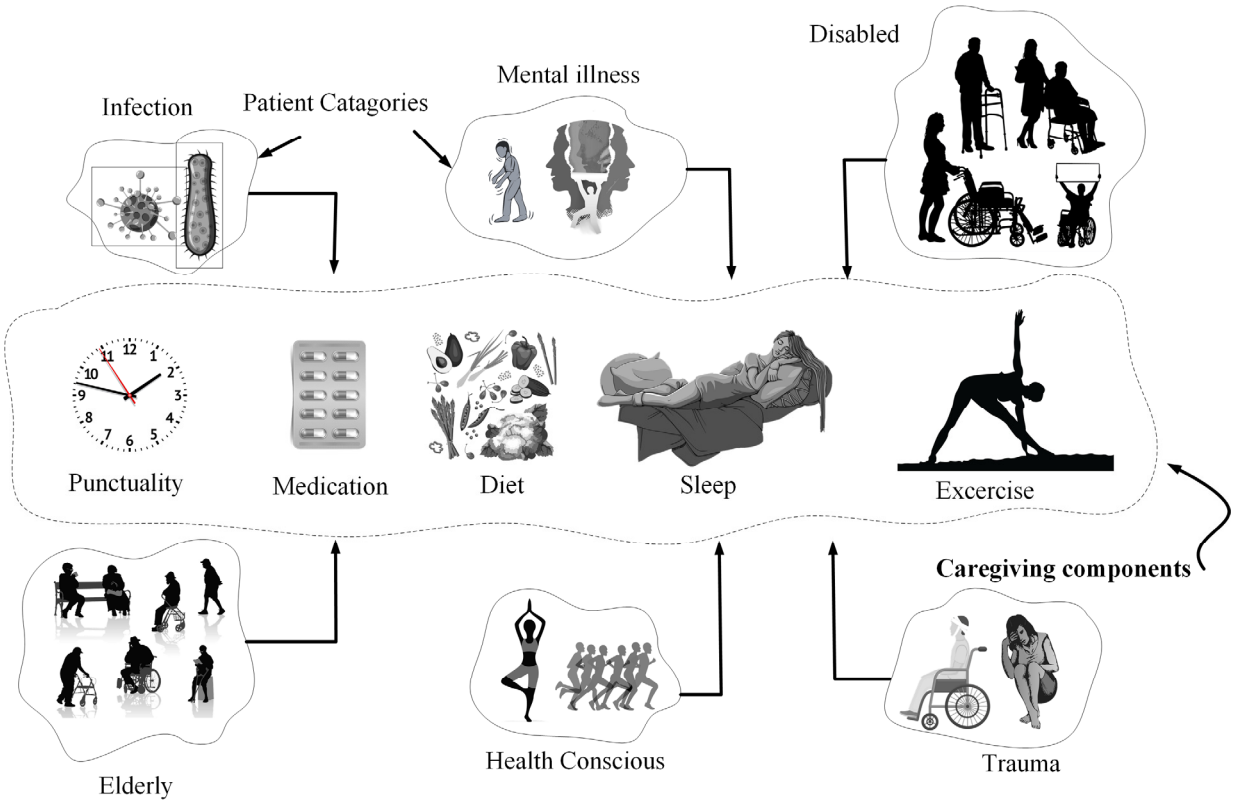


Fig. 1: Medication Adherence User Requirements

This adherence issue does not confine to prescriber or patient; instead, that indicates deployed system error. There is a need to share responsibilities and strategies among clinical and non-clinical care providers [10].

B. Technological Platform

Considering the illustration in fig. 2, the technological platform for the home-based rehabilitation system is discussed as below.

(1) Human Centric Systems:

The human centric systems as the superset of smart homes where the health parameters are also the part of participating devices. As an example, an air conditioner of a smart home may be controlled remotely as it is connected with the communication network through an internet of things (IoT) protocol, and, the same platform may be used by tonometer (blood pressure meter) to send the blood pressure measurements to the intended locations. More and more devices may be added for a composite and complete tele-healthcare (TH)/ telemedicine (TM) systems. Such systems, which integrate health process and equipment in the IoT paradigm, are the Health Centric Systems (HCS). As shown in fig. 2, the HCS platform has following additional functions to perform:

- Collecting the health and environment related information from respective sensors.
- Pushing the information to the communication platform
- Facilitating the doctor's and patient's distant conversation
- Initiating the medicine and help delivery request
- Initiating emergency processes

These are the need-based functions and are initiated when required, and have different priority settings for the nature of the call. The HCS system can also be understood as the remote hub site, as discussed earlier.

(2) 5G and Beyond technology

The reachability and performance of the system depends on the communication technology platform on which the tele-healthcare system operates. In the figure, we expect 5G and beyond to take a lead in implementing the TH systems. The low latency and high throughput of 5G and 5G+ technologies are desirable for its successful deployment. The routers at the HCS helps to interconnect the devices and interact with information via cloud.

Fig. 2 shows a brief description of communication technology that are required for proper dissemination of TH services. The TH system uses the common communication network that has a base station subsystem (BSS) and Core Sub System (CSS). The BSS is responsible for the deployment of network sites within the network service are and the NSS is responsible for integrating all the BSS of various geographical areas, At the same time, NSS is also responsible for communication with internet and cloud. In this way, a TH service can communicate with the public network through either WIFI or direct access with the communication network. The data in the cloud is used by various applications that support TH services.

In fig. 2, we have shown that the two kinds of network deployment that are required for the TH systems, the macro level and the pico level. On the larger level, network service provider of the respective area covers the geography by deploying macro level network. This is the usual communication network, which is being used by the common users for their normal communications, and here we extend its use to the TH applications. The second level is the pico level, which is a dense network, within either a hospital or professional care centers that associate equipment with the TH network.

(3) Telemedicine / Telehealth services

In fig. 2, we have shown several services that are required for the TH services to function efficiently. Each service is prioritized based on the call and the requirement. These services are:

- Regular rehabilitation procedures (RRP): Fig. 1 shows the kind of procedures that are associated with the TH systems. To keep check on the rehabilitation process, it is required that the rehabilitation seeker is always in a constant touch with the user. This is expected by the TH network to provide a constant accessibility with the patient. A patient, or even a consultancy seeker, must have a ability to connect with their consultant or caregiver at any instant of time, and RRP provides this facility to the users. Besides stringent situations, RRP also helps in keeping track of caregiving processes, such as maintaining punctuality in medication, diets, exercises, and sleep. It is important to note that RRP applies to HCS where the patient is located at his or her residence or native place, or is in nomad mode.

- Healthcare professional services: These are the services that associated with TH / TM systems, such as hospitals, medical institutions, and caregiving centers. The medical instruments such as x-ray, MRI, CT-Scan, etc. can be connected to TH server for information exchange. The medical practitioner can access the patients information, collected at both residence and hospitals, anywhere in the globe through TH server. The advanced care, which is only possible at hospitals, can be assigned based on the patient's need and consultancy.

- Emergency Services: These services include Ambulance, Fire, and Police services, and in all three modes, ground, aerial, and waterways. These services are integrated via TH server for prompt and coordinated attempts. Usually, the TM services do not include police and fire segments, but here we suggest to accommodate all three modes of actions and their accessibility is desirable 24 × 7.

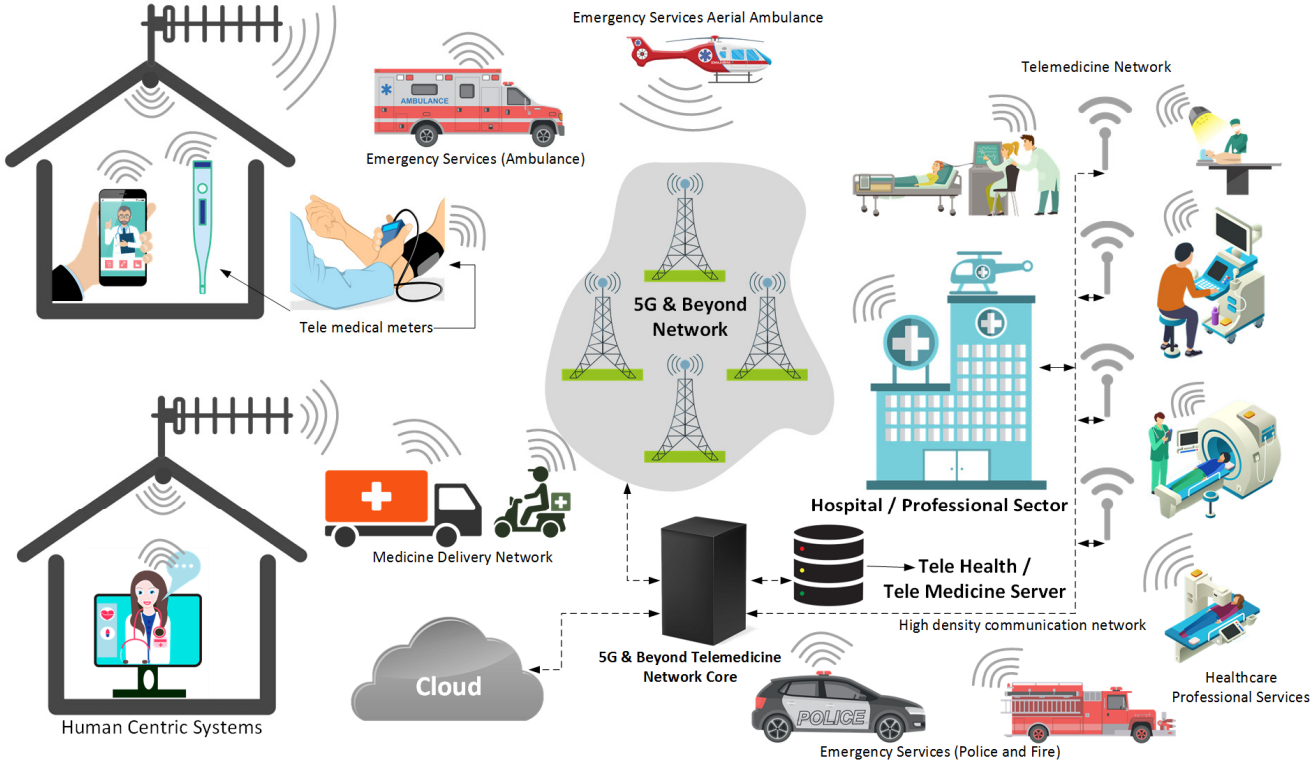


Fig. 2: Proposed Telemedicine Infrastructure

IV. Discussion: Home Based Telemedicine

Let us consider a patient, who has just been relieved from the hospital for the home based rehabilitation. The caregiver or medical expert plans and uploads the rehabilitation schedules for the patient on the HCS, which includes the daily plan of medicine intakes, sleeping times, exercises, and diets (see fig. 1). The patient, at his home is constantly monitored and instructed by HCS via the TH systems. Both, patient and caregiver or doctor, can initiate a prompt communication with each other on the need or regular basis. Both caregiver and medical expert (doctor) can change the rehabilitation plan from the remote location on the individual HCSs.

Now, let us assume that on one day, HCS detects a suspicious information, which could be sudden change in some vital parameters (cardiac arrest, faint, etc.) or no information at all. The TH / TM server coordinates with HCS to process the information and sets up emergency to rush to the patient in trouble. At the same time, the Healthcare Professional Services are alarmed for the incoming patient and the details of the patient's parameter are sent to them. In this way, doctors know the patient's condition prior to arrival, which gives them time to prepare for the case.

If in case, HCS itself in trouble, such as fire, fire, theft, sabotage, etc., which can put patient's life in danger, then other two emergency services can also be put in action to cover the causes. This is also very helpful for elderly people who, sometimes, forget to turn off the kitchen stove or electrical appliances, leave the door open, etc., which are enough reason for welcoming problems.

V. Conclusions

Long-term therapies and chronic diseases expect compatible patient behavior for medication adherence. Multiple chronic diseases, especially in older age, require numerous dose administration. Medication adherence can be enhanced with the technological platform and new innovative solutions, but research is still needed to improvise the technical model by considering the different factor that hinders patient to follow up schedule or care plan. If the developed platform can improve the understanding of the patient towards disease or through behavioral modification strategies implementation, then it is possible to reduce the non-adherence of medication. This paper presents a home based rehabilitation architecture, which not only provides artificial caregiving, but also is also efficient to cover patient's stringent needs. The TM system architecture has one TM server, which connects with the core of a communication network to access the information on the cloud. Each health component, such as hospital, professional instruments, emergency vehicles, are connected with the TH server for a overall care. At the resident end, the rehabilitation is taken care by HCS, which reads the environment and health parameters and uploads them on the cloud. The TH server accesses the cloud information and sets up services for each HCS. In this way, the healthcare and rehabilitation services become autonomous and reliable.

References

[1] R. Walker, Clinical Pharmacy and Therapeutics E-Book. Elsevier Health Sciences, 2011

[2] R. J. Cipolle, L. Strand, and P. Morley, Pharmaceutical Care Practice: The Patient-Centered Approach to Medication Management, Third Edition. McGraw Hill Professional, 2012.

[3] . S. Al-Lawati, "A report on patient non-adherence in Ireland.," Pfizer Healthcare Ireland; Irish Pharmacy Union; Irish Patients' Association, Dublin, Report, Mar. 2014.

[4] "Issue Brief: Medication Adherence and Health IT." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:ibgxffWrzEIJ:https://www.healthit.gov/sites/default/files/medicationadherence_and_hit_issue_brief.pdf+&cd=1&hl=en&ct=clnk&gl=dk.

[5] "Adherence and Concordance." [Online]. Available: http://webcache.googleusercontent.com/search?q=cache:77TxMVrYwUQJ:www.eu-patient.eu/globalassets/policy/adherence-compliance-concordance/adherence-paper-final-rev_external.pdf+&cd=1&hl=en&ct=clnk&gl=dk.

[6] R. Finkel (PharmD.), M. A. Clark, and L. X. Cubeddu, Pharmacology. Lippincott Williams & Wilkins, 2009.

[7] S. Yan, S. Zhang, Y. Tong, X. Yin, Z. Lu, and Y. Gong, "Nonadherence to Antituberculosis Medications: The Impact of Stigma and Depressive Symptoms," The American Journal of Tropical Medicine and Hygiene, vol. 98, no. 1, pp. 262–265, Jan. 2018.

[8] K. Kvarnström, M. Airaksinen, and H. Liira, "Barriers and facilitators to medication adherence: a qualitative study with general practitioners," BMJ Open, vol. 8, no. 1, p. e015332, Jan. 2018.

[9] C. Llor et al., "A study of adherence to antibiotic treatment in ambulatory respiratory infections," International Journal of Infectious Diseases, vol. 17, no. 3, pp. e168–e172, Mar. 2013.

[10]] A. Atreja, N. Bellam, and S. R. Levy, "Strategies to Enhance Patient Adherence: Making it Simple," MedGenMed, vol. 7, no. 1, p. 4, Mar. 2005.

[11] C. Sortsø, A. Green, P. B. Jensen, and M. Emneus, "Societal costs of diabetes mellitus in Denmark," Diabet. Med., vol. 33, no. 7, pp. 877–885, Jul. 2016.

Wireless Personal Communications (2020) 113:1567–1578
https://doi.org/10.1007/s11277-020-07299-x

Connections of Chronic Diseases and Socio-dynamic Cues for Integrating ICT with Care Plan Adherence

Sadia Anwar[1] · **Ramjee Prasad**[1]

Published online: 11 April 2020

Abstract
Chronic disease requires healthy patient behaviour to follow the care plan that becomes very vital if the patient has multiple chronic conditions and disability. Integration of Information and Communication Technologies (ICT) and focal health care business models provide high-grade answers to achieve adherence with a care plan to overcome socio-economic cost and improve the workforce. Analysis of the socio-dynamic cues (SDC) among different regions and interpretation models for data gathering through the ICT infrastructure can assist in better diagnosis, treatment, finding relevance between chronic diseases among regions of the world and the extent by which a patient follows the care plan with optimization strategies. The paper highlights that technology trust and implementation requires regulations as well as the multidisciplinary approach at all sectors as a deciding element for care plan adherence as well as shows how to make connections among diseases with a preliminary framework to develop a business model which is more efficient for assistive technological devices and eHealth applications.

Keywords Chronic diseases connections · Data mining · Socio-dynamic cues · Behavioural modifications · Stakeholders involvement · ICT · Care plan adherence · Interpretation models

1 Introduction

Non-communicable diseases (NCDs) are not interchangeable from one person to another person, for example, diabetes, cardiovascular diseases, respiratory diseases etc. These diseases are also referred to as chronic diseases that need lifetime stagnancy for treatment. Many factors contribute to their occurrence that could be environmental, our genetic material, and some could be physiological. In contrast, others depend on the behaviour of the particular patient to follow a care plan or lifestyle choices. Pieces of evidence show that 15 million of the deaths related to NCDs happen between the ages of 30–69 years [1].

✉ Sadia Anwar
sadia@btech.au.dk

Ramjee Prasad
Ramjee@btech.au.dk

[1] Department of Business Development and Technology, Aarhus University, Herning, Denmark

Risk factors are the main elements that induce or further intensify chronic disease condition. These can also be the primary factors to initiate another chronic disease condition in connection to a primary chronic disease. Risk factors can be behavioural or biological risk factors. Behavioural risk factors are unhealthy food choices, more use of alcohol, tobacco use and physical inactivity. These risk factors can be modified if the patient is motivated to eliminate or reduce them by self-effort. The biological risk factors are elevated blood pressure, glucose level, cholesterol level or obesity etc. These mentioned risk factors are the primary cause of death or related disabilities among the people in the globe [2]. Prevention is the only solution that can guarantee good health physically as well as mentally.

In Europe, deaths caused by NCDs cost EUR 115 billion per year [3]. Although due to the latest advancement in the technology and health care system setups the overall life expectancy has been increased, this has also increased the survival rate of the ageing population moving through chronic diseases. Socioeconomic cost is the primary area that needed to be addressed, as it would be necessary for the future that patients having chronic diseases should be consistent with the treatment plan. Irregularities or behavioural fluctuation can lead to higher cost. Socioeconomic status is also one of the predicting factors for the development of the risk factors that can initiate chronic disease. Low socioeconomic status and low education rate can also determine the prevalence of chronic diseases. Danish healthcare is one of the highly ranked systems in the world. Accordingly, the European Observatory on Health Systems and Policies1 report-2017, Denmark is ranked eighth for the percentage of grownups reported to be in good health, and seventh for spending on healthcare [4].

However, there are several healthcare issues, which are the country's biggest worries. As per the same report, cancer, cardiovascular, and ischemic heart diseases remain the leading cause of death in Denmark. Additionally, depression and musculoskeletal problems are among the leading indicators of poor health in Denmark. Apart from the EU, Denmark is also a keen player in funding several projects to modify the healthcare paradigm. One aspect of such transformation is the integration of healthcare and ICT; as a result, Denmark enjoys a great use of ICT in healthcare. Besides treating illness, another significant Danish healthcare expense is for rehabilitation and caregiving, and several research projects, either concluded, in progress or commenced, is cantered to this context. This paper examines how ICT Integrated solutions with business modelling can help to improve well-being.

Figure 1 illustrates the map of the prevalent chronic diseases throughout Europe. The broader spectrum can be seen in case of cardiovascular, neuropsychiatric and malignant neoplasms.

The article has six parts. Section 1: describes the introduction, Sect. 2 tells about the connection between chronic diseases and their impact on society. Section 3 explains Denmark strategies for digital health care and Sect. 4 tells about the importance of health care business models. Section 5 illustrates how ICT can help in care plan adherence with possible approaches, and Sect. 6 presents the conclusion and eventually references at the end of the paper.

2 Relevance of Multi-chronic Diseases and Importance of the Care Plan

Chronic disease has many adverse effects on the health of the patient and daily activities. Risk factors could be the same if a patient has multiple chronic diseases. What is required here is to implement a care plan that can assist patients in numerous ways to avoid the

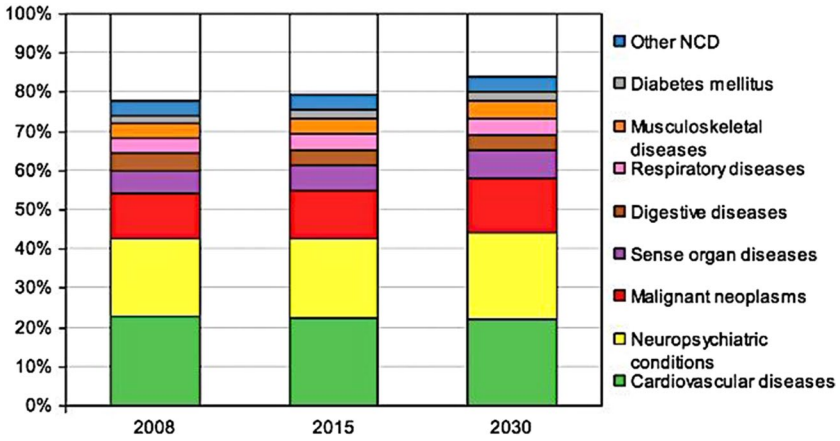


Fig. 1 Represents Health statistics, WHO, a spectrum of prevailing chronic diseases in Europe, 2008 and forecasts for 2015–2030 [5]

severity of chronic disease into numerous chronic diseases. Lousy lifestyle behaviours and multiple chronic diseases can vary the quality of health and life of the patient. The care plan should cover the common adverse effects as well as risk factors for chronic disease for overall improvement. If one risk factor that can lead to one or two chronic diseases afterwards, it is essential to eliminate such a risk factor. Some of the common side effects are given below in case of multiple chronic diseases

- Associated Depression.
- Decrease Quality of life.
- Long term therapy.
- Require a persistent approach both at patient, doctor and service provider level.
- Lifestyle modification = healthy habits Development.
- Motivation.
- Poverty Issues.
- The social, economic and emotional burden.
- Commitment and trust in technology and the health care team.

2.1 Care Plan Non-adherence and Impact on Society

Morbidity and Mortality with chronic diseases have a significant impact on the overall social progress. The life span expectancy has been increased for the past 40 years in the 28 countries of Europe. The 3.2 years of life span increase in males and 2.5 years in females during the period of 2003–2013 have been observed [6]. The increase, as mentioned above, is not healthy in life expectancy. At the age of 65, only a few are enjoying life with good health, while others have multiple chronic diseases with decreased quality of life. The decreasing quality of life and increased life expectancy can lead to several problems.

- Increase socio-economic cost (Burden on the Government and municipalities)
- Less availability of Workforce
- Increasing aged population

- Decreased social engagement and involvement in activities as a productive citizen

Chronic diseases are a global constraint on health and economics, and they cause the premature death of more than 550.000 (25–64 year) each year in EU countries. These deaths dissipate 3.4 million productive life years, considering if these people are employed until the age of 65 years with the same employment rate as the rate of rest population. An analysis was conducted in 28 EU countries, and Table 1 describes some of the nations concerning productivity and death loss:

They are considering the Annual income of ordinary EU workers as €33,800. Then the amount leads to the expense of EU economics €115 billion or GDP of 0.8 annually. Patients face a challenge to adhere to the care plan as it is challenging to develop new habits or lifestyle modification.

2.2 Societal Factors and Non-adherence

New innovative solutions guided by ICT are available for care plan adherence and lifestyle modification, especially in case of multi chronic diseases. These technology-based solutions can reduce the common side effects and can increase the quality of life of the patient and overall health [8].

2.3 Adherence Needs Collaborative Efforts

Adherence to a care plan does not confine to prescriber or patient; instead, it indicates deployed system error. There is a need to share responsibilities and strategies among clinical and non-clinical care providers [9]. Clinical and non-clinical care providers lead to the development of a framework or protocol for execution of a plan with mutual benefits. Structure or protocol could be a value or cost-based like to increase motivation, QoL, productivity, reduce the premature death of the patient, ultimately reduction of the care plan cost. The structure and model can be attached to business strategy and technological use. Non-clinical care providers could be technical, pharmaceutical or municipalities (Table 2).

Table 1 Health expenditure, chronic disease, Europe, 2016 [7]

EU country	Premature deaths		Potential productive life loss	
	Number	Rate/100,000 population	Number	Rate/100,000population
Denmark	5177	178	29,755	1023
Italy	48,231	147	312,026	952
Spain	38,003	142	256,969	960
Romania	40,621	361	247,952	2203

Table 2 Shows some of the relevant issues are described in the table below regarding technology trust and people perceptions

Acceptability of innovative technologies	eHealth literacy	Cultural and Religious Beliefs
Slower to adopt	User-friendly ICT solutions are required	Perceptions about health, illness and death?
Technology easy to use	Consultation at all levels	Beliefs about the causation of the disease?
Difficulty in learning, reading due to disability	Concept of blended staff for multipurpose tasks	Access to health promotion ideas?
Skeptical attitude	Deployment of solutions related to technologies for sustainability	How is disease felt and experienced by an individual?
Attitude ⇒ interest and willingness to invest		Where patients seek help and preferences?
Less social network		Types of treatment patients prefer?
		Availability of user-friendly solutions?

3 Denmark Healthcare System, Municipalities and Technological Business Models

Denmark has put substantial weight on public–private partnership. Businesses in the eHealth industry have an estimated turnover of $680 million, and Denmark is one of the front-runners in the development of eHealth solutions and has Digital welfare 2016–2020 strategies for caregiving and medicine. It is based-on Telemedicine to reduce expense and to increase the safety and convenience of the patient at various stages of the hospital, GPs and municipalities. It also provides a better framework for the business community and public–private sector [10]. Municipalities deliver welfare allowance for older, disabled and people with chronic diseases after their discharge, from the hospital. There is intense stress on making patients self-sustained and staying at home as possible through active and health-promoting programs [11]. These services are provided by public taxes and the professional person hired by the municipalities. The number of ageing populations is rising in Denmark, an immediate challenge, and it is putting a burden on local governments for finances [12] (Fig. 2).

Operating expenditure is different from service expenditure. Service expenditure was DKK 230.1 billion as compared to operating expenditure DKK 323.7 billion for 2014. Denmark's population is nearly 5.5 million. Every year there are 79 diabetes new cases in Denmark. The number of Danes diagnosed with diabetes is 320.545. It is 5.7 percent of the total population of Denmark, and the number is going to rise in the next ten year that is almost double the current rate. The projections of diabetes for 2030 hit 430.000 Danes. Diabetes is causing approximately DKK 86 million socio-economic expenses [14].

Telemedicine market in Europe grew $3.1 billion from 2010 to $4.8 in 2011, and it is expected to triple in 2019. Information communication technological investments, increasing aged population, and less adherence to the care plan are the driving forces for the telemedicine market [15]. Technology is expanded to reduce morbidity, and enhancing motivation of patients with behavioural change is the essential factor in recent research. Many studies with different avatars or robots are investigating that can help in adherence to care plans [16]. Performance of an eHealth system and business model's creation depends on the site where it is going to be implemented, patient relationship, value creation, delivery channels or framework, overall impact and value-based outcomes generation [17].

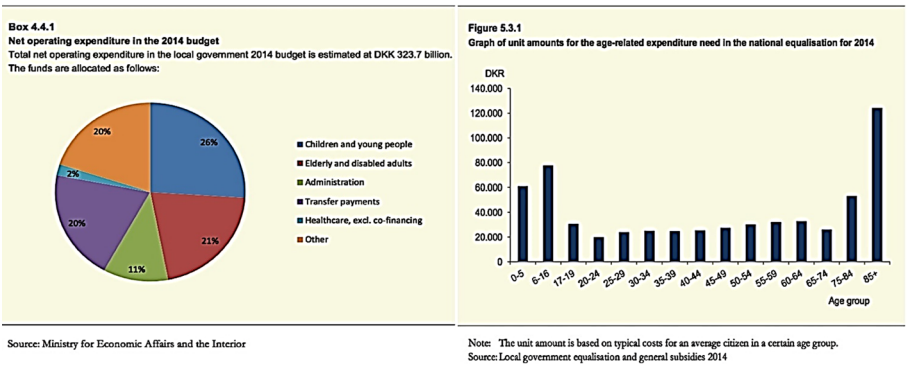


Fig. 2 Illustrates net operating expenditure, percentage distribution, and age-related expenditures, 2014 [13]

For e-business models, eHealth and ICT products can be disposed of that can accelerate self-management and induce adherence to the care plan. There is a need to understand components of eHealth, involved stakeholders and post-self-care programs in making patients independent via adherence to the care plan [18, 19]. Pharmaceutical companies can furnish a digital solution with treatment tailored for the application. A medicinal box can be improvised with sensors, implants, and smart tablet box [20]. The primary target of the 7th framework of the European Union is to amplify human-specific computer models for personalized care plans blended with technology.

4 Integrating and Framework for the ICT Paradigm with Medical Adherence to Care Plan and Wellbeing

Communication technologies, such as 4G, 5G (or IMT2020), and all futuristic communication technologies have a common goal of enabling more and more devices to communicate with humans as well as with each other. Healthcare systems have taken massive advantage from this amalgamation to revolutionize and modernize its value propositions. Figure 3 below shows a generic description of the paradigm shift in healthcare for its integration with ICT.

The objectives of the integrated health care system with ICT are to increase the quality of life for increasing life expectancy. It could be in many forms, for example, development and innovation in ICT for healthcare can contribute to specific challenges regarding rehabilitation of patients at home. The integration of ICT in care-pathway and adherence will influence the less socioeconomic cost and provide developing companies or start-ups to come up and contribute to the hospital profession. It will provide more jobs and expand business models. There are many possible ways for research and development in healthcare systems by ICT solutions and joint ventures to find out the scientific relevance or connection between chronic diseases.

Fig. 3 ICT and Healthcare integration and flow of patient data from home to the physician at a distant place

The socio-dynamic queues (SDC) specific to a geographical area or culture can also give an insight, dissect a culture following and the prevalence of diseases and their patterns. Verbal, non-verbal stimuli, environmental factors and personality traits are different in different areas of the world that makes a person get one or several comorbidities. The underdeveloped countries are more at risk as sanitary conditions, level of eHealth literacy and health care system, even the association of different stakeholders are shallow. Latest ICT platforms, data mining techniques and artificial intelligence can deep dig into that pattern, and the data can be integrated at one platform regarding behavioural change and adherence to a care plan to improve Quality of Life (QoL) of the patient with a vision for a value proposition, cost reduction and productivity based Business models of the Health Care. New business models related to assistive technologies need to study the socio-dynamics and stakeholder involvement specific to the area so that the productivity of the particular device can be enhanced. After data collection and research studies, technology itself gives insight into the health care Businesses about how to plan/ optimize the Health services or assistive devices. Analysis of the understanding of eHealth education between patient and service providers for ICT can further enhance the service for the target population after studying the SDC and surrounding environment.

4.1 Possible Solutions in the Frame of ICT Integrated Health Care Assistance

The below diagram shows that the Data analysis and interpretation models can help to strategize chronic disease connections and optimize adherence to care plan. If one chronic disease is targeted for the care plan and lifestyle modification, it can very likely decrease the probability of other chronic diseases. If a person has multiple chronic diseases by the implementation of a simple treatment care plan can reduce chances or exaggeration for other chronic diseases as well. It is possible by finding the possible connections for chronic diseases, then positive motivational strategies and solid care plans can be suggested (Fig. 4).

Increased depression can lead to increase palpitation that can disturb the rhythm of the heart. Depression can also lead to an increased level of the stress hormones, which will, in return, disrupt the blood glucose level. The disturb glucose level can lead to diabetes mellitus.

If we can take the data by seeing the socio-dynamic cues (SDC), it will also help in finding the conclusion and association. Likely if a person is living in an area or following a culture that promotes eating carbohydrate and more fat can lead to weight gain. Weight gain is associated with many chronic diseases. Depression and high stress can lead to weight gain. Lifestyle modification can be beneficial but to apply a strategy requires a particular region or area exploration, as environmental stimuli are significant for developing habits.

Data collection in terms of area specificity and SDC can help to identify the area-specific diseases and associated diseases that can help to make models for helping assistive technology-based business and different stakeholders to target the specific area with high efficiency (Fig. 5).

The Results can be seen in multiple scenarios like decreased socio-economic expenditure, several total deaths, increased commitment with care plans worldwide and improved the QoL of the patient. The outcomes can give insight to municipalities, pharma & tech industries to seize value or cost-based business models for eHealth applications and assistive technology devices. The findings can help in cost channelization to the added payer by innovative BM integration for patient adherence to the care plan. The outcomes can give

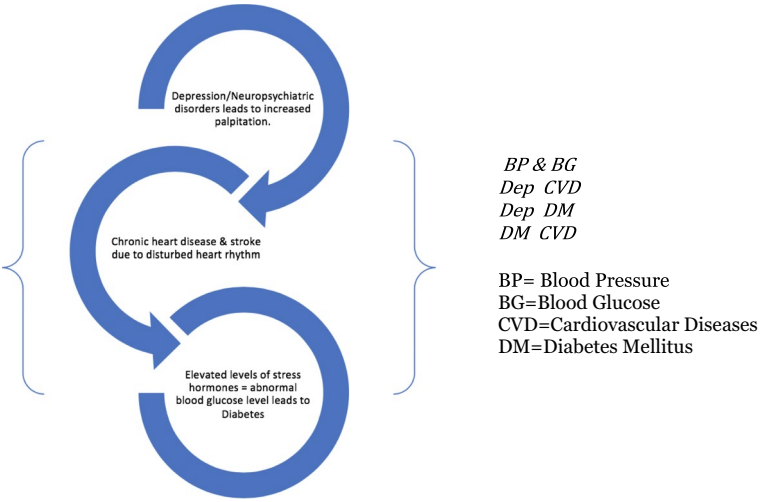


Fig. 4 Describes how one chronic disease or risk factor can lead to multiple chronic diseases and their interrelations

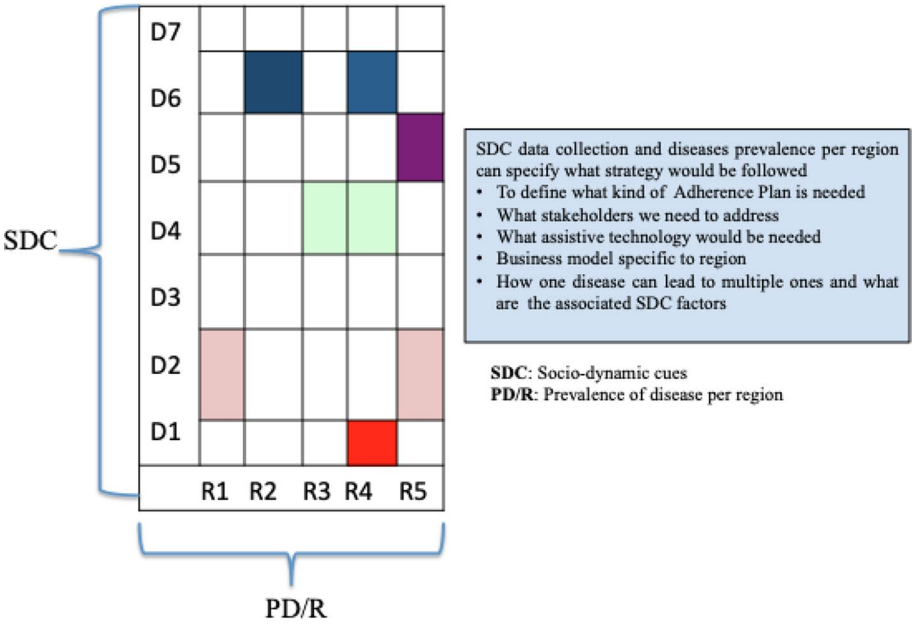


Fig. 5 Describes how socio-dynamic cues specific to region or culture can help to modify the care plan strategy

insight to municipalities as well as service providers about how to plan an eHealth service in the plot of BM for chronic disease adherence to care plan. A device or service, which is a user-friendly, secure technology platform and requires little eHealth literacy and multiple uses of technological devices.

5 Conclusions

There is no mistrust that the future of the healthcare system is aligned with the current and upcoming technological platforms. The world is getting smarter day by day due to faster services all over the globe and communication with lower latency and speedier data rates. Interpretation and analytical models can better help in the analysis of care plan and provision of up to date treatment protocol for behavioural modifications. Artificial Intelligence is a broader form of the integrated technologies that would soon revolutionize the treatment plan with better outcomes. The latest technological platform can deep dig down and dissect the dimensions of a particular region. There are some inherent challenges with new technologies, but continuous development can reduce the barrier soon. There is a need of collaboration among different sectors of the government at national and international level for the establishment of regulations as well as the development of a common platform where problems could be discussed, and solutions could be channelized globally.

References

1. Denmark: Country Health Profile 2017—en—OECD. Retrieved June 06, 2019, from https://www.oecd.org/health/denmark-country-health-profile-2017-9789264283343-en.htm.
2. Non-communicable Diseases. Retrieved from https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases
3. Hoy, D. (2013). Risk factors for chronic disease in Viet Nam: a review of the literature. *Preventing Chronic Disease, 10*, E03.
4. Anonymous. (2016). Overview: Public Health—European Commission. Retrieved November 25, 2016, from https://ec.europa.eu/health/state/summary_en.
5. WHO. (2004). The global burden of disease: 2004 update. Retrieved from https://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/
6. Pathirana, T. I., & Jackson, C. A. (2018). Socioeconomic status and multimorbidity: a systematic review and meta-analysis. *Australian and New Zealand Journal of Public Health, 42*(2), 186–194.
7. Health at a Glance: Europe—Public Health—European Commission," Public Health. Retrieved from http:www/health/state/glance_en.
8. Anwar, S., & Prasad, R. (2018). Framework for future telemedicine planning and infrastructure using 5G technology. *Wireless Personal Communications, 100*(1), 193–208.
9. Atreja, A., Bellam, N., & Levy, S. R. (2005). Strategies to enhance patient adherence: making it simple. *MedGenMed, 7*(1), 4.
10. Digital Welfare. Retrieved from https://admin.en.digst.dk/policy-and-strategy/digital-welfare/.
11. Egeland, C. C. (2008). Alle medarbejdere på Institut for Folkesundhedsvidenskab. Retrieved March 10, 2008, from https://forskning.ku.dk/search/?pure=da/publications/denmark-health-system-review(91e7dcc5-f651-4573-a303-ee464eb1290b)/export.html.
12. Olejaz, M., Juul Nielsen, A., Rudkjøbing, A., Okkels Birk, H., Krasnik, A., & Hernández-Quevedo, C. (2012). Denmark health system review. *Health Systems in Transition, 14*(2), 1–192.
13. Municipalities and Regions: Tasks and Financing. Retrieved from https://webcache.googleusercontent.com/search?q=cache:mdkapqfm6WgJ:https://english.oim.dk/media/16477/municipalities-and-regions-tasks-and-financing-june-2014.pdf+&cd=1&hl=en&ct=clnk&gl=dk.
14. Facts About Diabetes in Denmark. Retrieved from https://diabetes.dk/diabetesforeningen/in-english/facts-about-diabetes-in-denmark.aspx.
15. European Telemedicine Market | Size | Share | Forecast (2017–2022). Retrieved from https://www.mordorintelligence.com/industry-reports/european-telemedicine-market-industry.
16. Chi, N.-C., Sparks, O., Lin, S. Y., Lazar, A., Thompson, H. J., & Demiris, G. (2017). Pilot testing a digital pet avatar for older adults. *Geriatric Nursing, 38*, 542–547.
17. Business Models for eHealth. Digital Single Market. Retrieved from https://ec.europa.eu/digital-single-market/en/news/business-models-ehealth.

18. eHealth Start-up Guide for Business Success. A practical introductory manual on business modeling and routes to market. Retrieved from https://webcache.googleusercontent.com/search?q=cache:d7MbQxiXmhwJ:digitalezorg.nl/digitale/uploads/2015/04/RESOURCE-GET-on-Track.pdf+&cd=1&hl=en&ct=clnk&gl=dk.
19. Business Models for eHealth: Final Report. European Innovation Partnership—European Commission. European Innovation Partnership. Retrieveed June 14, 2012, from https://ec.europa.eu/eip/ageing/library/business-models-ehealth-final-report_en.
20. Kaltenbach, T. (2014). The impact of E-health on the pharmaceutical industry. *International Journal of Healthcare Management, 7*(4), 223–225.

Sadia Anwar received her degree in Doctor of Pharmacy in 2011 from Government College University, Pakistan. She had worked for three years as a community pharmacist. She also served as a Hospital Pharmacist and Drug information consultant. She arrived in Denmark, December 2015 and started working as a Guest Researcher at CTiF in the department of electronic systems, Aalborg University under the supervision of Professor Ramjee Prasad. She served in the Interdisciplinary area specifically focused in 4 sections: Medicine, Telecommunication, Big data and economics. She joined Aarhus University in December 2016 in the Department of Business Development and Technology as Research Scientist for seven months. She worked as a Research Assistant in the same department from October 2017-September 2019. Her research interests were based on the interdisciplinary area of Medicine, eHealth, ICT, and Business Development. She worked with a EU project vCare (Virtual Coaching Activities for Rehabilitation in Elderly)—EU Horizon 2020 Research and Innovation funding programme. She is also involved in administrative and managerial tasks. She has produced many research articles for the conferences and Journals as an Author and co-Author. She also has been part of three EU Horizon H2020 projects proposals preparation and submission process. Currently, she is working as a Central Project representative.

Dr. Ramjee Prasad is a Professor of Future Technologies for Business Ecosystem Innovation (FT4BI) in the Department of Business Development and Technology, Aarhus University, Denmark. He is the Founder President of the CTIF Global Capsule (CGC). He is also the Founder Chairman of the Global ICT Standardization Forum for India, established in 2009. GISFI has the purpose of increasing the collaboration between European, Indian, Japanese, North-American and other worldwide standardization activities in the area of Information and Communication Technology (ICT) and related application areas. The University of Rome "Tor Vergata", Italy as a Distinguished Professor of the Department of Clinical Sciences and Translational Medicine honoured him on March 15, 2016. He is Honorary Professor of University of Cape Town, South Africa, and University of KwaZulu-Natal, South Africa. He received Ridderkorset af Dannebrogordenen (Knight of the Dannenberg) in 2010 from the Danish Queen for the internationalization of top-class telecommunication research and education. He has received several international awards such as IEEE Communications Society Wireless Communications Technical Committee Recognition Award in 2003 for making contribution in the field of "Personal, Wireless and Mobile Systems and Networks", Telenor's Research Award in 2005 for impressive merits, both academic and organizational within the area of wireless and personal communication, 2014 IEEE AESS Outstanding Organizational Leadership Award for: "Organizational Leadership in developing and globalizing the CTIF (Center for TeleInFrastruktur) Research Network", and so on. He has been Project Coordinator of several EC projects, namely, MAGNET, MAGNET Beyond, eWALL, and so on. He has published more than 30 books, 1000 plus journal and conference

publications, more than 15 patents, over 100 PhD Graduates and a more significant number of Masters (over 250). Several of his students are today worldwide telecommunication leaders themselves. Under his leadership, magnitudes of close collaborations are being established among premier universities across the globe. The collaborations are regulated by guidelines of the Memorandum of Understanding (MoU) between the collaborating universities.

Collaborative Strategies and Socio-dynamic cues (SDC) Insights for Assistive Healthcare Technology Applications

Sadia Anwar*, Peter Lindgren and Ramjee Prasad

Department of Business Development and Technology, Aarhus University, Herning, Denmark
E-mail: sadia@btech.au.dk; peterli@btech.au.dk; ramjee@btech.au.dk
**Corresponding Author*

Received 18 September 2020; Accepted 30 November 2020;
Publication 26 January 2021

Abstract

Healthcare assistive Technologies has made many complicated/complex tasks within patient care, care plan therapy implementation and use of electronic health or medical records into more quickly handled tasks only by the use digital tools. Digitals tools provide systemic, real-time and reliable task handling. Data is thoroughly put, investigated in real-time with the accepted solutions/protocols in the health care settings. The paper highlights how important is for the digital tools for their acceptance and adaptation to look into the SDC variance among cultures and difference in sectors working environment as a research question and highlight its usefulness by a Danish case "assistive digital healthcare software failure" in Copenhagen hospital. The article also provides few recommendations to those technology providing businesses to modify their current business model canvas in specific areas by highlighting the example of Danish Case and learnt experience. The paper also emphasizes for looking a technological device which is easy to use by patients, healthcare professionals and customized to avoid a rush of multiple products launch in the market after failure without realization of the failure cause as well as value generation for the sustainability of a specific marketed product for a more extended period.

Journal of Mobile Multimedia, Vol. 17_1–3, 205–224.
doi: 10.13052/jmm1550-4646.171311

Keywords: Socio-dynamic cues (SDC), technology adaptation and acceptance, business model (BM), business model canvas (BMC), business dimensions, BeeStar.

1 Introduction

Energy efficiency Today we have a well-described definition of patient empowerment by the World Health Organization (WHO), which says, "Patient empowerment is a method that assists people to gain control over their own lives and enhances their capacity to act on issues that they define as important" [1].

Quality of life of patient moving through different chronic diseases can be enhanced by the use of assistive healthcare technology, mHealth (mobile-based) apps and customized therapy plans. Today with all the technologies accessible and keeping track of one personal health profile is much easier and more straightforward than it ever was. Modern technologies and their quick availability have made an ordinary person more conscious about their health and fitness. Empowered and proactive patients have a modest understanding of the latest methods of treatment and medication therapy. For example, wearable smart devices, along with smartphones, have made it easier for people to use various sensors with the ability to check and predict their health status continuously. Information associated with different diseases and healthcare conditions is easily accessible today by using mobile apps. Several mobile apps can suggest over the condition, precaution and cure-to various diseases. A lot of competition is available for assistive technology-based medical devices since they are producing Software and tools for patients or customers. In 2016, 12,000 applications were received to get the patents for assistive technology devices, 41% of applications came from Europe. The data also shows that in 27,000 assistive technology-based companies, 95% were small and medium enterprise (SMEs) [2].

The European Commission has already approved many projects in the line of assistive technology and rehabilitation. Many SMEs take part besides research organizations and Universities for the development of products and its use in clinical trials to check the efficacy of the developed product to acquire valuable data. Several EU projects have been accomplished in the area of assistive technology to improve consumer/patient quality of Life (QoL), and many are ongoing projects [3].

The persuasion to stick with the therapy, performing the suggested tasks and behavioural changes can be achieved through different digital tools for

example virtual coaches, the wireless diagnostic sensor to send and receive the iterated data, lifestyle modification applications to motivate and adhere patient to the advised therapy plans. Similarly, (Sawesi et al., 2016) systemically reviewed and analyzed the effectiveness of information technology for patient engagement with health care process and behavioural change to stick with the therapy with positive results. Still, they mentioned that while reviewing and moving through different research articles, they highlighted the absence of a common framework for behavioural change, therapy plan adherence, health-related outcomes, and not using the specific behaviour theories [4].

Aligning with that, (Anwar & Prasad, 2020) highlighted the need for analysis and importance of the SDC variance in a particular group of people/regions/countries all around the globe to motivate them to engage with the treatment plans while utilizing those digital tools and therapy plans [5]. Social Dynamics refers to the behaviour of groups that results from the interactions of individual group members as well to the study of the relationship between individual interactions and group level behaviours [6, 7]. Many eHealth applications or Software have diagnostics, medication adherence plans, documentation/record-keeping, lifestyle modification facilities based on the general views or common doings that have been observed by the observers, however, cultural specificity and SDC variance has not been highlighted for assistive healthcare technologies.

With that, Different countries have different health care ecosystem that varies from Government policies or plans to administration to the managerial hierarchy of the hospital staff, handling admitted patients' cases, medication purchase and access. There are also different legislations for prescription over-medication and the counter medication purchase by the public and hospital. Similarly, other rules and regulations exist for pharmaceutical companies for their promotion. The system varies not only by the parameter mentioned above, but also it profoundly penetrates in culture and language variation.

According to the (Thies et al., 2017) effectiveness of many mHealth applications are unclear. They evaluated the eHealth applications for clinical outcomes for hypertension and diabetic patients with hospital staff involvement. Still, they saw many inconsistencies in software demand in Case of use, building interest and fulfilling the needs of the end-users.[8] The other main factors as highlighted by the (Anwar et al., 2020) is eHealth literacy of the healthcare staff and end-user, technology itself adaptation and acceptance by the user, socio-dynamic cues variance among cultures and among different

group of people, choices regarding selecting an assistive healthcare technology device or eHealth application. Also, the analytical skills of the end-user to distinguish between what is right and wrong regarding information available on the internet and different applications can affect treatment adherence [9].

There is a need for improvisation of the Business model used by different assistive healthcare technology companies to deep dig into SDC and variance of technology use among different regions of the globe to avoid product failure. A significant change to have a complete shift from the current product-based models would be critical as sudden traditional model changes will disrupt and put a financial burden which would not be a healthy or sustainable way. Therefore, a sustainable strategy for a dynamic business model is required. The need comes as technology is moving fast and the selection of technology-based devices of a particular brand is very likely dependent on customer behaviour which is also changing day by day since they are becoming more aware. The other factor is the difference that exists in the healthcare ecosystem. The sustainable approach would be to make a business model to cope with and predict the upcoming disruption and provide the suggestions for suitable adaptation within the framework and changes in the existing product-oriented models [9].

The paper presents a case example for an assistive digital healthcare software failure and highlights the difference between the SDC and healthcare system variance. The article recommends some solutions for assistive healthcare technology applications where a product is customized according to the needs of the users. The article also suggests business "TO BE" while developing those products so that business is not ended up with a failed device /device that can cost a lot in finance as well as associated business values. The paper also highlights the importance of collaborative strategies among stakeholders while deploying those products.

2 Assistive Digital Healthcare Software Failure: Danish Hospital Case

The Case is original, and it is related to the problem countered by the Copenhagen Hospital in for assistive healthcare technological device. Its case description has been taken from the website (Lost in Translation: Epic Goes to Denmark - POLITICOBack ButtonSearch IconFilter IconArrow, n.d.) A grant from the Commonwealth Fund supported the case story through the Association of Health Care Journalists [10] and by a thesis report (Learnings from the Implementation of Epic, n.d.) [11].

The Case highlights the importance of SDC, variance in the healthcare ecosystem and one solution for all can vary among different regions. It also suggests or needs to explore or change of business model by following different strategy which is more aligned with the customized solutions. The discussion on the Case does not suggest that the assistive digital healthcare software is a complete failure or to down the reputation of the company or being sponsored by other companies. However, it highlights the significance of SDC and suggestions that can enhance the marketing for the product of companies associated in a similar business. Information about the Case, as mentioned above, is available on the internet with the given references.

2.1 Background

The Case is about digital health software failure in the Danish healthcare system. Epic Systems, a business that has done many software implementations, provides the reasons, Danes chose the Epic digital health software. Danish health authorities in 2016 spent around 2.8 billion DKK on the Epic software implementations in 18 hospitals in an area with approximately 2.8 million residents. On May 20, Epic launched in the first hospital.

The efforts for its installation are made by Gert Galster, who is a doctor and having a PhD in informatics. He tried to convert the Software into the workable hospital management system for Copenhagen as well as in the surrounding regions for three years, and 45,000 clinicians in eastern Denmark were plunged into the system.

2.2 Expectations

The expectation was that the Software would make it easier for doctors to work in the health care system, exchange patient information and handling cost.

2.3 Problem Encountered

The problem that occurred includes the translation of the medical terms and relying on the google translator. The design of the Software was very hardcoded for the USA system that it was not very easy to disintegrate to make it appropriate for the use in the Danish Healthcare ecosystem. Others differences that have been seen include, for example, C-section is not a medical emergency procedure in the Danish version. Still, it is in the USA, as well as speech and language pathologist does not exist in Denmark. It was a

considerable financial loss because they felt that it would work the same way and be successful as with other countries.

It was observed and highlighted by many professionals working in the hospital and who were engaged with the assistive healthcare technology software use that although we as people move through the same diseases, same medical books, similar diagnosis, However, the use of IT system where collaboration is needed among users depends on the culture where the particular system and collaboration happens. The problem does not suggest that problem was in the device but its use and integration into a specific system.

The other problem that has been faced, for example, nurses in Denmark in an emergency can prescribe medication, and they can explain the reason for its use and prescription in a later period. In Epic Software, any effort to practice a prohibited role made a rejection. That shows how different healthcare system exists throughout the globe although having similarities. Denmark has a system of socialized medicine and its very similar in other Scandinavia countries where you don't pay for bills and insurances.

However, in the US healthcare sector, the physicians bill the patient very efficiently by bought digital records, and in their system, the value of care comes in the latter part. The other differences are, for instance, the physician and nurses in Denmark dispense medication while in the USA, it is done by the pharmacist. A similar procedure has been followed in many Asian countries where pharmacist dispenses medicine like the USA. In the mid of 2018, a report was published in which it is found that Epic deployment led the 57 per cent of patients to wait for more than 30 days just for taking the appointments, however in the area where Epic was not deployed it was 4 per cent. The reason again the same of the difference in the hierarchical structure and associated roles. The satisfaction for using the Epic decrease to 12 per cent by the physician in Feb 2019 and 60 per cent came with a very high level of dissatisfaction because of difficultly in coping with the things applied by the Software.

In Copenhagen, 71 physicians signed a petition to remove Software from the hospital system in 2018. Afzal Chaudhry, who is the chief information officer of Addenbrooke's Hospital in Cambridge, England, said that they implemented the epic system successfully in the year 2015 and encountered very few problems. He also quoted that he visited Copenhagen many times to help out Danish for Epic implementation. He also added that you couldn't push people and for this, you need a mindset of acceptance among the management as well as a clinical team which allows.

However, in the UK, Epic launched live at Cambridge University Hospitals in the year of 2014. While in Denmark, Epic launched live at Herlev and Gentofte Hospital in the year of 2016. After the launch of the Epic in the UK they have also reported some experiences and problems like incomplete approach to patient medical history, disruptions in the delivery of pathology test results, inconsistency in care and care plans with 20 per cent t drop in the performance of the emergency department and patient productivity decrease in large numbers. The inspection reports that came showed the CUH hospital itself services were inadequate and report mentioned for improvement while the second assessment report showed positive results with Epic and CUH. The other reason that was said that staff got the familiarity as well as the integration of patient administrative and necessary clinical information Norway is going to have an implementation plan in 2021. Many important deductions can be learnt through the Danish and UK experiences for Epic [12].

It highlights that apart from SDC, acceptance of technology, mindset, and its usability are also important. eHealth literacy places a significant role in that area. With that, it also shows that Epic is a very reputable software solution company, and that's why they all were motivated to install the Software and launched a big project with lots of investment. However, the failure also highlights critical factors that need for business model change and customized solutions so that technology integration would be accessible without significant changes in the system.

Conclusion after case analysis the above Case highlights many disparities which are related to cultural difference, SDC variance, mindset (technology adaptability and acceptability), One device cannot provide a solution for all and puts the importance of the collaborative strategies among different stakeholders. Many medical devices or assistive health care technology software are coming into the market. Still, few get the success that signifies the importance of sustainable and collaborative strategies throughout the globe.

3 Tools for Analysis for Epic Business Model

To analyze the digital health software failure and Epic Systems case, Business Model Canvas have been used as business modelling tools to see how Epic as a business is working for software development to help people stay well with better health. The information for making a Business model canvas has been collected through the Epic Systems website (Epic Systems, 2016a) to analyze

their business model and necessary gap findings [13]. Before going into the analysis, a small description of the BeeStar is as follows

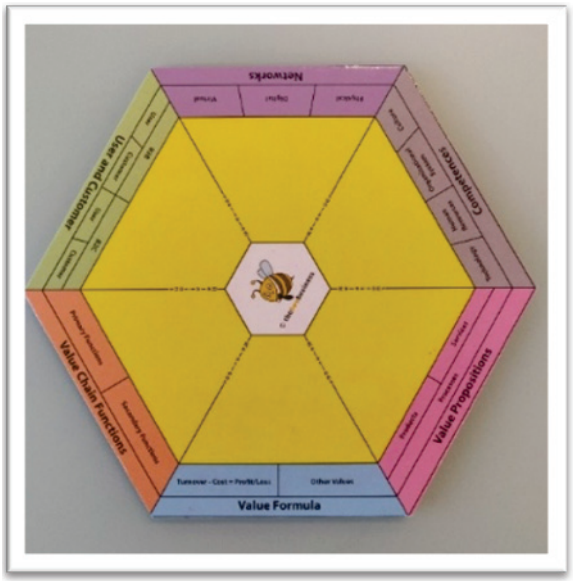


Figure 1 BeeStar.

3.1 BeeStar

BeeStar is a visual tool developed by Prof. Peter Lindgren (Peter, 2018) to describe a business model. BeeStar simplifies the complexities of a business model and illustrates any business model in "As Is" or "To Be" state. In BeeStar, all the business models have seven dimensions [14]. These dimensions are:

Table 1 BeeStar seven dimensions

1	Value Propositions
2	User or Customer
3	Value Chain Functions
4	Competencies
5	Network
6	Value Formula
7	Relations

3.2 Business Model Canvas (BMC)

Business Model Canvas is a graphic tool developed by Alexander Osterwalder (Business Model Generation, n.d.) to represent any business model on a single sheet of paper. [15] Business Model Canvas has nine building blocks that are

Table 2 Business model canvas blocks

1	Key Partners
2	Key Activities
3	Value Proposition
4	Customer Relationship
5	Customer Segment
6	Key Resource
7	Distribution Channel
8	Cost Structure
9	Revenue Stream

4 Analysis

The analysis has been made by using BeeStar, and Business Model Canvas and suggestions would be made for the sustainable business model after the analysis that can assist assistive healthcare technology product-based companies to review their business model for sustainable solutions with collaborative strategies for product success. BeeStar tool and Business model Canvas will be utilized to explore the business model of Epic Systems. Deductions will be presented at the end of the analysis.

4.1 BeeStar – A digital health software failure (Denmark Case)

Every dimension of a BeeStar has specific values that represent the given dimension. The values in all the Dimensions are linked to some other values in other dimensions by a seventh value called Relations. The digital health software failure, Denmark case would be analyzed by disintegrating the BM into the BeeStar to define “As is” and “To be” business model for Epic Systems by taking information through different internet sources as Epic Systems is not being contacted. The analysis has only been done just to give

some ideas by seeing Danish Case as an example which is implementable and provide values to the business and Customer.

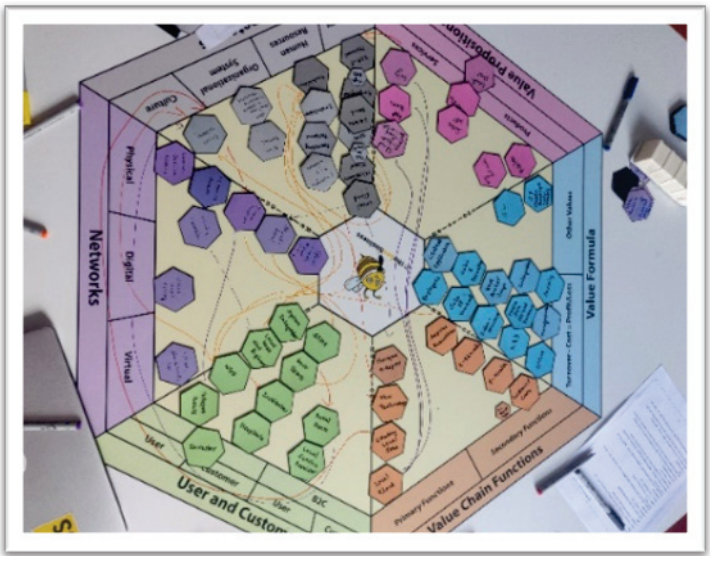


Figure 2 Represents how to use a BeeStar as a tool to dismantle and analyze a business model in seven dimensions, and example has been given from the Bluetown business case (Singh et al., 2019) [16].

The "To be" business can be used by any business having the same or similar Business model so that their product remains in the market and not being ended up as a failure product just as happened in the Danish Case. Epic systems were established in 1970 with dollars 70,000 investments, and currently, it has offices in the UK, Denmark, Netherlands, United Arab Emirates, Finland, Melbourne and in many other countries. Epic systems are privately owned and make Software for the healthcare industry. (History of Epic Systems Corporation – FundingUniverse, n.d.) [17]. Epic Systems is a technological leader and have expensive products with installation price.

Above given table shows all the dimensions, categories and values of Epic systems on a BeeStar and helps us better understand the digital health software failure case.

Table 3 Epic systems BeeStar dimensions

Dimensions	Categories	Values
User & Customer	B2B B2C	Hospitals, Clinics, ambulatory surgical centres, Healthcare maintenance organizations (HMOs) (Epic Systems, 2016b) [13] Clinical area, includes the district hospitals, rehabilitation centres, local clinics, educational, medical centres as well as practice which are done. Patients have the accessibility to the Software by their mobile devices as well as in their home care settings. [18] (10 Things need to Know about Epic, n.d.)
Network	Physical Digital Virtual	NorthShore (University health system) (Jr, 2015) [19] Premise Health and Mayo Clinic (EHRIntelligence, 2017) [20] Apple for new mHealth application (Apple Partners With Epic, Mayo on New Health App Platform, n.d.) [21] Partners Healthcare (http://pages/hit-consultant-llc/302199219847409, 2012) [22] Offices in the UK, Denmark, Netherlands, United Arab Emirates, Finland, Melbourne and in many other countries. (History of Epic Systems Corporation – FundingUniverse, n.d.) [17]
Competences	Technology Human Resource Organizational Culture	One of the leading HER vendor, Software IT platform for medical records Hospitals and supporting hospital functions Cooperate culture (Epic Decoded: An Inside Look at Life and Corporate Culture at the Center of the Health IT World, n.d.) [23] EPIC HRMS (provides automation paper-based HR) (EPIC Software Corporation, n.d.) [24]
Value Chain Function	Primary Function Secondary Function	Health and Information Technology electronic health records and medical health records, customer care, advisory (What Is Epic Systems?, n.d.) [25] training material for installation, Technical support for installation, consultation
Value Formula	Cost Revenue	Manufacturing, research and development, installation, consultation,
Value Proposition	Product Service Process	HER/EMR Software and education/training material, Applications support functions related hospitals Ecosystem, Installation and advisory, cloud hosting service for customers

4.2 Business Model Canvas – Epic Systems

The data has been taken from an internet source (Epic Systems, 2016b) [13] and presented in the form of a table below and it represents the Epic Systems on Business Model Canvas and its nine building blocks

Table 4 Epic systems BMC building blocks

Key Partners	• NorthShore (University health system) (Jr, 2015) [19] • Premise Health and Mayo Clinic (EHRIntelligence, 2017) [20] • Apple for new mHealth application (Apple Partners With Epic, Mayo on New Health App Platform, n.d.) [21] • Partners Healthcare (http://pages/hit-consultant-llc/302199219847409, 2012) [22] • Offices in the UK, Denmark, Netherlands, United Arab Emirates, Finland, Melbourne and in many other countries. (History of Epic Systems Corporation – FundingUniverse, n.d.) [17] • National and International
Key Activities	EMR solutions for hospitals and ambulatory clinics. Scheduling and registration of patients, care providers including physician, nurses, pharmacist, laboratory technologist, emergency personnel, radiologist and billing system for people with insurances.
Key Resources	Technical Solution, Business Model, EMR/EHR products and solutions, its human resources which create and make those products.
Value Proposition	Multi Faced System, an excellent reputation, voted top overall software suite in the 2015/2016 Best in KLAS awards, best-selling electronic health records system.
Customer Relationship	Dedicated personal-assistance nature type, Employee from Epic interact with the Customer during or after the sale, hands-on help
Channels	International offices and by website, It does not have social media platforms, No significant spending on marketing, Customer reach out to Epic Systems
Customer Segment	Hospital and clinics, Ambulatory surgical centres, Healthcare maintenance organizations (HMOs)
Cost Structure	Considerable money is spent on EMR, and little cash on sales and marketing as Customer directly access the Epic Systems
Revenue Streams	Epic makes its revenue through a mixture of upfront fees for the implemented Software and ongoing upgrade, support, consultation and service fees.

5 Deductions from the Above Analysis Business Model Analysis

After analyzing the Epic System business model through BeeStar and Business Model Canvas, the following analysis has been made. The analysis can be assistive for sustainable solutions and collaborative strategies in similar business model-based companies.

5.1 "AS IS"

After analyzing the Epic Systems BM using BeeStar and BMC, it is clear that Epic Systems needs to look into new solutions for its technology acceptance and adaptation seeing the Danish Case. The Case has also put some major concerns as well as upgrading the strategies towards customer satisfaction, Socio-dynamic cues variance and its difference among cultures and different group of people.

5.2 "TO BE"

After analyzing the Danish Case, it has been deduced that Epic Systems needs some new business model under pre and postmarking of products that can be added to the Epic Systems current portfolio of value propositions and channel building block by analyzing the present BMC. After doing research online, some of the recommended solutions that can be integrated are as follows:

(i) Post Marketing surveillance strategy

For continuous product innovation, it is essential to get the data after the product is launched in the market that will reveal what the problematic area to be addressed to avoid product failure is. As mentioned in the BMC for Epic System that the spending is less for marketing the product and requires a dedicated team as the BMC shows only buying and sale of the product between Customer and employee and this would also indicate the less availability of the post-marketing surveillance reporting.

(ii) Customized product and customer satisfaction

Before introducing any product, it is essential to check the flexibility to adopt different systems, especially the software-based healthcare technology. The marketing and sale team can work on hiring those people that can easily perceive the customer demand and then check the feasibility of the

product to adopt the customer requirement. They should do a comprehensive customer interview/counselling regarding the needs as well as the system where it is going to be deployed. In the Danish Case, the Software was complicated to understand and change according to the hospital requirement. A business should not only be involved in revenue generation by sale but also be interested in value creation through deep digging in the needs of a customer.

(iii) Collaborative Approach and country-specific data availability

Epic System can also collect the data before marketing a product from key partners or major countries to increase product use for example in the health care system, their specific infrastructure needs, SDC and cultural values and sector hierarchy. The consideration will make the marketed product as a universal product that can be deployed with ease. Danish Case used google translator to translate many terms from the deployed Software, and many procedures were invalid as well as roles and hierarchy of the professionals who are working in the hospital. As Epic System is a significant healthcare technology vendor, they should consider those strategies as part of product development to sustain their reputation in the market. A dedicated team can easily break those terminologies, Socio-dynamic cues variance, cultural and system difference before marketing. Product success demonstrates that there is no one solution for all. The one answer should be flexible for acceptability and adoptability under customer needs and satisfaction.

6 Conclusions

Digital tools and assistive healthcare applications are still evolving. There is a lot to be evaluated to avoid thousands of products in the market with less value and quick replacement. The example of Epic systems and Danish Case puts emphasis and provide an example for others companies to go for an integrated, collaborative strategical approach in digital solution marketing. Epic systems have unique technology for HER/EMR. The above-mentioned suggestion considering the highlighted case, may increase the value of the product in the market with a less financial loss. However, there is a need and space for a lot of research for product sustainability and marketing customized solutions.

References

[1] "European Patient Forum, Patient empowerment campaign, 20-21 May 2015 'http://www.eu-patient.eu/campaign/PatientsprescribE/'

[2] K. Khosla, "The Best MedTech Startups in Europe." [Online]. Available: https://www.valuer.ai/blog/the-best-medtech-startups-in-europe. [Accessed: 20-Apr-2020].

[3] trinoma, "EU-funded research projects into technologies for accessibility," Shaping Europe's digital future - European Commission, 13-Dec-2018. [Online]. Available: https://ec.europa.eu/digital-single-market/en/eu-funded-research-projects-technologies-accessibility. [Accessed: 20-Apr-2020].

[4] Sawesi, S., Rashrash, M., Phalakornkule, K., Carpenter, J. S., & Jones, J. F. (2016). The Impact of Information Technology on Patient Engagement and Health Behavior Change: A Systematic Review of the Literature. JMIR Medical Informatics, 4(1), e1. https://doi.org/10.2196/medinform.4514

[5] Anwar, S., & Prasad, R. (2020). Connections of Chronic Diseases and Socio-dynamic Cues for Integrating ICT with Care Plan Adherence. Wireless Personal Communications. https://doi.org/10.1007/s11277-020-07299-x

[6] Social dynamics. (2020). In Wikipedia. https://en.wikipedia.org/w/index.php?title=Social_dynamics&oldid=964929325

[7] Skyrms, B. (2014). Social Dynamics. Oxford University Press.

[8] Thies, K., Anderson, D., & Cramer, B. (2017). Lack of Adoption of a Mobile App to Support Patient Self-Management of Diabetes and Hypertension in a Federally Qualified Health Center: Interview Analysis of Staff and Patients in a Failed Randomized Trial. JMIR Human Factors, 4(4), e24. https://doi.org/10.2196/humanfactors.7709

[9] Anwar, S., Prasad, R., & Chowdhry, B. S. (2020). Literacy and Socio-dynamics Cues Insights Decision Analytics for Care Plan Adherence. Wireless Personal Communications. https://doi.org/10.1007/s11277-020-07400-4

[10] Lost in translation: Epic goes to Denmark—POLITICOBack Button-Search IconFilter IconArrow. (n.d.). Retrieved July 8, 2020, from https://www.politico.com/story/2019/06/06/epic-denmark-health-1510223

[11] Jensen, S. M. (n.d.). Learnings from the implementation of Epic Benefits, issues, causes and recommendations.

[12] M. Hertzum and G. Ellingsen, "The implementation of an electronic health record: Comparing preparations for Epic in Norway with experiences from the UK and Denmark," International Journal of Medical Informatics, vol. 129, pp. 312–317, Sep. 2019, doi: 10.1016/j.ijmedinf.2019.06.026.
[13] Epic Systems. (2016, August 22). Cleverism. https://www.cleverism.com/company/epic-systems/
[14] Peter, L. (2018). The Multi Business Model Innovation Approach. River Publishers.
[15] Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers | Wiley. (n.d.). Wiley.Com. Retrieved July 9, 2020, from https://www.wiley.com/en-dk/Business+Model+Generation%3A+A+Handbook+for+Visionaries%2C+Game+Changers%2C+and+Challengers-p-9780470876411
[16] Singh, K., Kumar, A., Anwar, S., & Gupta, S. N. (2019). Technology oriented value propositions for Bluetown Case. 2019 22nd International Symposium on Wireless Personal Multimedia Communications (WPMC), 1–5. https://doi.org/10.1109/WPMC48795.2019.9096206
[17] History of Epic Systems Corporation – FundingUniverse. (n.d.). Retrieved July 9, 2020, from http://www.fundinguniverse.com/company-histories/epic-systems-corporation-history/
[18] 10 things to know about Epic. (n.d.). Retrieved July 9, 2020, from https://www.beckershospitalreview.com/healthcare-information-technology/10-things-to-know-about-epic.html
[19] Jr, H. M. K. (2015). Becoming the Best: Build a World-Class Organization Through Values-Based Leadership. John Wiley & Sons.
[20] EHRIntelligence. (2017, May 16). Epic EHR Interoperability at Center of New Partnership. EHRIntelligence. https://ehrintelligence.com/news/epic-ehr-interoperability-at-center-of-new-partnership
[21] Apple Partners With Epic, Mayo on New Health App Platform. (n.d.). Retrieved July 9, 2020, from https://www.beckershospitalreview.com/healthcare-information-technology/apple-partners-with-epic-mayo-on-new-health-app-platform.html
[22] http://pages/hit-consultant-llc/302199219847409. (2012, May 20). Partners Healthcare Considers Epic Systems for EHR. https://hitconsultant.net/2012/05/20/partners-healthcare-considers-epic-systems-for-integrated-statewide-system/
[23] Epic decoded: An inside look at life and corporate culture at the center of the health IT world. (n.d.). Retrieved July 9, 2020, from https://www.

beckershospitalreview.com/healthcare-information-technology/epic-decoded-an-inside-look-at-life-and-corporate-culture-at-the-center-of-the-health-it-world.html
[24] EPIC Software Corporation. (n.d.). Retrieved July 9, 2020, from http://www.epic-soft.com/epic-hrms.php
[25] What is Epic Systems? - Definition from WhatIs.com. (n.d.). SearchHealthIT. Retrieved July 9, 2020, from https://searchhealthit.techtarget.com/definition/Epic-Systems-Corp

Biographies

Sadia Anwar received her degree in Doctor of Pharmacy in 2011 form Government College University, Pakistan. Currently, she is working as a Research Assistant in Skagen Uddannelses- og Udviklingscenter where she is deploying her skills and experience for SET II Project for ports. She is also jointly collaborating with research groups CGC (CTIF global Capsule) and CET (Center for Energy Technology) in Aarhus University, Denmark. She had worked for three years as a community pharmacist. She also served as a Hospital Pharmacist and Drug information consultant. She arrived in Denmark, December 2015 and started working as a Guest Researcher at CTiF in the department of electronic systems, Aalborg University under the supervision of Professor Ramjee Prasad. She served for Interdisciplinary area specifically more focused in 4 sections: Medicine, Telecommunication, Big data and economics. She joined Aarhus University in December 2016 in Department of Business Development and Technology as Research Scientist for seven months. She worked as a Research Assistant in the same department from October 2017-September 2019. Her research interests were based on the interdisciplinary area of health care technology. She worked with a EU project vCare (Virtual Coaching Activities for Rehabilitation in Elderly) – EU Horizon 2020 Research and Innovation funding programme. She was also involved in administrative and managerial tasks. She has produced many

research articles for the International conferences and Journals as an Author and co-Author. She also has been part of three EU Horizon H2020 projects proposals preparation and submission process.

Peter Lindgren holds a full Professorship in Multi business model and Technology innovation at Aarhus University, Denmark – Business development and technology innovation and is Vice President of CTIF Global Capsule (CGC). He is Director of CTIF Global Capsule/MBIT Research Center at Aarhus University – Business Development and Technology and is member of Research Committee at Aarhus University – BSS.He has researched and worked with network based high speed innovation since 2000. He has been head of Studies for Master in Engineering – Business Development and Technology at Aarhus University from 2014–2016 and member of the management group at Aarhus University Btech 2014–2018. He has been researcher at Politechnico di Milano in Italy (2002/03), Stanford University, USA (2010/11), University Tor Vergata, Italy (2016/2017) and has in the time period 2007–2011. He has been the founder and Center Manager of International Center for Innovation www.ici.aau.dk at Aalborg University, founder of the MBIT research group and lab – http://btech.au.dk/forskning/mbit/ – and is cofounder of CTIF Global Capsule – www.ctifglobalcapsule.org. He has worked as researcher in many different multi business model and technology innovations projects and knowledge networks among others E100 – http://www.entovation.com/kleadmap/, Stanford University project Peace Innovation Lab http://captology.stanford.edu/projects/peace-innovation.html, The Nordic Women in business project – www.womeninbusiness.dk/, The Center for TeleInFrastruktur (CTIF), FP7 project about "multi business model innovation in the clouds" – www.Neffics.eu, EU Kask project – www.Biogas2020.se, Central Project, Motor5G, Recombine,

Greenbizz. He is cofounder of five startup businesses amongst others – www.thebeebusiness.com, www.thedigibusiness.com, www.vdmbee.com. He is author to several articles and books about business model innovation in networks and Emerging Business Models. He has an entrepreneurial and interdisciplinary approach to research. His research interests are multi business model and technology innovation in interdisciplinary networks, multi business model typologies, sensing-, persuasive- and virtual- business models.

Ramjee Prasad is a Professor of Future Technologies for Business Ecosystem Innovation (FT4BI) in the Department of Business Development and Technology, Aarhus University, Denmark. He is the Founder President of the CTIF Global Capsule (CGC). He is also the Founder Chairman of the Global ICT Standardization Forum for India, established in 2009. GISFI has the purpose of increasing of the collaboration between European, Indian, Japanese, North-American and other worldwide standardization activities in the area of Information and Communication Technology (ICT) and related application areas. He has been honored by the University of Rome "Tor Vergata", Italy as a Distinguished Professor of the Department of Clinical Sciences and Translational Medicine on March 15, 2016. He is Honorary Professor of University of Cape Town, South Africa, and University of KwaZulu-Natal, South Africa. He has received Ridderkorset af Dannebrogordenen (Knight of the Dannenberg) in 2010 from the Danish Queen for the internationalization of top-class telecommunication research and education. He has received several international awards such as: IEEE Communications Society Wireless Communications Technical Committee Recognition Award in 2003 for making contribution in the field of "Personal, Wireless and Mobile Systems and Networks", Telenor's Research Award in 2005 for impressive merits, both academic and organizational within the field of wireless and personal

communication, 2014 IEEE AESS Outstanding Organizational Leadership Award for: "Organizational Leadership in developing and globalizing the CTIF (Center for TeleInFrastruktur) Research Network", and so on. He has been Project Coordinator of several EC projects namely, MAGNET, MAGNET Beyond, eWALL and so on. He has published more than 30 books, 1000 plus journal and conference publications, more than 15 patents, over 140 PhD Graduates and larger number of Masters (over 250). Several of his students are today worldwide telecommunication leaders themselves. Under his leadership, magnitudes of close collaborations are being established among premier universities across the globe. The collaborations are regulated by guidelines of the Memorandum of Understanding (MoU) between the collaborating university.

5G, an approach towards future telemedicine

Sadia Anwar
Center for TeleInfrastruktur,
Aalborg University,
Aalborg, Denmark,
saa@es.aau.dk

Ambuj Kumar
Center for TeleInfrastruktur,
Aalborg University,
Aalborg, Denmark
in_kumar@es.aau.dk

Bhawani S. Chowdhry
Mehran University of
Engineering and
Technology, Jamshoro
c.bhawani@ieee.org

Ramjee Prasad
Center for TeleInfrastruktur,
Aalborg University,
Aalborg, Denmark
prasad@es.aau.dk

***Abstract*—The use of smartphones has been increasing rapidly and it is expected that in future most people will have a smartphone capable of high speed Internet connection. The capability of smartphones with high definition display, computation power and multitude of sensors made it an excellent candidate for telemedicine application. Telemedicine's applications and high data medical information generally require high definition visuals and lower latency connection, in addition mobility and reliability. The next generation of wireless communication standard, known as 5G, will provide data speed in (Gigabit per second) Gb/s with lower latency and higher reliability connection, and can be better approach for future telemedicine. In this paper we survey the current state of telemedicine along with examining the characteristics of 5G technology. We also present research challenges concerning 5G and telemedicine.**

***Keywords*—5G, Telemedicines, Wireless Communications**

I. INTRODUCTION

According to recent survey [1] 90% of medical practitioners are utilizing smartphones for clinical applications. By using smartphones, communication or interaction to patients becomes very easy and more effective. The estimated number of clinical applications available on smartphone is approximately 95,000. Furthermore, Internet of things (IoTs) is changing the way of our everyday life, as it is going to allow many things feasible and accessible e.g., smarter health care services, smart town and cities, smart automobiles and smarter retailing and shopping.

Wireless mobile communication is not only changing the way of our life but also becoming an integral part of our lives. 6martphones contribute a lot in keeping us updated in every aspect of life, as they can access a large number of information through Internet anytime, anywhere, and at a high speed. In early days, cellular technology was only focused on messaging and making phone calls but now it is possible to perform much more complex communication and computation tasks, in particular being connected with broadband mobile Internet connection.

As smartphones or smart devices are becoming more and more computationally powerful, along with high resolution displays, multiple ways of interaction, and various kind of embedded sensors that need for faster data rate, the low latency and higher reliability become more and more crucial and thus important. Therefore, 5G will be very important in this scenario, having capacity and high data rates, and is able to transmit data at Gb/s speed in 2020, which is about 200 times faster than 4G.

Telemedicine or telehealth is an inter-disciplinary area, which uses telecommunication technology to deliver medical information, medical help and services to remote areas at distant places, especially for the elderly and disabled persons. Telemedicine can be utilized as a first line strategy in case of emergency situations and disaster management. It was first applied in Mexico disaster by NASA in 1985. Voice communication was possible within 24 hours. With the passage of time and advancement in technology, this latency is now become small as in milliseconds by continuous modification and now by the new technology concept 5th generation mobile wireless communication (5G) which is becoming reality in 2020 [2].

We predict 5G along with telemedicine is going to revolutionize healthcare, and can be imagined in case of availability and time factors. Whereas, availability factor is basically introducing more specialists and medical physician to come and practice the telemedicine and time factor is handled by the faster wireless technology with high data rates such as 5G effectively and precisely for the delivery of virtual authentic medical care to patients.

The main lineaments of telemedicine are that it should be climbable, transparent or crystalline, provide geographical or global coverage, and fault tolerance with security, and authentication. Hospital digital networking concept came into being because of new faster wireless communication technologies, which are enhancing the approach of specialists and patients with each other to communicate visually and talk and share their condition with suggestive approach and strategies.

The rest of the paper is structured as follows: Section II describes important attributes of 5G in relation to telemedicine. Section III presents what are the research challenges in connection to 5G and telemedicine. And lastly, conclude the paper in Section IV.

II. IMPORTANT ATTRIBUTES OF 5G IN RELATION TO TELEMEDICINE

In 2020, new and more revolutionized telehealth services will need wireless technology which can support high

definition (HD) video quality, faster speed, low latency with no interruption in signaling pathway, more authentic in providing security and supportive for subscribers to use and subscribe applications especially in telemedicine, which is a concept truly based on the delivery of medical information to remote areas by utilizing wireless communication technology. 5G is going to address M2M (machine to machine) communication. Which is further divided into:

- Massive machine type communication, it includes low cost and low energy devices e.g. sensors involved in monitoring or diagnosis of vital signs. These devices need faster speed and real time communication [3].
- Mission critical type communication, it is real time controlled and has automated field function and processing such as robotically performed remote tele-surgery. In tele-surgery doctors can perform a surgery without their presence in a particular location, virtually through wireless technology. Tele-surgery needs more immense coordination between different surgeons which are remotely connected and this also requires that information of each performed task should be available with minimum latency in real-time scenario. 5G, in this scenario, will be more reliable with faster speed and low latency [4].

Some of the important attributes concerning 5G are as follows:

A. Some of the important attributes concerning 5G are as follows:

- Connectivity and coverage in Gb/s [8], will be available even in natural disasters or emergency situations, thus having this technology, more lives can be saved.
- Strong authentication with secured patient profile would be imagined with 5G. However, research is still under process to avoid jamming attacks and similar complications.
- Remote monitoring of patients in distant areas would be easy, because 5G will be able to provide higher bandwidth.
- Power consumption of batteries is viewed for 2020, and charging is available for at least 10 years in M2M scenario, [8].
- 5G also enables various sensors and implant to connect with different service configurations to see patient condition and to provide them best regime or therapy.
- 5G has mobility with faster speed and low latency [8], which is less than one millisecond. Virtual reality and HD videos should be as detailed as human retina can detect. For this 300 Mb/s is generally required and this technology is 100 times above with low data rate and ultra-reliability, to carry out the High definition videos. It will be very helpful in dealing patients in video conferences to avoid breach in communication [5].
- Medical image transmission and videos require larger bandwidth. These images and videos are compressed during transmission and it is expected on the other end that there would be no data or image loss after receiving. 5G can handle HD videos and high data transmission in case of remote monitoring of patients, video conferencing, robotic equipment's, smart pharmaceuticals such as ventilators, fluid rate and drug delivery systems attached to the patients in remote areas. As an example, in diabetic patients, insulin reservoir are controlled and connected with wireless technology. Sensors provide the signals on daily basis for body glucose level. Insulin is then injected accordingly after taking the values.
- With 5G, first-aid could be delivered in small duration of time and communication without interruption available with the blink of eye.
- More and more patients are motivated to consult with doctors online. It is not only saving time but its cost effective features making it more reliable. 5G can play a more vital role to access these consultations frequently and remotely with ultra-low cost and low-end data rate reliability.
- Cloud service robotics for supportive therapy will be easy as offloading and uploading of information for recognition of language, object and cognitive skills will be predicted on real time with no interruption. Cost will also be reduced as less number of robots is involved [4].
- Remote monitoring of elderly patients will be optimized through continuous updates about life style modification and treatment for patients with chronic diseases and related disabilities. Their rehabilitation care plan and strategies can be reviewed by wireless communication, for this wireless technology has to follow the same standard for urban and rural areas where there is higher density of followers and users.

III. RESEARCH CHALLENGES

A new and advance form of existing technology always has inherent challenges to deal with new problems. First generation mobile communication (1G) came in 1980s while fifth generation (5G) is going to be commercialized in 2020. It is a journey of approximately 40 years. During the modification and transformation of these technologies, we are still lacking proper infrastructure, standards, security and legislations concerning wireless communication technology. Fig.1 shows and elaborate concept of telemedicine services running on 5G network.

The challenges that we are facing in wireless communication concerning telemedicine are:

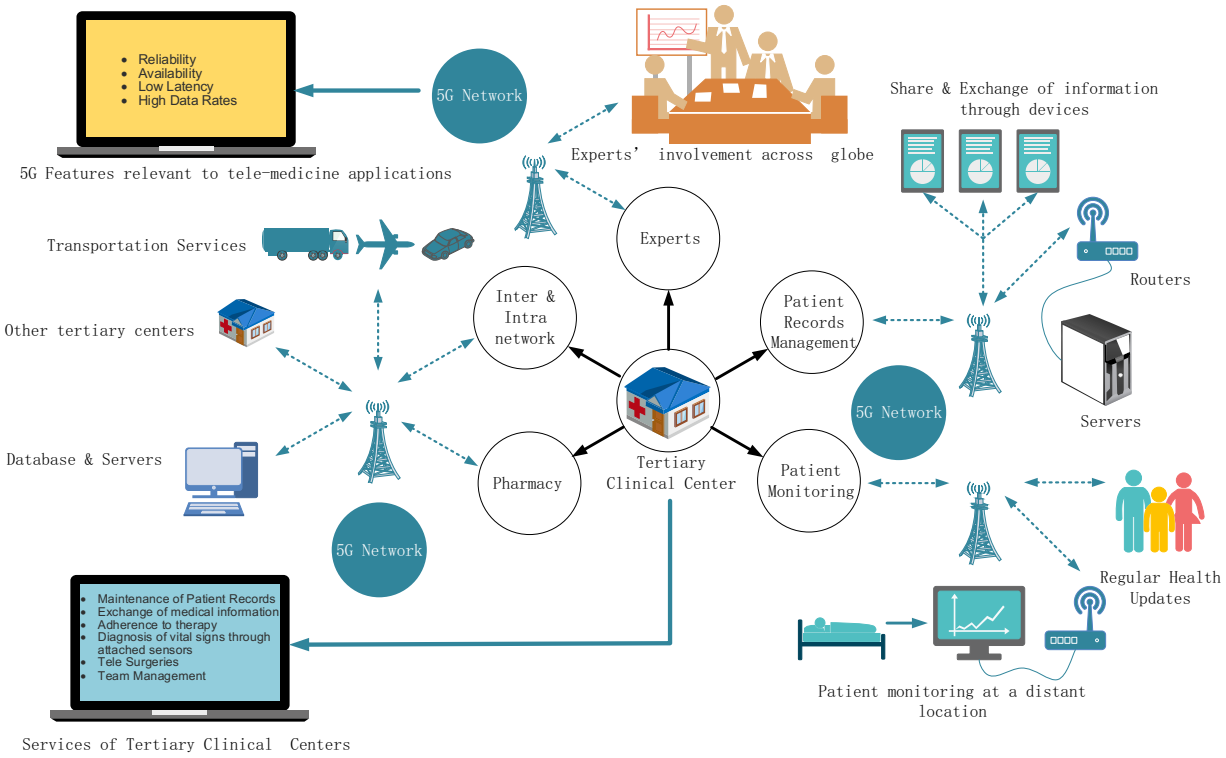


Fig 1: 5G for telemedicine applications

A. Bandwidth requirements for offloading medical services and applications

Clinical services can be divided for telemedicine into two main categories within a clinical organization.

- Inter telemedicine services
- Intra telemedicine services

Tertiary clinical center implicate two or three medical professionals to deal with a common patient case especially in pediatric cardiology, where data which is in the form of images or medical records are transferred to get a common solution of a given problem e.g., ECG, chest radiology and murmurs of neonates is called inter telemedicine services.

On the other hand, different tele conferences and meetings would be arranged to join different medical professionals from different departments called intra telemedicine services. This is mostly happened by communication through wireless technology. For Medical images transmission and videos require larger bandwidth and high resolution for 3D (three dimensional) images and other body scans so that after compression during transmission, there would be no data loss or interruption in the other receiving end because service is shared by different users at one time in a common place.

On the contrary, this band- width requirement provoke the situation to more critical level, when there is a need to see or monitor a patient on a distant place like patient with disabilities or elderly people with degenerative pathologies (e.g.: Alzheimer, or the insurgence of other pathologies such as stroke, cardio circulatory and muscular dysfunction etc. Last clinical advice is to perform physical activity regularly during the day and to maintain a social activity. For this there is a need of comprehensive health care plan. So, constant engagement with physician is needed.

The biggest socioeconomic challenge that has been arising in Europe is aging. According to EU commission public health policy, by 2025 more than 20% of Europeans will be 65 or over, with a particularly rapid increase in numbers of over-80s. (EU Commission) [6].

There is a need to decrease their abundance in hospital because it will not only create burden for medical staff but also made the environment more congested to deal with. Latest GPRS (General packet data rate service) system is not able to provide this real time communication precisely especially for the recording of patient movements during exercise, for this patient has to be monitored in hospital to get the values accurately. Apparatus utilized in hospitals are very outdated and based on the radiometry with limited area for coverage [7].

There is a need of high definition breakage free wireless communication that can fill up the gap of space (which means less occupancy of patients) and time factor (response is quick). Patient and physician can communicate data from different attached sensors, exoskeletons to see patient movements and

smart pharmaceutical devices which are providing dose tailored on suggestive and maintained therapy on a signaling pathway by the physician on real time with no delay especially for remote areas. 5G can change this whole scenario and can help to fill this gap created by space and time factor. Data could be easily analyzed with suggestive therapy on a mobile anywhere, anytime with a few milliseconds delay and can be handled with fastest communication.

Less costly cellular displays, medical applications and software's can easily be accessed and managed. Medication and dose adjustment by sensors and smart pharmaceutical devices for cardiac and diabetic patients can easily be done by physician with positive feedback mechanism.

B. Reliability and availability requirements

Recent increase in emergency situation and disasters, forecasting or their prediction is not easy. Sometimes, it is very time consuming, but recently happened events, can give us a knowledge that how we can deal with them in future and how help can be provided based on a real time with no communication loss. Billons of people are affected by these disasters. These disasters could be technical, natural or human generated which can cause deaths, disabilities and psychological stress for a long time.

Hospitals are continuously active in these crises and the biggest challenge in disaster management is communication. Proper system and methodology is not fully available in handling, processing and transmission of critical data on real time especially at a distant place properly. In disasters, regional communication services are severely affected and communication becomes constrained and distorted.

There is a need of secure architecture for wireless communication system and 5G will be beneficiary in such scenario as 5G has a high band-width and low latency, and this system can be integrated with cloud computing system by this health care services will be more reliable and available.

C. Standards and security

5G, being a new emerging technology is still lacking standards and this might take many months to years, to be defined as well implemented. Many of the universities and government organizations are working in this part to make 5G concept into a reality based technology. It is said that set standards will released in 2020, to make this target date into reality many of the public and government organization like IEEE, 3GPP, universities, ITU are making efforts to make this possible [8].

Prevailing Technological and operational guidelines which are in practice concerning telemedicine are [9]:

- Audio-video and data transmission should be of high quality and fulfill telehealth existing practice. Equipment's must have latest security software's as recommended by the device manufacturer. There must be a backup plan in case of communication or data loss.
- Multiple authentications and no activity timeout function can be utilized and in case of mobile or device loss or get stole, provider must be able to disable the connection and data.
- Real-time connectivity or synchronization requires bandwidth of at least 384kbps for down and uplink assignments and such kind of services must also provide a resolution of 640*480 at 30 frame/seconds. According to some health practitioner that high speed standard quality of video is not similar on a same bandwidth provided by different technologies.
- Video conference must utilize a link that in case of band width loss, stabilize and connection must not be lost.
- Whole disk encryption must be done for storage of a synchronized intentional data if cloud services are unable to give higher level of safety for health professionals and patient records, then it should be streamed to avoid unauthorized users and hacking attacks.
- Patient and physician should pretest the connection before communication is going to be happen. Tele or video conference software's must open one session to be conducted for discussion if there is an attempt or a hack to open second session, it must be automatically log off or access to second session must be denied.

These guidelines are helpful to set the standards. Here are some of the areas, where standardization is still needed.

1) Minimum delay require for delay application services

Telephonic education about medical issues require rate of data transfer from few 100 Mb/s to many 100 Gb/s The speed of 4G is approximately 10 to 20 Mb/s. Synchronized applications needs a minimum delay of 400 milliseconds [10].

International telecommunication service has given us the value of transmission of a data packet in IP networks for 3G which is 100 to 400 milliseconds for end to end delay and 1 per 1000 packets loss for synchronized services. In telemedicine for routine patient checkup QoS (quality of service) for 3G offers 150 to 400 millisecond delay which is less important as compared to emergency services where it offers a delay of 0 to 150 millisecond [11].

2) Bandwidth requirement for video based application

5G in such perspective is effective because it can transfer the images and data for telemedicine without interruption with very small delay or latency of about one millisecond. It will be more effective and reliable especially in remote patient monitoring with effective real time consultation [12].

Information technology utilization especially in health care sector has been very slow and the gatekeepers involved in this sector, making it difficult to develop in case of standards for data delivery and content [4].

In case of any network like Wi-Fi, 3G, 4G wireless network or wire system for an effective video call transmission, require a minimum band width of 230kbps (standard resolution) for uploading while for downloading of an additional video of ongoing call per video window require 178MB more. If we add more people in ongoing communication 128kbps are more needed for additional downloading per video window [13].

File size and type for transfer in medical facility is different for telediabetic retinopathy, MRIscans, digitalchest films, electrocardiogram studies and telepathology [14].

By adopting 5G which has data rate of 10 Gbit/s is more appropriate in transmission of these files with ease, higher speed and data rate because it has ability to cover all the challenges arises due to speed and audio video quality by providing higher bandwidth with low latency rates.

3) Security requirement and data encryption

Standards for data transmission and policies are not fully grown, still on basic or initial phase which needs reevaluation. There are not safety standards available for new innovative telemedicine services and for these cost is very high for their transmission on a broad band services [15].

Security makes a linkage between three main parts. These are self-sustainability which means, data is fully available not fragmented. Second is confidentiality which denotes that data is shared between authorized persons or users and third part of this linkage is availability which is the utilization of different services of networking. These three parts are interconnected and their balance actually is the success of provision of medical services. The first two parts are very important in telemedicine while, third is not as critical as others because there is always a backup plan available for data access. Self-sustainability is also important in this scenario, because in case of data loss it will directly affect the patient treatment or regime; the reason for this is that sound information is lost during transmission.

Data can also be encrypted, as a secret key is shared between one particular health unit and related staff dealing with a particular patient. They can access the data for treatment anytime. Data can be hacked or misused iso security is much more important within the hospital. Food and drug authority is only concerned to regulate medical instrument or devices and does not set any standards for consumer devices and application related to privacy concerns. So basically it is for patient safety but not concerned with patient privacy.

IV. CONCLUSION

In our survey we can conclude that work is still needed to define standards, and in particular security framework to make telemedicine services secure and also to make these services more applicable globally. A comprehensive framework is required to address future telemedicine using 5G technologies. There are, however, many uncertain areas what 5G is promising such as if a consistent, low latency and reliable connection will be available globally. More future research is needed to explore what kind of telemedicine application can emerge in connection to 5G technology, and more advanced smart devices having various sensors, and artificial intelligence.

REFERENCES

[1] Mobile devices in healthcare come with pros and cons,? SearchHealthIT. [Online]. Available: http://searchhealthit.techtarget.com/tip/Mobile-devices-in-healthcare-come-with-pros-and-cons. [Accessed: 03-Jun-2016].

[2] Y. Smith, ?A Brief History of NASA?s Contributions to Telemedicine,? NASA, 16-Aug-2013. [Online]. Available: http://www.nasa.gov/content/a-brief-history-of-nasa-s-contributions-to-telemedicine. [Accessed: 03-Jun-2016].

[3] 5G Radio Access for Ultra-Reliable and Low-Latency Communications,? Ericsson Research Blog, 11-May-2015. .

[4] 5G-PPP: 5G and e-Health.? .

[5] 5G Vision: 100 Billion Connections, 1 ms Latency, and 10 Gbps Throughput.? [Online]. Available: http://www.huawei.com/minisite/5g/en/defining-5g.html. [Accessed: 03-Jun-2016].

[6] Policy - European Commission.? [Online]. Available: http://ec.europa.eu/health/ageing/policy/index_en.htm. [Accessed: 03-Jun-2016].

[7] V. Oleshchuk and R. Fensli, ?Remote Patient Monitoring Within a Future 5G Infrastructure,? Wirel. Pers. Commun., vol. 57, no. 3, pp. 431?439, Jul. 2010.

[8] J. Best, ?The race to 5G: Inside the fight for the future of mobile as we knowit,? TechRepublic. [Online]. Available: http://www.techrepublic.com/article/does-the-world-really-need-5g/. [Accessed: 03-Jun-2016].

[9] J. Bernard and J. D. Linkous, ?Core Operational Guidelines for Telehealth Services Involving Provider-Patient Interactions.? [Online]. Available: http://www.americantelemed.org/docs/default-source/standards/core-operational-guidelines-for-telehealth-services.pdf?sfvrsn=6. [Accessed: 03-Jun-2016].

[10] [S. L. Kota, K. Pahlavan, and P. A. Lepp„nen, Broadband Satellite Communications for Internet Access. Springer Science & Business Media, 2011.

[11] Y.1541ÿ:ÿNetwork performance objectives for IP-based services.? [Online]. Available: https://www.itu.int/rec/T-REC-Y.1541-201112-I/en. [Accessed: 03-Jun-2016].

[12] 5G Radio Access for Ultra-Reliable and Low-Latency Communications,? Ericsson Research Blog, 11-May-2015. .

[13] What is the minimum amount of bandwidth required for a video call? Do you have high resolution video?? [Online]. Available: http://support.oovoo.com/link/portal/3908/4244/Article/1503/What-is-the-minimum-amount-of-bandwidth-required-for-a-video-call-Do-you-have-high-resolution-video. [Accessed: 03-Jun-2016].

[14] D. S. Kayange, ?Telemedicine Available Bandwidth Estimation Simulation Model for Effective E-Health Services: Categories, Requirements and Network Application,? Acad. Res. Int., vol. 5, no. 5, pp. 11?20, Sep. 2014.

A. Tedesco, D. Di Lieto, L. Angrisani, M. Campanile, M. De Falco, and A. Di Lieto, ?Telemedicine & Broadband,? Intechopen, 16-Aug-2013. [Online]. Available: http://cdn.intechopen.com/pdfs/14281/InTech-Telemedicine_broadband.pdf. [Accessed: 03-Jun-2016].

5G and Telemedicine: A Business Ecosystem Relationship within CONASENSE Paradigm

Ambuj Kumar[1], Sadia Anwar[2]
Department of Business Development and Technology,
Aarhus University, Herning, Denmark
[1]ambuj@btech.au.dk, [2] sadia@btech.au.dk

Abstract*—The use of smartphones has been increasing rapidly and it is expected that in future most people will have a smartphone capable of high speed Internet connection. The capability of smartphones with high definition display, computation power and multitude of sensors made it an excellent candidate for telemedicine application. Telemedicine's applications and high data medical information generally require high definition visuals and lower latency connection, in addition mobility and reliability. The next generation of wireless communication standard, known as 5G, will provide data speed in (Gigabit per second) Gb/s with lower latency and higher reliability connection, and can be better approach for future telemedicine. In this paper we survey the current state of telemedicine along with examining the characteristics of 5G technology. We shall see how the Telemedicine and 5G, together, form a composite business ecosystem. We also discuss the research challenges concerning 5G and telemedicine.

Keywords*—5G, Telemedicines, Wireless Communications, Business Modeling, Business Ecosystems.

I. INTRODUCTION

According to recent survey [1] 90% of medical practitioners are utilizing smartphones for clinical applications. By using smartphones, communication or interaction to patients becomes very easy and more effective. The estimated number of clinical applications available on smartphone is approximately 95,000. Furthermore, Internet of things (IoTs) is changing the way of our everyday life, as it is going to allow many things feasible and accessible e.g., smarter health care services, smart town and cities, smart automobiles and smarter retailing and shopping.

Wireless mobile communication is not only changing the way of our life but also becoming an integral part of our lives. 6martphones contribute a lot in keeping us updated in every aspect of life, as they can access a large number of information through Internet anytime, anywhere, and at a high speed. In early days, cellular technology was only focused on messaging and making phone calls but now it is possible to perform much more complex communication and computation tasks, in particular being connected with broadband mobile Internet connection.

As smartphones or smart devices are becoming more and more computationally powerful, along with high resolution displays, multiple ways of interaction, and various kind of embedded sensors that need for faster data rate, the low latency and higher reliability become more and more crucial and thus important. Therefore, 5G will be very important in this scenario, having capacity and high data rates, and is able to transmit data at Gb/s speed in 2020, which is about 200 times faster than 4G.

Telemedicine or telehealth is an inter-disciplinary area, which uses telecommunication technology to deliver medical information, medical help and services to remote areas at distant places, especially for the elderly and disabled persons. Telemedicine can be utilized as a first line strategy in case of emergency situations and disaster management. It was first applied in Mexico disaster by NASA in 1985. Voice communication was possible within 24 hours. With the passage of time and advancement in technology, this latency is now become small as in milliseconds by continuous modification and now by the new technology concept 5th generation mobile wireless communication (5G) which is becoming reality in 2020 [2].

We predict 5G along with telemedicine is going to revolutionize healthcare, and can be imagined in case of availability and time factors. Whereas, availability factor is basically introducing more specialists and medical physician to come and practice the telemedicine and time factor is handled by the faster wireless technology with high data rates such as 5G effectively and precisely for the delivery of virtual authentic medical care to patients.

The main lineaments of telemedicine are that it should be climbable, transparent or crystalline, provide geographical or global coverage, and fault tolerance with security, and authentication. Hospital digital networking concept came into being because of new faster wireless communication technologies, which are enhancing the approach of specialists and patients with each other to communicate visually and talk and share their condition with suggestive approach and strategies.

Business ecosystem [3] is a stage where various inter-/cross- disciplinary areas collocate for realistic commercial arena. Based on the aforementioned information, we can see that 5G and Telemedicine shall converge forming a steady and sturdy business ecosystems.

The rest of the paper is structured as follows: Section II describes important attributes of 5G in relation to telemedicine. Section III presents what are the research challenges in connection to 5G and telemedicine. Section IV

shall elaborately stress on the Business domain of this amalgamation And lastly, conclude the paper in Section V.

II. Important Attributes Of 5G In Relation To Telemedicine

In 2020, new and more revolutionized telehealth services will need wireless technology which can support high definition (HD) video quality, faster speed, low latency with no interruption in signaling pathway, more authentic in providing security and supportive for subscribers to use and subscribe applications especially in telemedicine, which is a concept truly based on the delivery of medical information to remote areas by utilizing wireless communication technology. 5G is going to address M2M (machine to machine) communication. Which is further divided into:

- Massive machine type communication, it includes low cost and low energy devices e.g. sensors involved in monitoring or diagnosis of vital signs. These devices need faster speed and real time communication [4].
- Mission critical type communication, it is real time controlled and has automated field function and processing such as robotically performed remote tele-surgery. In tele-surgery doctors can perform a surgery without their presence in a particular location, virtually through wireless technology. Tele-surgery needs more immense coordination between different surgeons which are remotely connected and this also requires that information of each performed task should be available with minimum latency in real-time scenario. 5G, in this scenario, will be more reliable with faster speed and low latency [5].

Some of the important attributes concerning 5G are as follows:

A. Some of the important attributes concerning 5G are as follows:

- Connectivity and coverage in Gb/s [9], will be available even in natural disasters or emergency situations, thus having this technology, more lives can be saved.
- Strong authentication with secured patient profile would be imagined with 5G. However, research is still under process to avoid jamming attacks and similar complications.
- Remote monitoring of patients in distant areas would be easy, because 5G will be able to provide higher bandwidth.
- Power consumption of batteries is viewed for 2020, and charging is available for at least 10 years in M2M scenario, [9].
- 5G also enables various sensors and implant to connect with different service configurations to see patient condition and to provide them best regime or therapy.
- 5G has mobility with faster speed and low latency [9], which is less than one millisecond. Virtual reality and HD videos should be as detailed as human retina can detect. For this 300 Mb/s is generally required and this technology is 100 times above with low data rate and ultra-reliability, to carry out the High definition videos. It will be very helpful in dealing patients in video conferences to avoid breach in communication [6].
- Medical image transmission and videos require larger bandwidth. These images and videos are compressed during transmission and it is expected on the other end that there would be no data or image loss after receiving. 5G can handle HD videos and high data transmission in case of remote monitoring of patients, video conferencing, robotic equipment's, smart pharmaceuticals such as ventilators, fluid rate and drug delivery systems attached to the patients in remote areas. As an example, in diabetic patients, insulin reservoir are controlled and connected with wireless technology. Sensors provide the signals on daily basis for body glucose level. Insulin is then injected accordingly after taking the values.
- With 5G, first-aid could be delivered in small duration of time and communication without interruption available with the blink of eye.
- More and more patients are motivated to consult with doctors online. It is not only saving time but its cost effective features making it more reliable. 5G can play a more vital role to access these consultations frequently and remotely with ultra-low cost and low-end data rate reliability.
- Cloud service robotics for supportive therapy will be easy as offloading and uploading of information for recognition of language, object and cognitive skills will be predicted on real time with no interruption. Cost will also be reduced as less number of robots is involved [5].
- Remote monitoring of elderly patients will be optimized through continuous updates about life style modification and treatment for patients with chronic diseases and related disabilities. Their rehabilitation care plan and strategies can be reviewed by wireless communication, for this wireless technology has to follow the same standard for urban and rural areas where there is higher density of followers and users.

III. Research Challenges

A new and advance form of existing technology always has inherent challenges to deal with new problems. First generation mobile communication (1G) came in 1980s while fifth generation (5G) is going to be commercialized in 2020. It is a journey of approximately 40 years. During the modification and transformation of these technologies, we are still lacking proper infrastructure, standards, security and legislations concerning wireless communication technology.

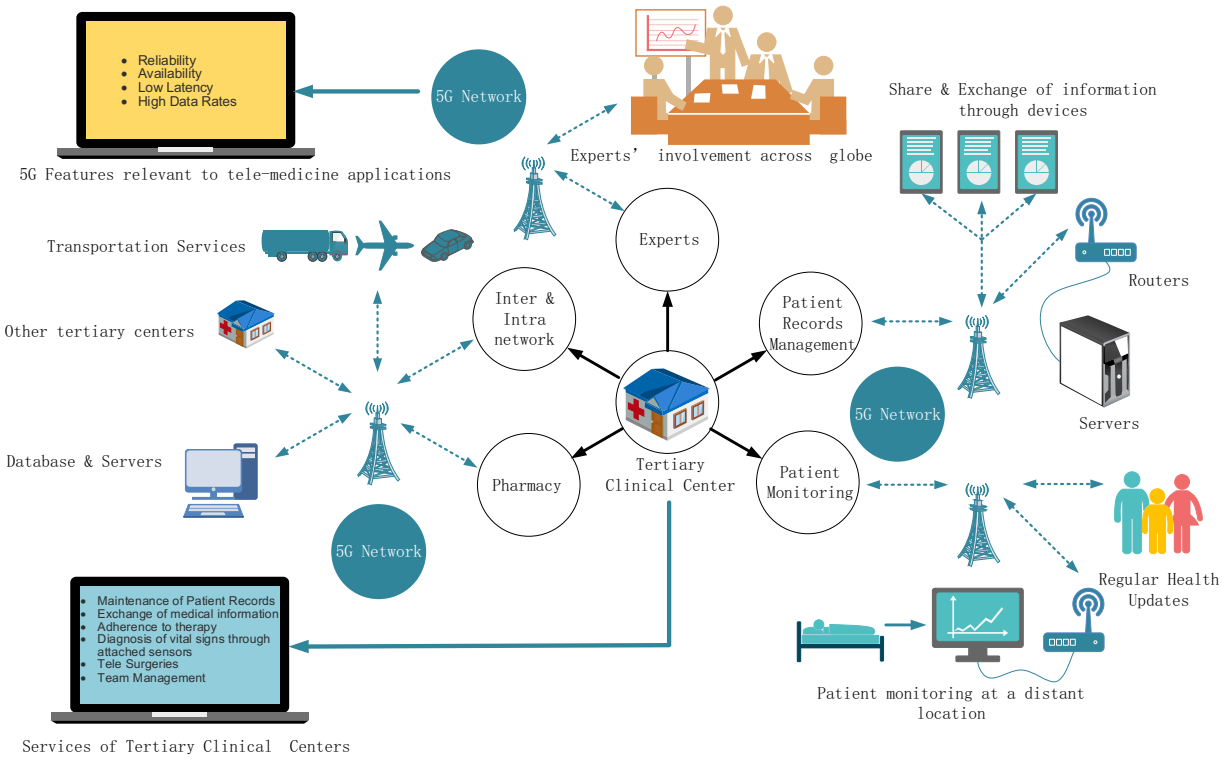


Fig 1: 5G for telemedicine applications

Fig.1 shows and elaborate concept of telemedicine services running on 5G network. The challenges that we are facing in wireless communication concerning telemedicine are:

A. Bandwidth requirements for offloading medical services and applications

Clinical services can be divided for telemedicine into two main categories within a clinical organization.

- Inter telemedicine services
- Intra telemedicine services

Tertiary clinical center implicate two or three medical professionals to deal with a common patient case especially in pediatric cardiology, where data which is in the form of images or medical records are transferred to get a common solution of a given problem e.g., ECG, chest radiology and murmurs of neonates is called inter telemedicine services.

On the other hand, different tele conferences and meetings would be arranged to join different medical professionals from different departments called intra telemedicine services. This is mostly happened by communication through wireless technology. For Medical images transmission and videos require larger bandwidth and high resolution for 3D (three dimensional) images and other body scans so that after compression during transmission, there would be no data loss or interruption in the other receiving end because service is shared by different users at one time in a common place.

On the contrary, this band- width requirement provoke the situation to more critical level, when there is a need to see or monitor a patient on a distant place like patient with disabilities or elderly people with degenerative pathologies (e.g.: Alzheimer, or the insurgence of other pathologies such as stroke, cardio circulatory and muscular dysfunction etc. Last clinical advice is to perform physical activity regularly during the day and to maintain a social activity. For this there is a need of comprehensive health care plan. So, constant engagement with physician is needed.

The biggest socioeconomic challenge that has been arising in Europe is aging. According to EU commission public health policy, by 2025 more than 20% of Europeans will be 65 or over, with a particularly rapid increase in numbers of over-80s. (EU Commission) [7].

There is a need to decrease their abundance in hospital because it will not only create burden for medical staff but also made the environment more congested to deal with. Latest GPRS (General packet data rate service) system is not able to provide this real time communication precisely especially for the recording of patient movements during exercise, for this patient has to be monitored in hospital to get the values accurately. Apparatus utilized in hospitals are very outdated and based on the radiometry with limited area for coverage [8].

There is a need of high definition breakage free wireless communication that can fill up the gap of space (which means less occupancy of patients) and time factor (response is quick).

Patient and physician can communicate data from different attached sensors, exoskeletons to see patient movements and smart pharmaceutical devices which are providing dose tailored on suggestive and maintained therapy on a signaling pathway by the physician on real time with no delay especially for remote areas. 5G can change this whole scenario and can help to fill this gap created by space and time factor. Data could be easily analyzed with suggestive therapy on a mobile anywhere, anytime with a few milliseconds delay and can be handled with fastest communication.

Less costly cellular displays, medical applications and software's can easily be accessed and managed. Medication and dose adjustment by sensors and smart pharmaceutical devices for cardiac and diabetic patients can easily be done by physician with positive feedback mechanism.

B. Reliability and availability requirements

Recent increase in emergency situation and disasters, forecasting or their prediction is not easy. Sometimes, it is very time consuming, but recently happened events, can give us a knowledge that how we can deal with them in future and how help can be provided based on a real time with no communication loss. Billons of people are affected by these disasters. These disasters could be technical, natural or human generated which can cause deaths, disabilities and psychological stress for a long time.

Hospitals are continuously active in these crises and the biggest challenge in disaster management is communication. Proper system and methodology is not fully available in handling, processing and transmission of critical data on real time especially at a distant place properly. In disasters, regional communication services are severely affected and communication becomes constrained and distorted.

There is a need of secure architecture for wireless communication system and 5G will be beneficiary in such scenario as 5G has a high band-width and low latency, and this system can be integrated with cloud computing system by this health care services will be more reliable and available.

C. Standards and security

5G, being a new emerging technology is still lacking standards and this might take many months to years, to be defined as well implemented. Many of the universities and government organizations are working in this part to make 5G concept into a reality based technology. It is said that set standards will released in 2020, to make this target date into reality many of the public and government organization like IEEE, 3GPP, universities, ITU are making efforts to make this possible [8].

Prevailing Technological and operational guidelines which are in practice concerning telemedicine are [10]:

- Audio-video and data transmission should be of high quality and fulfill telehealth existing practice. Equipment's must have latest security software's as recommended by the device manufacturer. There must be a backup plan in case of communication or data loss.
- Multiple authentications and no activity timeout function can be utilized and in case of mobile or device loss or get stole, provider must be able to disable the connection and data.
- Real-time connectivity or synchronization requires bandwidth of at least 384kbps for down and uplink assignments and such kind of services must also provide a resolution of 640*480 at 30 frame/seconds. According to some health practitioner that high speed standard quality of video is not similar on a same bandwidth provided by different technologies.
- Video conference must utilize a link that in case of band width loss, stabilize and connection must not be lost.
- Whole disk encryption must be done for storage of a synchronized intentional data if cloud services are unable to give higher level of safety for health professionals and patient records, then it should be streamed to avoid unauthorized users and hacking attacks.
- Patient and physician should pretest the connection before communication is going to be happen. Tele or video conference software's must open one session to be conducted for discussion if there is an attempt or a hack to open second session, it must be automatically log off or access to second session must be denied.

These guidelines are helpful to set the standards. Here are some of the areas, where standardization is still needed.

1) Minimum delay require for delay application services

Telephonic education about medical issues require rate of data transfer from few 100 Mb/s to many 100 Gb/s The speed of 4G is approximately 10 to 20 Mb/s. Synchronized applications needs a minimum delay of 400 milliseconds [11].

International telecommunication service has given us the value of transmission of a data packet in IP networks for 3G which is 100 to 400 milliseconds for end to end delay and 1 per 1000 packets loss for synchronized services. In telemedicine for routine patient checkup QoS (quality of service) for 3G offers 150 to 400 millisecond delay which is less important as compared to emergency services where it offers a delay of 0 to 150 millisecond [12].

2) Bandwidth requirement for video based application

5G in such perspective is effective because it can transfer the images and data for telemedicine without interruption with very small delay or latency of about one millisecond. It will be more effective and reliable especially in remote patient monitoring with effective real time consultation [12].

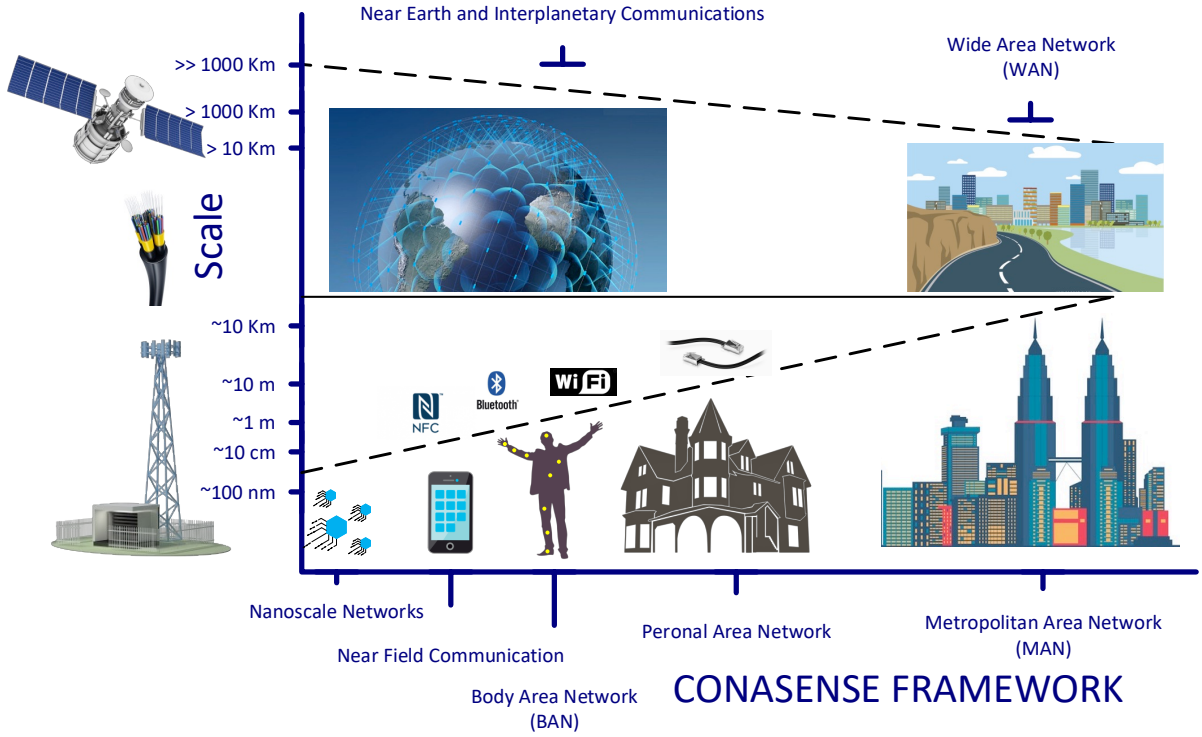


Fig 2: CONASENSE Framework[#]

Information technology utilization especially in health care sector has been very slow and the gatekeepers involved in this sector, making it difficult to develop in case of standards for data delivery and content [5].

In case of any network like Wi-Fi, 3G, 4G wireless network or wire system for an effective video call transmission, require a minimum band width of 230kbps (standard resolution) for uploading while for downloading of an additional video of ongoing call per video window require 178MB more. If we add more people in ongoing communication 128kbps are more needed for additional downloading per video window [14].

File size and type for transfer in medical facility is different for telediabetic retinopathy, MRIscans, digitalchest films, electrocardiogram studies and telepathology [15].

By adopting 5G which has data rate of 10 Gbit/s is more appropriate in transmission of these files with ease, higher speed and data rate because it has ability to cover all the challenges arises due to speed and audio video quality by providing higher bandwidth with low latency rates.

3) Security requirement and data encryption

Standards for data transmission and policies are not fully grown, still on basic or initial phase which needs reevaluation. There are not safety standards available for new innovative telemedicine services and for these cost is very high for their transmission on a broad band services [16].

Security makes a linkage between three main parts. These are self-sustainability which means, data is fully available not fragmented. Second is confidentiality which denotes that data is shared between authorized persons or users and third part of this linkage is availability which is the utilization of different services of networking. These three parts are interconnected and their balance actually is the success of provision of medical services. The first two parts are very important in telemedicine while, third is not as critical as others because there is always a backup plan available for data access. Self-sustainability is also important in this scenario, because in case of data loss it will directly affect the patient treatment or regime; the reason for this is that sound information is lost during transmission.

Data can also be encrypted, as a secret key is shared between one particular health unit and related staff dealing with a particular patient. They can access the data for treatment anytime. Data can be hacked or misused iso security is much more important within the hospital. Food and drug authority is only concerned to regulate medical instrument or devices and does not set any standards for consumer devices and application related to privacy concerns. So basically it is for patient safety but not concerned with patient privacy.

IV. Business Ecosystem Paradigm in Relation to the Integration of Communication, Navigation, Sensing and Services

Telemedicine is a kaleidoscope of multi-/inter-/cross-disciplinary. The world telemedicine itself is intersection of two extremely independent scientific areas, namely

telecommunications and medicine. This is unique to CONASENSE[17,18,19] as most of its works are associated to telecommunication paradigm. Through this discussion, we are pointing out the fact that CONASENSE is also associated to business ecosystem and telemedicine is one such example. Figure 2 shows the CONASENSE framework in telecommunications. Here, we can see how communication technology ranges from Nanoscale Networks to Near Earth intra-/intra planetary communication, and no other field other than telemedicine has possibility of penetrating into the CONASENSE domain at every level of this framework. This means that from nanoscale to satellite communications, telemedicine can be benefitted at every level.

As an example, the nanoscale communications can be very beneficial in injectable nanobots who can travel in the blood vessels for pin-point treatments/ surgeries, whereas the satellite scale can be used for broader medical services. Figure 3 shows that broader application of CONASENSE in relation to telemedicine, where, the human biological parameters are measure by biosensors that are either wearable or positioned across smart home. These biosensors use telecommunication to store and transmit parametric data. These transferred data can be then collected at the servers/ computers for analysis, and/ or can be used for calling appropriate services.

Figure 4 shows the hepta dimensional [20] business model that is uses the B-Lab, which is developed in CTIF Global Capsule, Aarhus University, Herning, Denmark. Figure 3 expresses telemedicine in CONASENSE perspective. Following is the discussion about the seven dimensions of telemedicine in relation to the CONSASENSE.

1) Value Proposition: It is the value that a business model provides to its customers or users. These values can be a product, service or solution of a problem. In case of telemedicine, the value propositions are Telehealth, Rehabilitation, Telepharmacy, Telesurgery, Telecardiology etc. This means that the telemedicine business models is incepted to intervene telecommunication between the patient and medical solution. Using the telecommunications, a patient can be facilitated with most of the medical needs from remote location including, rehabilitation, surgery, monitoring etc. Telemedicine can be extremely useful in underserved areas and in case of calamities.

1) Users and Customers: By definition, customers pay for the values and users return another value as compensation. In case of telemedicine, the customers can be hospitals, caregivers, municipality etc, whereas users may be doctors and end patients who do not pay directly to the telemedicine services. In both cases, the user/customers use telecommunications services to benefit their neets and the corresponsing provider uses them for prompt solutions.

2) Networks: This component correcponds to the relations with other businesses to achive values. In telemedicine, the Telecom providers, hospitals, caregivers are the networks that can be associated in the telemedicine process.

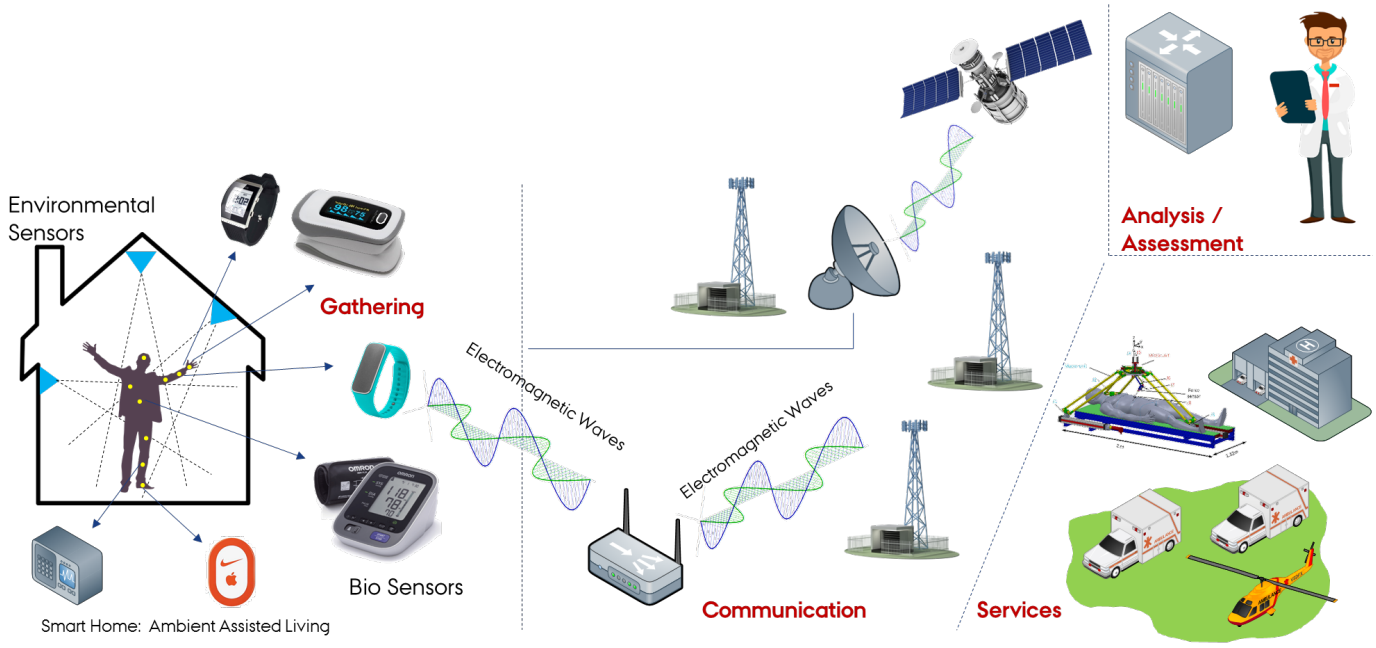


Fig 3: Telemedicine paradigm.*

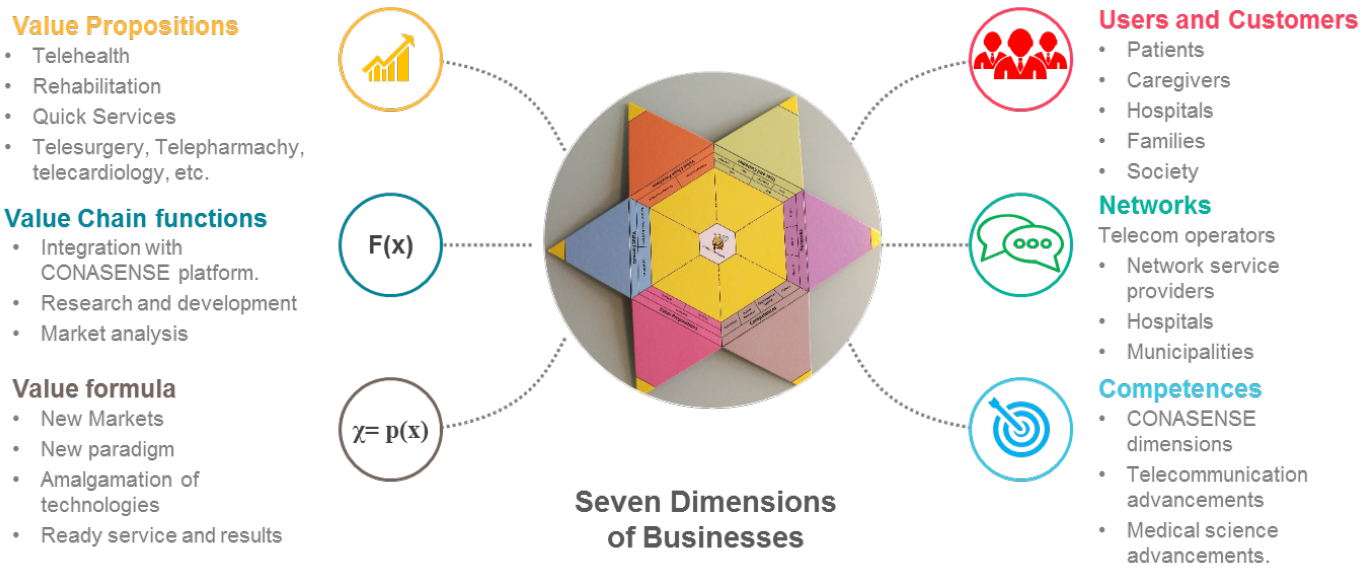


Fig 4: Telemedicine business model in seven dimensions, business ecosystem

3) Competences: This dimension corresponds to the business competences. In case of telemedicine, all dimesions of CONASENSE shall be the begggest competences besides the medical advancements.

4) Value Chain Function: This dimension associates with other values that are inevitable to achieve the business values. Integration with CONASENSE platform is the most favourable function that can be assissted with market analysis and research and developments.

5) Value formula: The value formula, meaning the returns of a business, of the telemedicine is the quality enhancements in patients' services. From rehabilitation to surgery, all the possible medical domains are redealy achievable due to the accomodation of CONASENSE paradigm.

6) Relations: This dimension relates all other dimensions with each other for the seamles business development.

Thus, we see that the Telemedicine-CONASENSE plaform, as shown in figure 5 can be a boon to the society. By introducing human-centric features in the CONASENSE paradigm, a lot can be achieved in business ecosysmes.

V. CONCLUSION

In our survey we can conclude that work is still needed to define standards, and in particular security framework to make telemedicine services secure and also to make these services more applicable globally. A comprehensive framework is required to address future telemedicine using 5G technologies. There are, however, many uncertain areas what 5G is promising such as if a consistent, low latency and reliable connection will be available globally. More future research is needed to explore what kind of telemedicine application can emerge in connection to 5G technology, and more advanced smart devices having various sensors, and artificial intelligence. Further, it is discussed that how CONASENSE can be a key-player in application of telemedicine services by allowing all its verticals to percolate in telemedicine domain. We have also discussed the seven dimensions of telemedicine business ecosystem and how CONASENSE can play its role in the business enhancements.

REFERENCES

[1] Mobile devices in healthcare come with pros and cons,? SearchHealthIT. [Online]. Available: http://searchhealthit.techtarget.com/tip/Mobile-devices-in-healthcare-come-with-pros-and-cons. [Accessed: 03-Jun-2016].

[2] Y. Smith, ?A Brief History of NASA?s Contributions to Telemedicine, NASA, 16-Aug-2013. [Online]. Available: http://www.nasa.gov/content/a-brief-history-of-nasa-s-contributions-to-telemedicine. [Accessed: 03-Jun-2016].

[3] 5G Radio Access for Ultra-Reliable and Low-Latency Communications,? Ericsson Research Blog, 11-May-2015.

[4] Lindgren, Peter. "Business model innovation leadership: how do SME's strategically lead business model innovation?." International Journal of business and management 7.14 (2012): 53.

[5] 5G-PPP: 5G and e-Health.? .

[6] 5G Vision: 100 Billion Connections, 1 ms Latency, and 10 Gbps Throughput.? [Online]. Available: http://www.huawei.com/minisite/5g/en/defining-5g.html. [Accessed: 03-Jun-2016].

[7] Policy - European Commission.? [Online]. Available: http://ec.europa.eu/health/ageing/policy/index_en.htm. [Accessed: 03-Jun-2016].

[8] V. Oleshchuk and R. Fensli, ?Remote Patient Monitoring Within a Future 5G Infrastructure,? Wirel. Pers. Commun., vol. 57, no. 3, pp. 431?439, Jul. 2010.

[9] J. Best, ?The race to 5G: Inside the fight for the future of mobile as we knowit,? TechRepublic. [Online]. Available: http://www.techrepublic.com/article/does-the-world-really-need-5g/. [Accessed: 03-Jun-2016].

[10] J. Bernard and J. D. Linkous, ?Core Operational Guidelines for Telehealth Services Involving Provider-Patient Interactions.? [Online]. Available: http://www.americantelemed.org/docs/default-source/standards/core-operational-guidelines-for-telehealth-services.pdf?sfvrsn=6. [Accessed: 03-Jun-2016].

[11] [S. L. Kota, K. Pahlavan, and P. A. Lepp,,nen, Broadband Satellite Communications for Internet Access. Springer Science & Business Media, 2011.

[12] Y.1541ÿ:ÿNetwork performance objectives for IP-based services.? [Online]. Available: https://www.itu.int/rec/T-REC-Y.1541-201112-I/en. [Accessed: 03-Jun-2016].

[13] 5G Radio Access for Ultra-Reliable and Low-Latency Communications,? Ericsson Research Blog, 11-May-2015. .

[14] What is the minimum amount of bandwidth required for a video call? Do you have high resolution video?? [Online]. Available: http://support.oovoo.com/link/portal/3908/4244/Article/1503/What-is-the-minimum-amount-of-bandwidth-required-for-a-video-call-Do-you-have-high-resolution-video. [Accessed: 03-Jun-2016].

[15] D. S. Kayange, ?Telemedicine Available Bandwidth Estimation Simulation Model for Effective E-Health Services: Categories, Requirements and Network Application,? Acad. Res. Int., vol. 5, no. 5, pp. 11?20, Sep. 2014.

[16] A. Tedesco, D. Di Lieto, L. Angrisani, M. Campanile, M. De Falco, and A. Di Lieto, ?Telemedicine & Broadband,? Intechopen, 16-Aug-2013. [Online]. Available: http://cdn.intechopen.com/pdfs/14281/InTech-Telemedicine_broadband.pdf. [Accessed: 03-Jun-2016].

[17] Ligthart, Leo P., and Ramjee Prasad, eds. Communications, Navigation, Sensing and Services (CONASENSE). River Publishers, 2013.

[18] Wang, Yapeng, and Ramjee Prasad. "Network Neutrality for CONASENSE Innovation Era." Role of Ict for Multi-disciplinary Applications in 2030. River Publishers, 2016. 167-184.

[19] Lala M. Purnima, Kumar, Ambuj, “Heterodox Networks An Innovative and Alternate Approach to Future Wireless Communication, Role of ICT for Multi-disciplinary Applications in 2030. Vol. 47. River Publishers, 2016.

[20] Lindgren, Peter, et al. "Open business model innovation in healthcare sector." Journal of Multi Business Model Innovation and Technology 1.1 (2012): 23-52.

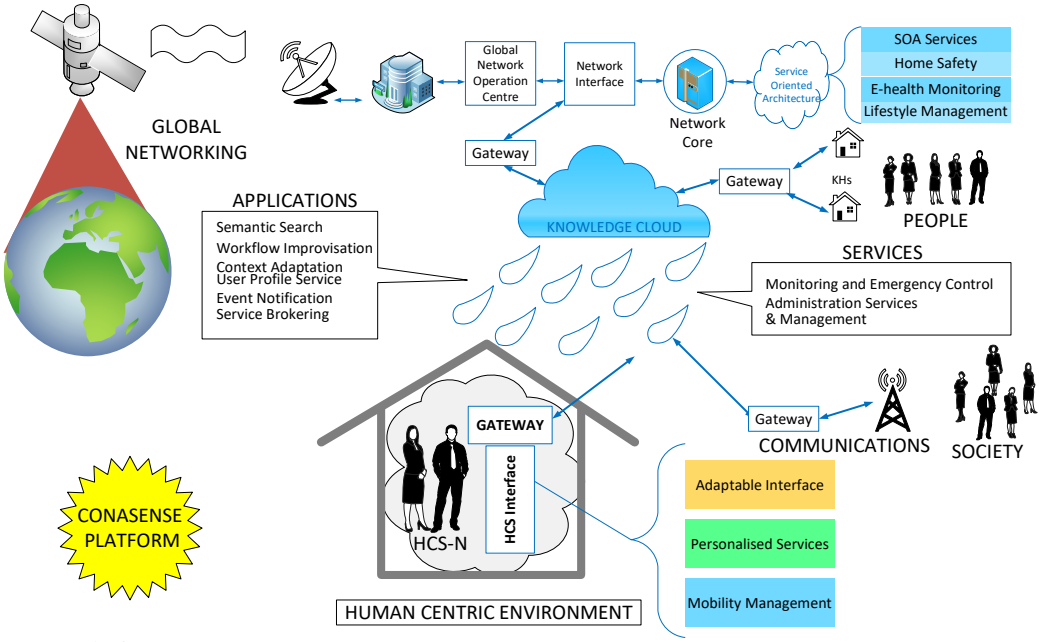


Fig 5: CONASENSE Platform

Sources:
#Figure1: Nanobots: https://www.researchgate.net/topic/Network-Architecture; Other pictures: https://stock.adobe.com
* Figure 3: Blood pressure meter: https://www.omron-healthcare.com/en/products/bloodpressuremonitoring;
Step sensor: Apple Nike and iPod Sensor; pulse oximeter: https://innovo-medical.com/products/ip900ap; Generic pictures: Google search.

Wireless Personal Communications (2019) 106:191–204
https://doi.org/10.1007/s11277-019-06273-6

A Telemedicine Platform for Disaster Management and Emergency Care

Sadia Anwar[1] · Ramjee Prasad[1] · Bhawani Shankar Chowdhary[2] · M. R. Anjum[3]

Published online: 25 March 2019

Abstract
Disaster or emergency can create unusual circumstances. And usually they are extremely hard to stop. However, an intelligent approach or strategy can limit the damage or causalities and can help in the restoration of the victims. The technology platform is promising for disaster management. But due to continuous innovation and shift in technology, one single platform for disaster still lacks to be settled that promise less depravity. Telemedicine can blend both technology and medical assistance that can aid in analysis, scalability and potential of a particular plan execution as well as in doing priority protocol practice based on victim's conditions, indicators and diagnosis. Distance from approaching a victim and waiting time can be lessened by a fight-or-flight strategy which is active and rebound since it demands coordination and communication between various sectors for compliance and rebuilding with an intelligent strategy. Telemedicine describes the use of medical information exchanged from one site to another via electronic communications to improve patients' health status and care. Its applications in disaster situation likewise earthquake, war etc., required efficient, reliable communication technology such as GPRS, LTE etc. However, transmission losses or delay occur during transmission. Using Friis transmission condition transmission loses can be minimized for efficient communication. This paper proposed a model where telemedicine technology could be helpful especially in the areas the shortage of medical specialist or doctors.

Keywords Telemedicine · Intelligent strategy · Coordination and communication · Fight-or-flight · Active & rebound · ICT · Wireless network

✉ Sadia Anwar
sadia@btech.au.dk
http://person.au.dk/sadia@btech.au.dk

M. R. Anjum
engr.muhammadrizwan@gmail.com

[1] Department of Business Development and Technology, Aarhus University, Herning, Denmark

[2] Institute of Information and Communication Technologies, Mehran University of Engineering & Technology, Jamshoro, Sindh 76062, Pakistan

[3] Department of Electronic Engineering, University College of Engineering & Technology, Islamia University of Bahawalpur, Bahawalpur, Punjab 63100, Pakistan

1 Introduction

Telemedicine can fit into all disaster conditions by sound strategy and planning. Telemedicine can be used for remote monitoring or provision of care by applying technology platform. Immediate access and prevention to premature deaths or disabilities are very challenging. Telemedicine in disaster management has a potential to provide care if emergency health services, hospitals are terminated by connecting to areas which are less affected and internationally by technology means. Many technological solutions are available, but disaster can indulge unusual situations in which intelligent methods or transitional strategy is required. In case older adults with chronic diseases and disability or critically injured by catastrophe need medical attention and subsequent analysis. The most useful device during such situation is a mobile phone to contact with the closed emergency healthcare service and to get information about the possible treatment [1]. There are many offline applications available to understand the essential information in a critical situation if electricity and other communication references are lost. There are several factors, which become the cause of losses in communication link as shown in Fig. 1 due to fading phenomenon appear in free space propagation of radio signal from base station transmitter to receiver end. Telemedicine system design architecture as shown in Fig. 2. Fundamental elements and stages of a disaster or emergency care management shown in Fig. 3. Cost for affording telemedicine services and devices is pretty less as compared to when these solutions evolved in the market.

National Aeronautics and Space Administration (NASA) first utilized telemedicine strategy in 1985 in Mexico City, and within 24 h voice transmission was confirmed [2]. Military agencies, many space programs and different disaster management agencies are examining several telemedicine services by real or self-generated simulations to see the effectiveness of a distinct service particularly the areas extra porn to a disaster.

This paper presents what could be practical planning for telemedicine in disaster management with recommendations by blending technology and medical area. This article has seven sections.

This paper presents what could be practical planning for telemedicine in disaster management with recommendations by blending technology and medical area. This article has Five sections, Sect. 1: describes causalities, economic loss and types of

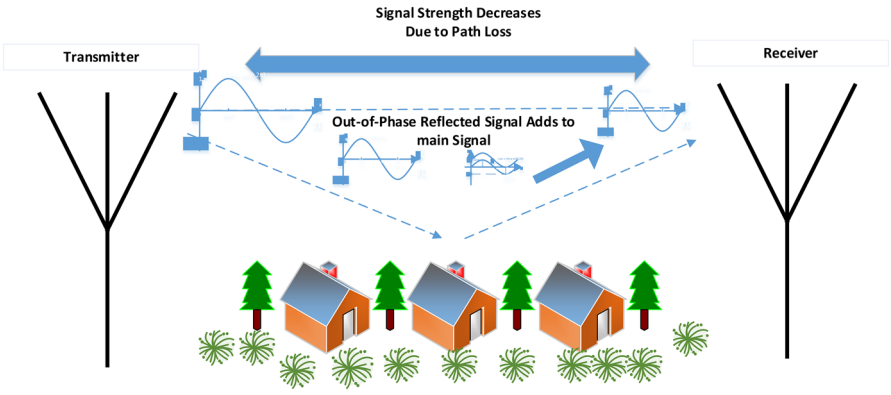


Fig. 1 Transmission losses due to fading in the communication link

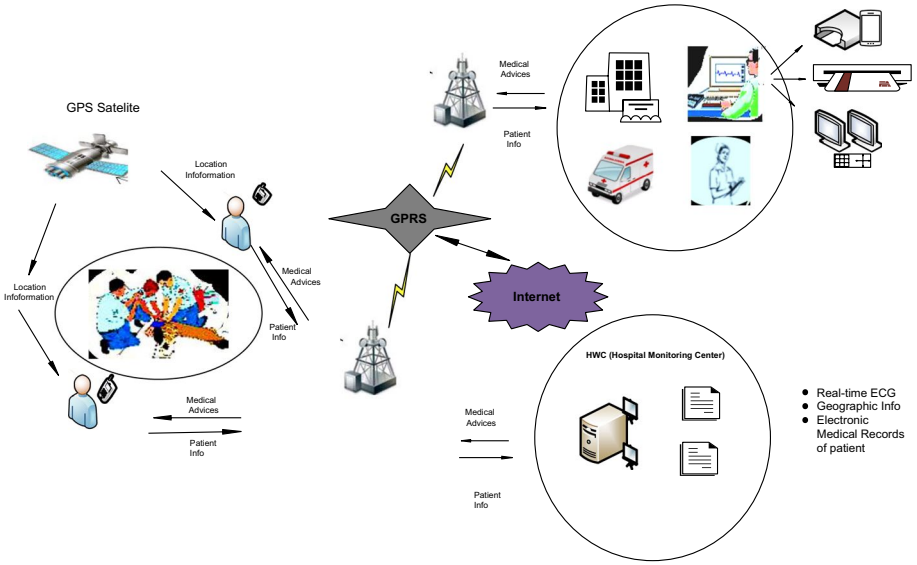


Fig. 2 Telemedicine system design architecture

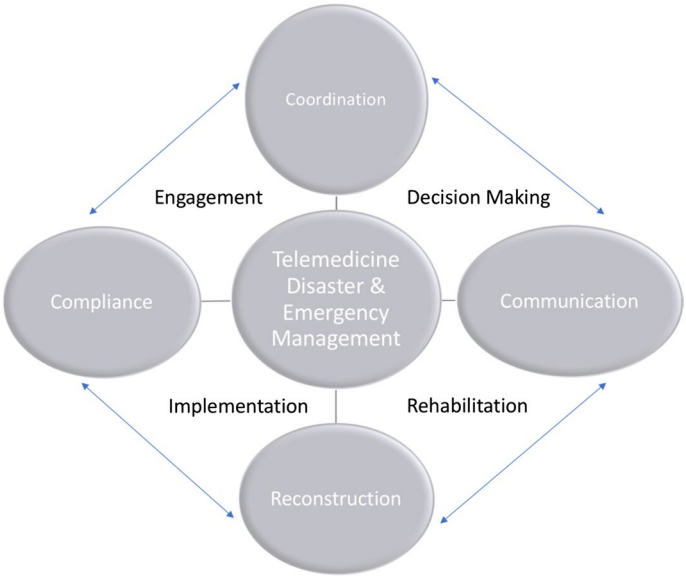


Fig. 3 Illustrates fundamental elements and stages of disaster or emergency care management

disasters, emergency care and disaster risk analysis. Section 2: Telemedicine tools in disaster, indicators and disease conditions in disaster. Section 3: Integrated communication tools. Section 4: Surveillance model has been discussed regarding problematic areas and what are the tools that can guide to making an intelligent, active and rebound

strategy for decision making recognizing telemedicine in case of disaster and lastly Sect. 5 conclusions and future scope.

1.1 Causalities, Economic Loss and Types of Disasters

According to World Health Organization (WHO) disaster [3] is a disruptive situation that disorients the functioning of a community and leads to human, infrastructure and a wide range of economic loss that surpasses the actual resources of a particular community to handle it.

Disaster can be categorized as technical, human generated or natural that can lead to damage of infrastructure, physical disability or psychological depression and stress, e.g., cyclone, earthquake, heat waves, floods etc. and it has affected 2.6 billion people from last decade [4]. It clearly shows that still, technology is unable to adequately provide the satisfactory solution for the random and variable situation.

From 1970, 98,000 natural disasters have been estimated that causes 3.7 million causalities and affected 5.8 billion people, and loss of economy Dollars 1.7 trillion throughout the world [5]. In the world, the most exposed and likely disaster region is Asia due to its geographical characteristics. Earthquakes, floods, tsunamis, cyclones are significant sources of significant causalities. It has been estimated and compared that people living in Pacific region are two times effected as compared to African people, 6- times from people living in Latin America, 30 times from North America or Europe from a natural disaster [6].

From the years 1980–2015 annual loss of GDP was highest in these following five countries, Magnolia 20.1%, Belize 9.3%, Maldives 18.5% and Solomon island 8.0% as a share of global GDP due to natural disasters by flooding and storms [7].

Disasters have also been increased from 1998 to 2009 in Europe and according to the European Environment Agency (EEA). These led to the human, economy and overall environment or ecosystem disruption and it clearly demands a correlated risk disaster management & intelligent approach [8]. These disasters have caused approximately 100,000 causalities and create an economic loss of EUR 150 billion.

Most common types of disaster in Europe and America are heat waves, drought, floods, earthquake, thunderstorms, wildfire, extreme winter weather, tornadoes etc. [9]. European Union has adopted the regulation to provide support for the region more prone to natural disasters like earthquake and floods and with this contribution EU will hold 95% of the coast [10]. In 2020 EUR 9.8 billion will be given to support the disaster region.

1.2 Emergency Care and Disaster Risk Analysis

There are four stages of disaster that distinguish how planning should be considered:

- Remission
- Preparedness
- Action or response
- Recovery plan [11]

Before hitting any disaster, it is necessary to study wisely and plan. In a disaster, the infrastructure, connectivity and healthcare provision interrupt when planning is not conducted or improvised. Telemedicine services are appropriate in those countries

where the health care system is robust. A disaster has uncertainty, emergency ad threat that affects not only the people but also the services that counter [12].

- It is essential to classify what sets of disaster a country has with a particular region regarding need assessment. What is the infrastructure of communication to support a telemedicine service can be utilized? It can be gathered by local expert opinion, region history and case studies, and framework used according to the infrastructure of a particular disaster-prone area.
- What kind of culture, believes people are having and their eHealth literacy rate. And what is their economic condition?
- Local municipality help to generate data about chronic diseases or disable people number as compared to healthy individuals.
- What types of domestic medical help is available in case of a small or local emergency [13].
- In case of emergency what person should be communicated or notified.
- People in a distinct area should be registered in medical record system so that in case of any disaster identity verification or contact to the closed one be available [14].

These all can help to define parameters to be considered.

2 Telemedicine Tools in Disaster Response

Tools are the devices for linkage between a medical professional and the patient or a person invaded by a disaster for identification, diagnosis, need analysis and provision of a particular treatment through a remote medical health service.

- Live video conference or video broadcast to see or directly consult by the use of audio–video technology like stock data- and- deliver
- to medical professional or help to victims by reliable transmission of information, for example, disturbing images, recorded video and other relevant data to maintain privacy and avoiding panic from relatives
- Remote monitoring and reciprocal actions if the big medical help is not available to a disaster area to make a person alive and engaged.
- Health education is essential about what possibly a Person can do to help severely injured or oneself [15].
- Sending drones which can transmit videos or pictures of a disaster area.
- Connected drones used for emergency supply.

To reduce depression or psychological stress, pain relief or emergency kit for vital signs monitoring and medication provision.

- First aid advice and resuscitation techniques and toxicity guidance

These tools can enhance survival rate, solve difficult condition and causalities.

Table 1 Describes the priority list to indicate the state of the victims involved and priority treatment

Priority	Indicators	Victims state	Condition	Transportation
Priority list 1	Red	Serious	Head injury, severe burns, bleeding, internal injuries, heart attack, breathing problems	Immediate
Priority list 2	Yellow	Moderate to serious	Fractures	Less immediate
Priority list 3	Green	Wounded and can walk	Minor injuries	Waiting list
Non-priority	Blue	Critical	Fatal injuries	No transportation

Table 2 It describes the biological indicators collection during a disaster situation

Telemedicine in disaster Tele-education Tele-consultation Medical assistance Tele surgery	Indicators Collection for the Victims	Heart rate Blood pressure Oxygen saturation Temperature Respiration ECG 12 leads Depression and stress level Level of consciousness Pulse rate

2.1 The Most General Medical Condition or Indicators in Disaster

The communicable disease can be classified into four different categories based on the infections

For example, through contaminated water, difficulty in breathing or respiratory infections, infections through insect's bites and spreading of infection through multiple injuries [16]. In the case of communicable disease, it is essential that strategy should be defined primarily. It is important through a telemedicine approach to guide and assist patient what important they should do in such kind of complicated situations like primary prevention and early diagnosis (Tables 1, 2).

- Prevention tools include public health measure guidance which should be developed immediately. The outbreak of disease reporting thoroughly with control measures like cholera and tetanus and demand for vaccination, e.g. Animals are carrying contagious disorders like zoonoses or anthrax displacement. Vector-borne diseases, for example, malaria, plague, fever and typhus program working should be immediately started.
- Rehabilitation is the prime factor, and it starts as a disaster happens.
- Water Supply and emergency medication, e.g., chlorination is advisable for water as 0.7 mg/l. It is also advised to follow proper hygiene and avoid the use of water for bathing and other purposes
- Indicators for victims and priority listing tools (Triage)

Triage is a French word that has a meaning to prioritize or sort out for victims that are injured for transportation. It is also called "Special Triage and Rapid Transport" (START). A START is a fast evaluation of treatment only to avoid resources wastage and to focus on Less injured victims [17]. The two below tables describe the priority of victim selection

and possible biological indicators that can be seen or reevaluated during the disaster situation [18].

Biological signs are reevaluated as "TRIAGE" to see whether the condition of the victims is improved or regraded.

Significant data analysis and a quick algorithm can help in patient assignment to multiple hospitals their classification for TRIAGE through a system called "MEDTOC" based framework [19]. This system features are enhanced by location prediction.

3 Integrated Communication Tools for Disaster Response

For quick response and recovery, communication plays a vital role in Disaster Management. Communication is integral in four different phases of the disaster as mentioned above. Although technology plays an important role but in floods and earthquake when all the infrastructure lost, trained forces can help more efficiently.

There is an International charter on space primarily for the exchange of information and images in case of disaster and emergencies between different Asian, European and American agencies. This charter has authorized members. Satellite communication snapshots can describe the severity of a particular disaster situation for remote sensing and forecasting of climate changes. Early response to the recovery phase of disaster requires intelligent strategic vision. Application of space technology has been utilized in Mahasen Cyclone in Bangladesh where several causalities happened, and 1.1 million people were evacuated, and only 13 people have lost their lives as compared to Cyclone Bhola and Cyclone Sidr in 2007 in Japan that led to several numbers of causalities [20].

The variable combination of digital tools of Information Communication technology and ICT can help in the rescue, relief operation rebuilding or recovery of the disruptive system in a disaster area. ICT tools can assist in identifying the potential, for example, GIS (Geographical Information system), GPS (Global positioning system) EWS, (early warning system) this system had been used in Japan in 2004 and still their use is in progress. These systems are utilized to give the notification before the hit of disaster [21].

Song GPS oriented prediction method that published in 2007 estimate the energy for the earthquake underwater and predicted the magnitude of the tsunami by a measurement of the sea surface height through NASA satellite. This method is sound from the early warning or prediction method that solely based on seeing the location and depth where an earthquake had happened to predict the size of the tsunami [22].

In a disaster communication system can be restored by using LET (3G, 4G, or future 5G) based wireless networking system a reliable network for communication during a disaster situation. It is a requirement in the disaster that the communication system should be safe, implementable and secure the linkage between variable networks deployed for user mobility [23]. Wireless sensor network system can also be utilized for efficient monitoring of disaster or crisis. A divided network system gives the flexibility, but lack of one fixed protocol leads to many security issues.

Indian institute is researching within a project name DiSARAM [24]. Peer to peer data system by using humans as carriers by using smartphones in case of WiFi service is not available. When they start to connect with WiFi within the range, their movement pattern grants help to communicate and to make a peer to peer connection, and if a smartphone is not available, then the placed routers provide data electrically due to human movement.

Drones are utilized for monitoring with a camera attached, but these can also be used to carry different types of devices and utilities for short distance delivery.

Drones or remotely piloted aircraft systems can produce images of the disaster area with real-time high resolution. These can also be helpful in mapping a particular area. Drones can enhance the prediction and assessment analysis. The time frame of 72 h after a disaster is critical for search and rescue operations in case of telemedicine services. Drones can reorient the damaged communication and can provide help in search of lost, injured people. These can also be employed for media coverage. UAVs can stay in the air for 15–20 min, so it is essential to use them adequately [25].

Drones can also be useful in the provision of emergency kits or communication devices as part of a telemedicine service in case of disaster or emergencies. A case has been studied to see whether an emergency ambulance is faster or a drone and after 18 consecutive flights of drone with an approximate distance of 2 miles [26]. It has been estimated that delivery of drone is fast as compared to the ambulance.

Drones can also be equipped with audio and video system in case of medical assistance. Google glass and other ICT technology can increase the benefits of the drones if we can change their flight time. Drones can be utilized in delivering blood sample in remote areas for surgeries. Drones have rescued many people in earthquake incident in Nepal after 2015 [27]. Matternet drone can carry around 4.4 pounds and transport to 10 km, travel time up to 40 km/h and these drones takes approximately 18 min from off to landing. These drones can create a path separate from the airport, significant buildings and public areas. Zipline is utilizing drone systems to deliver vaccine to 20 clinics in Rwanda [28].

Drones are the applicable and efficient device for the emergency or in disaster as they can carry an essential item, sensors, and communication devices for a small distance [29]. Their use for carrying different items is difficult as travel distance and weight constraint and their use have been checked for travel distance and weight bearing models.

Drone technology is up-and-coming if we can increase the time of flight and pre-load capacity it could be the precision delivery approach as the camera, google glass, wireless devices are attached to get the location and indicators about the victims. Medication and essential emergency items can be connected with drones to avoid significant wastage that mostly happens in the rescue operation by using helicopters. Ambulances and medical team as the entry to target place is challenging especially in an earthquake and floods. For targeted delivery of care and to optimize medical team strategy to victim's drone is a promising way.

4 Surveillance Model (Fight-or-Flight, Active or Rebound Approach)

This model interlinks four different parameters that consolidate a strategy and help in Decision making in the period of disaster or crisis. Big data analytics can enhance data mining to guide people engaged in delivering aid and establishing a framework which is technology based on improving commitment, plan implementation and final restoration of the victims in the disaster area.

Model is divided into four parameters if not precisely managed can limit the application of telemedicine service from locating to the provision of appropriate help to the victims stuck in a disaster.

4.1 Disaster Coordination Tool

Disaster can bring several challenges that require coordination from many emergency departments, e.g., fire, rescue operation team, technological department, Government, private and public support. First 60 min of a disaster is very challenging.

And there is a need for an intelligent strategy that can interlink these all disparities. As one system depends on the evaluation of the other system, it is necessary to be preplanned through simulation approach where you can already assume a disaster with predictive possibilities and commitment of different departments can already be defined. Lack of information can amplify the circumstances and wrong decision making. Telemedicine services should be involved as it is necessary to reduce injuries progress, mortality, morbidity as well as infections. Lack of knowledge, work stress, unwillingness to work with others, inconsistency and conflict can make the situation worse.

4.2 Disaster Communication Tool

For active strategy and deployment of technological tools it is imperative that communication between different department should be appropriate, e.g., what kind of sensors, devices, wireless communication system or network or drones could be used. Communication link establishes via transmitting and receiving antenna as shown in Fig. 4.

The power P of the plane wave incident on the receiver antenna at a distance "R" from the transmitter antenna is given by:

$$P = \frac{P_t}{4\pi R^2} \tag{1}$$

If the transmit antenna has the gain in the direction of the receive antenna given by G_t, then the power equation above becomes:

$$P = \frac{P_t}{4\pi R^2} G_t \tag{2}$$

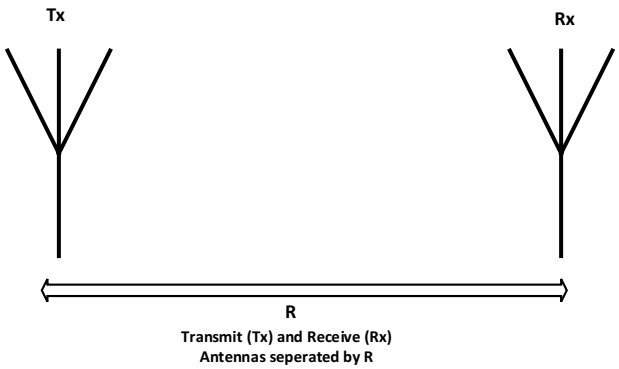


Fig. 4 Transmitting and receiving antenna

Assume now that the receive antenna has an Effective Aperture given by A_{ER}. Then the power received by this antenna is provided by:

$$P_R = \frac{P_t}{4\pi R^2} G_t A_{ER} \tag{3}$$

Effective Aperture can also be expressed as:

$$A_e = \frac{\lambda^2}{4\pi} G \tag{4}$$

Resulting received power can be written as:

$$P_R = \frac{P_t G_t G \lambda^2}{(4\pi R)^2} \tag{5}$$

This above expression is known as Friis Transmission equation.

$$P_R = \frac{P_t G_t G c^2}{(4\pi R f)^2} \tag{6}$$

This above expression is known as Friis Transmission equation in the frequency domain, where The term $\frac{1}{(4\pi Rf)^2}$ is called the free space loss factor. The loss in establishing a communication path is the difference between received power and transmitted power if losses increase it will degrade the quality at the reception. Friis transmission equation relates to power received to the power transmitted between two antennas placed in far-field of each other. The reliable communication link can be established by proper adjustment of transceiver distance so that minimum losses appear with high directivity of the antenna and better signal to noise ratio can be obtained at receiving end for smooth communication.

It can be possible through communication and the use of proper data mining techniques and analysis. Action from multinational telemedicine services can act fast and solve intricate puzzles if the answer is not possible through a national or local team. Communication should follow privacy and security obligations which is a big challenge but only through sound and reliable network system is possible. Lack of one particular platform, suspension of information, response and understanding of handling parameters should be considered. Big data analytics or data mining can help in the analysis of past incident and plan of access to the individual victim to aid in decision making.

4.3 Disaster Compliance Tool

Whatever information is collected, it is indispensable that it should make compliance with the decision for a strategy to be followed. A victim's current synopsis and condition detection through telemedicine service and after coordination between concerned people, compliance can verify the effectivity of tools as mentioned above about the kind of help that can aid or relief patient is made and confirmed by the following compliance. Compliance is examined by different parameters associated with patient condition and satisfaction of the victims.

4.4 Disaster Reconstruction Tool

Reconstruction can have various dimensions that can be seen through different parameters and victims' satisfaction.

It comprises

- Behavioral patterns improvement
- Stress and vital sign reduction
- Engagement with the deployed strategies
- Motivational spirit level
- Patient overall condition improvement
- Responsibility performance and analysis
- Personal and disaster data construction for future misshaping.
- ICT tools and communication network analysis regarding performance
- Business model development for rehabilitation and technology deployment in case of crisis for public and private partnerships.

5 Conclusions and Future Scope

Telemedicine can give appropriate medical help in disaster management, but due to transition and continuous development in technology, there is a need to specify a distinct strategy to be followed. For likely outcomes coordination and communication between public and private agencies is recommended especially in critical hours. There should be consciences between all agencies to generate a standard platform with responsibility distribution approach. eHealth literacy is very vital, and if all the agencies have the proper knowledge, then they can supervise victims in a crisis. There is a need to see what kind of technology or ICT solution can provide terminal aid by examining security and privacy matters as standards are still in the line of the verification. What is recommended is to build a local body of blended staff from medical to technology which is familiar in disaster-prone areas. It can understand the local system, culture, disparities, economy and accordingly create priority coordination, e.g., disaster management care hub with training, hiring and help delivery care strategy in collaboration with hospitals, municipalities, private and multinational agencies. The future direction of this research work can be extended by using IOT in communication technology for telemedicine in a disaster situation.

References

1. "3 Steps to telemedicine disaster preparedness." [Online]. Available: https://www.beckershospitalreview.com/telehealth/3-steps-to-telemedicine-disaster-preparedness.html.
2. Anwar, S. (2016). 5G, an approach towards future telemedicine. *Proceedings of the Global Wireless Summit 2016*.
3. "WHO | Definitions: emergencies," WHO. [Online]. Available: http://www.who.int/hac/about/definitions/en/.
4. "WHO | Disasters and emergencies," WHO. [Online]. Available: http://www.who.int/surgery/challenges/esc_disasters_emergencies/en/.
5. Kellenberg, D., & Mobarak, A. M. (2011). The economics of natural disasters. *Annual Review of Resource Economics, 3*(1), 297–312.

6. "Overview of Natural Disasters and their Impacts in Asia and the Pacific, 1970–2014 | United Nations ESCAP." [Online]. Available: http://www.unescap.org/resources/overview-natural-disasters-and-their-impacts-asia-and-pacific-1970-2014.
7. "Understanding the Impact of Natural Disasters: Exposure to Direct Damages Across Countries." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:zLY1tJaxuq0J:https://www.eenews.net/assets/2016/11/30/document_cw_01.pdf+&cd=9&hl=en&ct=clnk&gl=dk.
8. "Disasters in Europe: More frequent and causing more damage," European Environment Agency. [Online]. Available: https://www.eea.europa.eu/highlights/natural-hazards-and-technological-accidents.
9. "The 10 most common natural disasters in the U.S.," TopTenReviews. [Online]. Available: http://www.toptenreviews.com/services/articles/the-10-most-common-natural-disasters-in-the-u.s./.
10. "Regions hit by natural disasters to get more support from EU—Consilium." [Online]. Available: http://www.consilium.europa.eu/en/press/press-releases/2017/06/26/eu-support-natural-dissasters/.
11. "Phases of Disaster: Disaster preparedness and economic recovery," Restore Your Economy.
12. "Planning for Future Disasters: Telemedicine as a Resource." [Online]. Available: https://reader.elsevier.com/reader/sd/548765331D1EF3A4BB608AF5E3F64B2B78732D29916F1E0255AB5482496C7A60D1F00CD99E4D73D6B3067B5A28ED14D4.
13. Xiong, W., Bair, A., Sandrock, C., Wang, S., Siddiqui, J., & Hupert, N. (2012). Implementing telemedicine in medical emergency response: Concept of operation for a regional telemedicine Hub. *Journal of Medical Systems, 36*(3), 1651–1660.
14. "Managing health information during disasters." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:oRlWPNpl1tMJ:https://pdfs.semanticscholar.org/b0f6/e94a0f15168d7d3f72310a3defb03fdda432.pdf+&cd=6&hl=en&ct=clnk&gl=dk.
15. "Telehealth in emergency preparedness and response." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:jOXmtmgFfHUJ:https://www.healthcareready.org/system/cms/files/1571/files/original/HCR_Telehealth_Brief_SCREEN.pdf+&cd=2&hl=en&ct=clnk&gl=dk.
16. Jafari, N., Shahsanai, A., Memarzadeh, M., & Loghmani, A. (2011). Prevention of communicable diseases after disaster: A review. *Journal of Research in Medical Sciences, 16*(7), 956–962.
17. "Emergency Medical Response." [Online]. Available: http://bcn.boulder.co.us/community/explorer/ep493d4c.htm.
18. Ajami, S., & Lamoochi, P. (2014). Use of telemedicine in disaster and remote places. *Journal of Education and Health Promotion, 3,* 26.
19. Zubairi, J. A., & Idwan, S. (2017). Smart algorithms for patient assignment in disasters. *ICT Express, 4,* 107–111.
20. "Technical Paper: Space Applications for Improving Disaster Management | United Nations ESCAP." [Online]. Available: http://www.unescap.org/resources/space-applications-improving-disaster-management.
21. ur Rahman, M., Rahman, S., Mansoor, S., Deep, V., & Aashkaar, M. (2016). Implementation of ICT and wireless sensor networks for earthquake alert and disaster management in earthquake prone areas. *Procedia Computer Science, 85,* 92–99.
22. "NASA Demonstrates Tsunami Prediction System," NASA/JPL. [Online]. Available: http://www.jpl.nasa.gov/news/news.php?feature=2633.
23. Chiti, F., Fantacci, R., Maccari, L., Marabissi, D., & Tarchi, D. (2008). A broadband wireless communications system for emergency management. *IEEE Wireless Communications, 15*(3), 8–14.
24. "Human mobility powers wireless communication for disaster relief—The Financial Express." [Online]. Available: https://www.financialexpress.com/industry/technology/human-mobility-powers-wireless-communication-for-disaster-relief/764520/.
25. Erdelj, M., Natalizio, E., Chowdhury, K. R., & Akyildiz, I. F. (2017). Help from the sky: Leveraging UAVs for disaster management. *IEEE Pervasive Computing, 16*(1), 24–32.
26. J. H. CNN, "In the future, drones could save your life," CNN. [Online]. Available: https://www.cnn.com/2017/10/09/health/ambulance-drone-teching-care-of-your-health/index.html.
27. Choi-Fitzpatrick, A., et al. Up in the air: A global estimate of non-violent drone use 2009–2015. University of San Diego. [Online]. Available: https://digital.sandiego.edu/gdl2016report/.
28. Khazan, O. (2016). The super-secret, life-saving, flying robot. The Atlantic. [Online]. Available: https://www.theatlantic.com/technology/archive/2016/04/a-drone-to-save-theworld/476592/.
29. "Drone Delivery Models for Healthcare." [Online]. Available: https://webcache.googleusercontent.com/search?q=cache:PmOubpLq_OsJ:https://pdfs.semanticscholar.org/622a/d97506e882bf30ba4dab9c0748ce540ecee3.pdf+&cd=2&hl=en&ct=clnk&gl=dk.

Sadia Anwar received her degree in Doctor of Pharmacy in 2011 form Government College University, Pakistan. She had worked for three years as a community pharmacist. She also served as a Hospital Pharmacist and Drug information consultant. She arrived in Denmark, December 2015 and started working as a Guest Researcher at CTiF in the department of electronic systems, Aalborg University under the supervision of Professor Ramjee Prasad. She served for Interdisciplinary area specifically more focused in 4 sections: Medicine, Telecommunication, Big data and economics. She joined Aarhus University in December 2016 in Department of Business Development and Technology as Research Scientist for seven months. Now, she is working as a Research Assistant in the same department from October 2017. Her research interests are based on the interdisciplinary area of Medicine, eHealth, ICT, and Business Development. She is also Working with an EU project vCare (Virtual Coaching Activities for Rehabilitation in Elderly)—EU Horizon 2020 Research and Innovation funding programme. She is also involved in administrative and managerial tasks. She has produced many research articles for the conferences and Journals as an Author and co-Author.

Dr. Ramjee Prasad is a Professor of Future Technologies for Business Ecosystem Innovation (FT4BI) in the Department of Business Development and Technology, Aarhus University, Denmark. He is the Founder President of the CTIF Global Capsule (CGC). He is also the Founder Chairman of the Global ICT Standardization Forum for India, established in 2009. GISFI has the purpose of increasing of the collaboration between European, Indian, Japanese, North-American and other worldwide standardization activities in the area of Information and Communication Technology (ICT) and related application areas.

He has been honored by the University of Rome "Tor Vergata", Italy as a Distinguished Professor of the Department of Clinical Sciences and Translational Medicine on March 15, 2016. He is Honorary Professor of University of Cape Town, South Africa, and University of KwaZulu-Natal, South Africa.

He has received Ridderkorset af Dannebrogordenen (Knight of the Dannenberg) in 2010 from the Danish Queen for the internationalization of top-class telecommunication research and education.

He has received several international awards such as: IEEE Communications Society Wireless Communications Technical Committee Recognition Award in 2003 for making contribution in the field of "Personal, Wireless and Mobile Systems and Networks", Telenor's Research Award in 2005 for impressive merits, both academic and organizational within the field of wireless and personal communication, 2014 IEEE AESS Outstanding Organizational Leadership Award for: "Organizational Leadership in developing and globalizing the CTIF (Center for TeleInFrastruktur) Research Network", and so on.

He has been Project Coordinator of several EC projects namely, MAGNET, MAGNET Beyond, eWALL and so on.

He has published more than 30 books, 1000 plus journal and conference publications, more than 15 patents, over 100 Ph.D. Graduates and larger number of Masters (over 250). Several of his students are today worldwide telecommunication leaders themselves.

Under his leadership, magnitudes of close collaborations are being established among premier universities across the globe. The collaborations are regulated by guidelines of the Memorandum of Understanding (MoU) between the collaborating universities.

He is married to Jyoti Prasad Sinha, having Master's degree in Mathematics and Business Management from India and the Netherlands, respectively. She is presently the President of Savita Holding Company in Aalborg, Denmark. They are the parents of two sons and one daughter, with five grandchildren.

The eldest is a daughter, Neeli Rashmi Prasad. She has done her Master's degree in Telecommunication from Delft University of Technology, the Netherlands and PhD from University of Rome "Tor Vergata", Italy.

She is the founding CEO of the SPA LLC, California, USA and Professor & Vice Chair of the Department of Electrical and Computer Engineering, International Technological University, San Jose, USA.

Anand Reghwa Prasad, who is the elder son, Master's & PhD from Delft University of Technology, the Netherlands. He is Chief Advanced Technologist, Executive Specialist, at NEC Corporation, Japan, where he leads the mobile communications related security activity. He is also the chairman of 3GPP SA3 (mobile communications security standardization group), a member of the governing body of Global ICT Standardisation Forum for India (GISFI), founder chairman of the Security & Privacy working group and a governing council member of Telecom Standards Development Society, India.

Their youngest son, Rajeev Ranjan Prasad has Bachelor & Master's Degree from the Netherlands and Denmark, respectively. He is an entrepreneur and is the founding CEO of a rapidly growing publishing company, the River Publishers, with head-office located in Aalborg, Denmark. River Publishers has publishing segments in various countries including USA, the Netherlands, India & several other countries.

Bhawani Shankar Chowdhry is the Dean Faculty of Electrical Electronics and Computer Engineering and former Director IICT at Mehran Univer-sity of Engineering & Technology (MUET), Jamshoro, Pak-istan. He has the honour of being one of the editor of several books Wireless Networks, Information Processing and Sys-tems, CCIS 20, Emerging Trends and Applications in In-formation Communication Technologies, CCIS 281, Wireless Sensor Networks for Developing Countries, CCIS 366, Communication Technologies, Information Security and Sustainable Development, CCIS 414, published by Springer Verlag, Germany. He has also been serving as a Guest Editor for Wireless Personal Communications which is Springer International Journal. He has produced more than dozen PhDs and supervised more than 50 MPhil/Masters Thesis in the area of ICT. His list of research publication crosses to over 60 in national and international journals, IEEE and ACM pro-ceedings. Also, he has Chaired Technical Sessions in USA, UK, China, UAE, Italy, Sweden, Finland, Switzerland, Pakistan, Denmark, and Belgium. He is member of various professional bodies including: Chairman IEEE Communication Society (COMSOC), Karachi Chapter, Region10 Asia/Paci c, Fellow IEP, Fellow IEEEP, Senior Member, IEEE Inc. (USA), SM ACM Inc. (USA).

M. R. Anjum received his Ph.D. degree from Beijing Institute of Technology, Beijing China in 2015. M.E. degree in Telecommunication and Control Engineering and BE in Electronic Engineering in 2011 and 2007 respectively from Mehran UET Jamshoro, Pakistan. Currently he is working as Assistant Professor in the Department of Electronic Engineering, Islamia University of Bahawalpur, Pakistan. He has more than 20 international conferences and journal publications. His research interest includes wireless communication. He is member of PEC, IEEEP, IEP, IJPE, UACEE, IACSIT, ICCTD, IACSIT, IAENG and reviewer of several journal and conferences.