THE TSUNAMI OF DIGITALIZATION OF HEALTH CARE IN THE
PRE AND POST -COVID ERA AND ITS IMPACT ON THE INDIAN HEALTHCARE
INDUSTRY – SITUATION ANALYSIS

By

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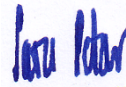
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Dedication

This study is wholeheartedly dedicated to the Entire healthcare fraternity, who have been my source of inspiration and given me strength and continued support throughout the research.

I also would like to dedicate this Research to My father MrShiriam S Dongare and my mother Surekha S Dongare, who continuously provided their moral, spiritual, and emotional support.

Lastly, I dedicated this thesis to the Almighty Lord Buddha, Dhamma, Sangha and the universe who gave me strength, wisdom, guidance, power of thinking, security, competence and giving me good health while doing this research work.

All of these, I offer to you.

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ABSTRACT

THE TSUNAMI OF DIGITALIZATION OF HEALTH CARE IN THE
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By

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Purpose

The healthcare system is trying to keep pace with the evolving times and the pressures have encouraged the acceptance and speed of adoption of digitalization. There is scarcity of empirical evidence and evaluation regarding the effectiveness and sustainability of digital health initiatives. Especially from the Indian context, we need research which identifies the competency of health care workers and opportunities, challenges, barriers and pitfalls, system preparedness which support/hinder digital technology adoption, particularly in the pre-and post-Covid era.

Method

Three cross-sectional surveys were conducted targeting health care workers and health care administrators from large, medium and small sized hospitals located in Tier 1, 2 and 3 cities of India. The cross-sectional survey explored the demographic

features, competencies, challenges and preparedness as reported by the participants by using a mixed-method approach, with both close ended and open-ended questions.

Results

151 healthcare workers, 64 health care managers and 25 health care administrators participated in the three surveys. The competencies of health care professionals in knowledge, skills and ease of use have increased significantly post-Covid. All have reported high motivation levels. While the focus was on adoption of new technology and finances in the pre-Covid era, the primary focus has been on human resource development and patient safety and patient compliance in the post-covid era. Patient data safety remains the most widely reported ethical concern.

Participants specified the impact of digitalisation on patient interaction, team collaboration, patient safety and health equity to be both positive and negative, depending on the context. Participants expressed that they needed 'In-depth and frequent training', 'Budget and 'manpower allocation', 'Active monitoring and awareness' for improving their digital health care delivery competence.

Conclusion

This is the first study to provide empirical evidence on self-reported competencies, opportunities, challenges and organizational preparedness from the health care workers and health care administrators' perspective. To increase the digital technology adoption, there is need for enhanced human resource training and address ethical issues of patient data safety.

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Digital health care in the pre-Covid and post-Covid era

Broadly defined, digital health describes using digital information data and communication technologies to collect, share, and analyze health information for purposes of improving patient health and health care delivery. To begin with, health care had remained relatively isolated from the digital and mobile technology revolution. Eventually with the creation of more powerful, versatile, and low-cost digital health technologies, titanic shifts in health care have been stimulated worldwide(Sharma *et al.*, 2018). The outbreak of the COVID-19 pandemic further accelerated the adoption of digitalization in healthcare, leading to significant advancements in patient care, remote consultations, and data-driven decision-making.

Pre-COVID-19, digitalization in healthcare focused on enhancing operational efficiencies, streamlining administrative processes, and improving patient experiences. Electronic health records (EHRs) digitized patient information, enabling efficient access and sharing among healthcare providers. Telemedicine emerged as a viable solution, providing remote consultations, increasing access to healthcare in rural areas, and reducing the burden on healthcare facilities. Wearable devices and health tracking apps empowered individuals to monitor their health proactively, facilitating preventive care and lifestyle management.

The COVID-19 pandemic, like all global crises in human history, caused unprecedented health and economic disruptions in many countries. However, at the same time, this new situation is favored the transition to digital solutions in many industries and in society as a whole (Golinelli*et al.*, 2020). Before the COVID-19 pandemic, it was expected that digital transformation in health care would be as disruptive as the transformations seen in other industries. However, the spread of COVID appears to have finally provided an ineludibly sound reason to fully embrace the digital transformation. Digital health systems were well suited to provide novel solutions to this public health emergency. These included development of robust surveillance systems, tele-health, novel diagnostic and clinical decision making tools, wider penetration of wearables for tracking of physiological parameters and development of interactive chat services for public dissemination of COVID-19 related information (Kapoor *et al.*, 2020).

Challenges with digitalisation of health care

Though it seems digitalization is the way ahead, acceptability of digital solutions may face challenges due to potential conflicts with users' cultural, moral, and religious backgrounds (Shah *et al.*, 2020). Globally, healthcare has been irrevocably altered by digital innovation and health professionals deploy an extensive range of social media and web-based tools on a daily basis. However, many healthcare professionals use these platforms in a regulatory vacuum-where there may not be specific legal or

ethical guidance-and without an appreciation of the associated risks (Etheredge and Fabian, 2022).

While private corporations and education institutions made rapid transitions to remote work and videoconferencing, the health care system still lagged in adopting digital solutions. This is mainly due to the fact that clinical workflows and economic incentives have been developed for a face-to-face model of care (Keesara, Jonas and Schulman, 2020).

Need for exploring health care worker and health administrator competencies

Healthcare Professionals had to keep abreast with the rapidly changing digital era which in turn questioned their competence. The WHO (2016) considers competence in digitalisation as part of human capital which requires perpetual education to keep existing skills in line with technological development and new knowledge. Healthcare professionals' competence in digitalisation is found to be closely related to their clinical knowledge and skills and is an integrational tool that can enhance clinical practices, patient care and workflow efficiency. The aspects of patient safety and integration of digitalisation into the professional context necessitate an assessment of healthcare professionals' competencies in digitalisation(Jarva *et al.*, 2022). There is limited literature especially in the Indian context which explores the digitalisation-related knowledge, skills and attitudes of healthcare professionals that is needed to integrate digital technology in the professional context of patient care(Konttila *et al.*, 2019).

Health leadership and management are essential for ensuring resilient health systems. A competent Healthcare Professional is strongly supported by a Healthcare management which strives to bring the best in them. Health management focuses on administrative processes such as planning, budgeting, and organizing, staffing, controlling and problem solving in relation to health services, resources and stakeholders(Car, Kyaw and Atun, 2018).

Need for exploring challenges of digitalisation of health care from the health care worker and administrator perspective.

One of the challenges faced by the health management in adopting digitalisation will be the susceptibility to new kinds of threats. Unauthorized users may steal sensitive data or block the utilization of patient records. Use of own mobile devices by health care personnel, remote patient access to health records, wide utilization of applications and electronic devices all increase cyber security threats and require specialized expertise to ensure appropriate data protection (Al-Atawi, Khan and Kim, 2022).

Another factor that can affect the efficiency of the healthcare management in adopting new policies is the degree of involvement of non-clinical staff in the system. The rapport and division of responsibilities between nonclinical and clinical managers can have a major impact on the choice of most relevant competencies(Car, Kyaw and Atun, 2018). This can make or break a stream. Hence the management should motivate every tier personnel in the healthcare system to get involved in the system.

There was restricted literature which demonstrated the role or the challenges faced by the healthcare management in the process of digitalizing the Healthcare system.

Need for exploring strategies adopted to improve digitalisation of health care

The healthcare system is trying to keep pace with the evolving times and the pressures have encouraged the acceptance and speed of adoption of digitalization. The outlook of major stakeholders & common consumer changed alike. The digital infrastructure improved over this period, but it is still going to need constant care & attention.

Many countries are in their early stages of health care digitalization post Covid. The legal and regulatory system to protect patient privacy and information security is still lacking. The readiness to implement electronic medical records varies across health providers and clinical practices. This pandemic has demonstrated the usefulness and reactivity of digital health solutions and constitutes an opportunity to insert these solutions into our health care systems in the long term. This creates an urgent need for policy makers, researchers, and health professionals to collectively and efficiently implement digital solutions into practice without further fragmenting the existing landscapes of care (Fagherazzi *et al.*, 2020).

1.2 Research Problem

The scarcity of empirical evidence and evaluation regarding the effectiveness and sustainability of digital health initiatives is an obstacle to Public and Private Heath

care systems alike in policymaking, development, and implementation of health care digitalization (Dang *et al.*, 2021).

Especially from the Indian context, we need research which identifies the competency of health care workers with respect to digital health care technology and what is needed to enhance the pace and quality of adoption. From the administrator's perspective, we need to explore the opportunities, challenges, barriers and pitfalls which support/hinder digital technology adoption. There are issues related to liability, data privacy, and international standardization of health care. Thus, there is a need to identify the system preparedness and organizational culture around digitalisation of health care.

1.3 Purpose of Research

The Indian health care industry is one of the largest globally. The health care industry ranges from large, multi-bedded super specialty hospitals to those working as single clinical units, in both public and private sector. The common denominator connecting the wide range of health care delivery system is the digital connect. The Indian health care industry was adapting to digital technology over the past few decades. The pace of adaptation hastened in the last decade, with COVID pandemic causing a metamorphic change to attitudes and practices towards digital health care.

While the technological advancements are rapid, it is vital to analyze whether the human resources involved in digital health care have kept pace with the change. There is an urgent need to identify the challenges and opportunities in the existing

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scenario to optimize the utilization of digital health care. Digital health care also throws up ethical and legal questions in terms of data ownership, data privacy in the patient centered care system.

We seek to develop an understanding of the competencies of health care professionals (HCPs) in adapting to digital health care and their perceived impact on the quality of patient management. We would also like to analyze the opportunities, challenges, barriers, and pitfalls of digitalisation of healthcare amongst hospital managements, with particular emphasis on system preparedness and organizational ecosystem. We would like to look at this research from the lens of the impact COVID 19 had on adoption and acceleration of digitalisation in health care.

1.4 Significance of the Study

Healthcare being swept by this tsunami of change in digitalisation, it is critical to take a step back and review our preparedness to adapt to these rapid changes. It is also vital to understand whether these new approaches helped to increase clinical productivity during the Covid-19 pandemic. Such information will be critical in understanding whether these emergency authorizations should be made permanent once the immediate crisis had resolved.

Hence it is integral to identify the opportunities and obstacles, assets and liabilities, strengths and weakness of various factors impacting digitalization of healthcare. As this study will explore the role of digitalization in healthcare; both pre and post the pandemic, highlighting its impact on healthcare systems, patients, and HCPs, the

results of the study will help in strengthening the domains much needed like developments, production, funding, implementation and evaluation and letting go of some overrated technologies. It is also essential to meet the most strategic needs to ease the life of people who are always at the forefront of any health crisis.

1.5 Research Purpose and Questions

This research seeks to address the three key elements pertaining to competency of Health care professionals, opportunities and challenges of digital health care management team, and the system preparedness and organizational culture supporting the adoption of digital health care in the pre-and post-Covid era.

The three pertinent questions of digital health care industry in India.

RESEARCH QUESTIONS (RQ)

RQ 1:

What is the current competency and preparedness of health care professionals in transitioning to digital health care systems in the pre- and post-Covid period?

RQ 2:

What are the opportunities, challenges, barriers, and pitfalls in digitalisation of health care amongst hospital management?

RQ 3:

What are the system preparedness and organizational ecosystem supporting digitalisation of health care in the pre- and post-Covid era?

CHAPTER II:

REVIEW OF LITERATURE

2.1 Theoretical Framework

Selection of articles for review:

A Comprehensive search strategy was carried out in various electronic databases like PubMed, Google Scholar, Cochrane Library, Science Direct and relevant conference proceedings. The title and the abstracts of the articles obtained were screened for relevance. Articles which were obtained were screened to fit the eligibility criteria and in case of ambiguity full text was referred. A total of 38 articles were obtained and after eliminating redundancies and those articles with limited relevance, a final list of 21 articles was discussed in this literature review. A conceptual framework was constructed, and 7 themes were identified under which these 21 articles will be dealt subsequently.

The 7 themes identified are:

2.1.1 Need for Digitalisation in Healthcare

2.1.2 Digitalisation Post Covid era

2.1.3 Challenges in the Digitalisation of Health Care Services

2.1.4 Competency of Healthcare Professionals in the Digitalisation Aeon

2.1.5 Efficiency of the Hospital Management System in Healthcare digitalisation

2.1.6 System Preparedness relating to Digitalization.

2.1.7 Digitalisation of Healthcare Pre and Post Covid – The Known and the Unknown

2.1.1 Need for Digitalisation in Healthcare:

Modern healthcare defines digital transformation as "a fundamental change process, enabled by the innovative use of digital technologies accompanied by the strategic leverage of key resources and capabilities, aiming to radically improve an entity and redefine its value proposition for its stakeholders" (Gong and Ribiere, 2021).

Broadly defined, digital health describes using digital information, data, and communication technologies to collect, share, and analyze health information for purposes of improving patient health and health care delivery (Sharma *et al.*, 2018).

Paper-based medical records are a part that any healthcare system is inefficient with suboptimal delivery of high-quality care. These record systems do not allow for critical clinical information to be consistently available to decision-makers when they are making their clinical decisions, leading to redundancy in services as well as medical errors (Agarwal *et al.*, 2010).

This US based research commentary was reported in 2010 that summarizes on the topic, Digital Transformation of Healthcare, its Current Status and the Road Ahead, mainly in the US and worldwide. This research being done Pre Covid times give a picture of how the Healthcare industry is trying to adopt digitalisation like other major fields and that it should focus on three main areas like 1) HIT (Healthcare Information Technology) design, implementation, and meaningful use; (2) measurement and quantification of HIT payoff and impact; and (3) extending the traditional realm of HIT.

Digital health technologies can potentially improve health outcomes by increasing patient engagement in self-care and caregiver care, closing communication gaps, and personalizing services to meet patient needs. There is substantial consensus that the digital transformation of healthcare in conjunction with other complementary changes can reduce costs and improve quality of healthcare (Baudier *et al.*, 2023).

Pre Covid, health care has remained relatively isolated from the digital and mobile technology revolution. In parallel with the creation of more powerful, versatile, and low-cost digital health technologies, a greater shift in global health care is visualized (Sharma *et al.*, 2018).

This review by Sharma et al., in 2018 narrates the areas which needs upgrading when it comes to digitalizing healthcare. This review analyzed the digital space of healthcare before Covid and emphasizes on the reasons why digitalisation is still under work in Healthcare. The principal reasons cited were information technology mismanagement, inadequate infrastructure to support new technology, and poor technology usability. Studies of such kind lend a helping hand in the rapid digitalisation acceptance by the healthcare systems across the world during the Covid pandemic. The domains that needed works were quickly addressed and digital transition was unexacting, thanks to evidence based evolution.

2.1.2 Digitalisation Post Covid era:

The COVID-19 pandemic, like all global crises in human history, caused unprecedented health and economic disruptions in many countries. However, at the same time, this new situation is favoring the transition to digital solutions in many industries and in society as a whole (Golinelli *et al.*, 2020).

This systematic review by Golinelli et al., in 2020 summarizes 124 articles that published early COVID-19–related literature (from January 1 to April 30, 2020) and seeks to identify the types of the digital technologies adopted by health care during the COVID-19.The authors categorized the digital tools based on the patient needs addressed in health care like diagnosis, prevention, treatment, adherence, lifestyle, and patient engagement. A total of 137 articles were reviewed and categorized based on the patients' need, its innovative status and scalability potential. This review gives a gist of the necessity to understand which digital technologies have been adopted to face the COVID-19 crisis and whether and how they can still be useful after the emergency phase.

During the pandemic, various studies in their online surveys found that most of the adults especially senior citizens, reportedly registered high/very high levels of depression, anxiety and stress in a large part of the sample. Fear of contracting the disease in a healthcare setting, transportation restrictions and isolation at home have become important barriers to treatment for many people (Di Carlo *et al.*, 2021a).

When mental health is gaining importance post Covid, a study by (Di Carlo *et al.*, 2021b) explains how tele-mental health services were particularly feasible and appropriate for the support of patients, family members and healthcare providers during this COVID-19 pandemic. The integration of tele-psychiatry with other technological innovations (e.g., mobile apps, virtual reality, big data and artificial intelligence (AI)) opened up interesting future perspectives for the improvement of mental health assistance.

One of the biggest gains of digital health is that it supports a shift from cure to prevention; this holds true both for primary and secondary prevention. Digital health technologies offer ways to self-manage health which positively impact on behavioral risk factors' distribution. For example, a systematic review assessed the potential benefits of digital health interventions on cardiovascular disease (CVD) outcomes and risk factors and reported telemedicine, Web-based strategies, e-mail, mobile phones, mobile applications, text messaging and monitoring sensors-based interventions to reduce CVD events, hospitalizations and mortality and to lower BMI and weight, as compared with normal care (Sharma *et al.*, 2018).

An editorial by (Fagherazzi *et al.*, 2020)discusses the situation regarding digital health solutions to fight COVID-19 as well as the challenges and ethical hurdles to broad and long-term implementation of these solutions. The following figure depicts and summarizes the various digital technologies which were adopted post Covid by the healthcare infrastructure at various levels.

Figure 1: The COVID-19 digital health ecosystem (Fagherazzi et al., 2020)

Technological interventions such as telemedicine visits with patients, virtual meetings with colleagues, and online interviews have been introduced, and many trainees are comfortable using a variety of technology platforms and techniques. Webinars and e-learning are gaining traction now, and their use, practicality, and cost-effectiveness makes them important in the post-COVID era. CME activities have migrated increasingly to virtual events and online programs, a trend that may also continue due to its practicality and cost-effectiveness (Shah *et al.*, 2020).

2.1.3 Challenges in the Digitalisation of Health Care Services:

Though it seems Digitalization is the way ahead acceptability of digital solutions may face challenges due to potential conflicts with users' cultural, moral, and religious backgrounds. Digital tools can provide collective public health benefits; however, they may be intrusive and can erode individual freedoms or leave vulnerable populations behind (Fagherazzi *et al.*, 2020).

In the context of the digital leap caused by the COVID-19 pandemic worldwide, though the private corporations and educational institutions have made rapid transitions to remote work and videoconferencing, the health care system is still lagging behind in adopting digital solutions. This is mainly due to the fact that clinical workflows and economic incentives have been developed for a face-to-face model of care. In addition to the history of health care policies, there are limiting factors to the implementation of tools such as telemedicine, including a legal framework that is not yet fully designed to regulate the use of innovative IT systems in health care, as well as an inadequate information and communications technology infrastructure (Shah *et al.*, 2020).

This commentary by Shah et al prettily summarizes the rapid adoption of digital technology by the Healthcare system, the management and the HCPs'. The authors compare the healthcare situation pre and post Covid on various moments where the HCPs' and the management adapting to online meetings, virtual CMEs, online fellowship programs, tele-visits and consultations.

Globally, healthcare has been irrevocably altered by digital innovation and health professionals deploy an extensive range of social media and web-based tools on a daily basis. However, many healthcare professionals use these platforms in a regulatory vacuum-where there may not be specific legal or ethical guidance-and without an appreciation of the associated risks. Given the special protections afforded to the practitioner-patient relationship, and the importance of a health practitioners' reputation, it is vital that we understand how to traverse the many ethical and legal challenges of the digital interaction (Etheredge and Fabian, 2022).

Telemedicine was already in place prior to the COVID-19 crisis but barriers are rapidly coming down to its widespread use and patients seem to embrace this, even as health-care systems navigate the complicated issues of cyber security and patient privacy.

2.1.4 Competency of Healthcare Professionals in the Digitalisation aeon:

The digitalization of health care has changed healthcare professionals' roles and responsibilities (WHO, 2020). HCPs' competence in digitalization has been previously described as consisting of sufficient skills in using digital technology to provide high quality ethical patient care, social and communication skills to use digital technology in health prevention, diagnoses and treatment, willingness and motivation to apply digital technology in a professional context, and collegial and organizational support to enhance positive experiences in digitalization (Konttila *et al.*, 2019). Rapidly changing technologies and new modes of digital communication

have increased the frequency at which healthcare professionals (HCPs) need to update their skill set to provide patient-centric care.

A study by Jarva et al in 2022 describes HCPs' perceptions of digital health competence. The HCPs' had a positive outlook on digital health services, either as whole or specific aspects of digital health, but also recognized the challenges associated with digitalization. These aspects were explored from the perspectives of how digital health should be incorporated into patient care and how digital solutions can be combined with traditional methods, which has not been evident in prior research (Jarva *et al.*, 2022). The authors also concluded that emphasis should be made on exposing HCPs to various digital health possibilities to increase familiarity, interest and user experience, which are perceived to increase digital health competence.

2.1.5 Efficiency of the Hospital Management System in Healthcare digitalisation:

Health leadership and management are essential for ensuring resilient health systems (Car, Kyaw and Atun, 2018). Digitalization could efficiently address the strain COVID-19 pandemic has put on healthcare systems in the availability and allocation of healthcare manpower, resources and infrastructure.

Digitalization is not only challenging for the HCPs' but also the Healthcare administration and the management in different levels. It includes the introduction, implementation, use and funding of digital health technologies which needs to be carefully evaluated and monitored. A framework for the management and

regularization of the digital health services is vital to generate the evidence required for decision-making on these services and its requirement for funding digital health strategies at various levels in the health care system (Car, Kyaw and Atun, 2018).

Health care is not only utilizing digital solutions but is also becoming dependent on them. This makes the health system susceptible to new kinds of threats. Cyber security plays a very important role in ensuring the undisturbed and safe functioning of health care facilities and services. Unauthorized users may steal sensitive data or block the utilization of patient records. Use of own mobile devices by health care personnel, remote patient access to health records, wide utilization of applications and electronic devices all increase cyber security threats and require specialized expertise to ensure appropriate data protection (Al-Atawi, Khan and Kim, 2022).

2.1.6 System Preparedness relating to Digitalization:

Health leadership is an essential component of health systems which provides safe and effective healthcare and in ensures health worker motivation and retention. In its new strategy on human resources for universal health coverage, the WHO highlights building capacity for effective public policy stewardship, leadership and governance as one of its four key objectives (Car, Kyaw and Atun, 2018).

Attainment of the broad health system goals, including quality, efficiency and equity, are objectives against which to judge new digital health services (Ricciardi *et al.*, 2019).

The type of financing (public vs. private) as well as size of organization (team, department, polyclinic or hospital) can have an important impact on the most pertinent healthcare leadership and management competencies(Car, Kyaw and Atun, 2018).

Figure 1: Conceptual framework for the use of eLearning for health workforce (HW) capacity building on health system outcomes
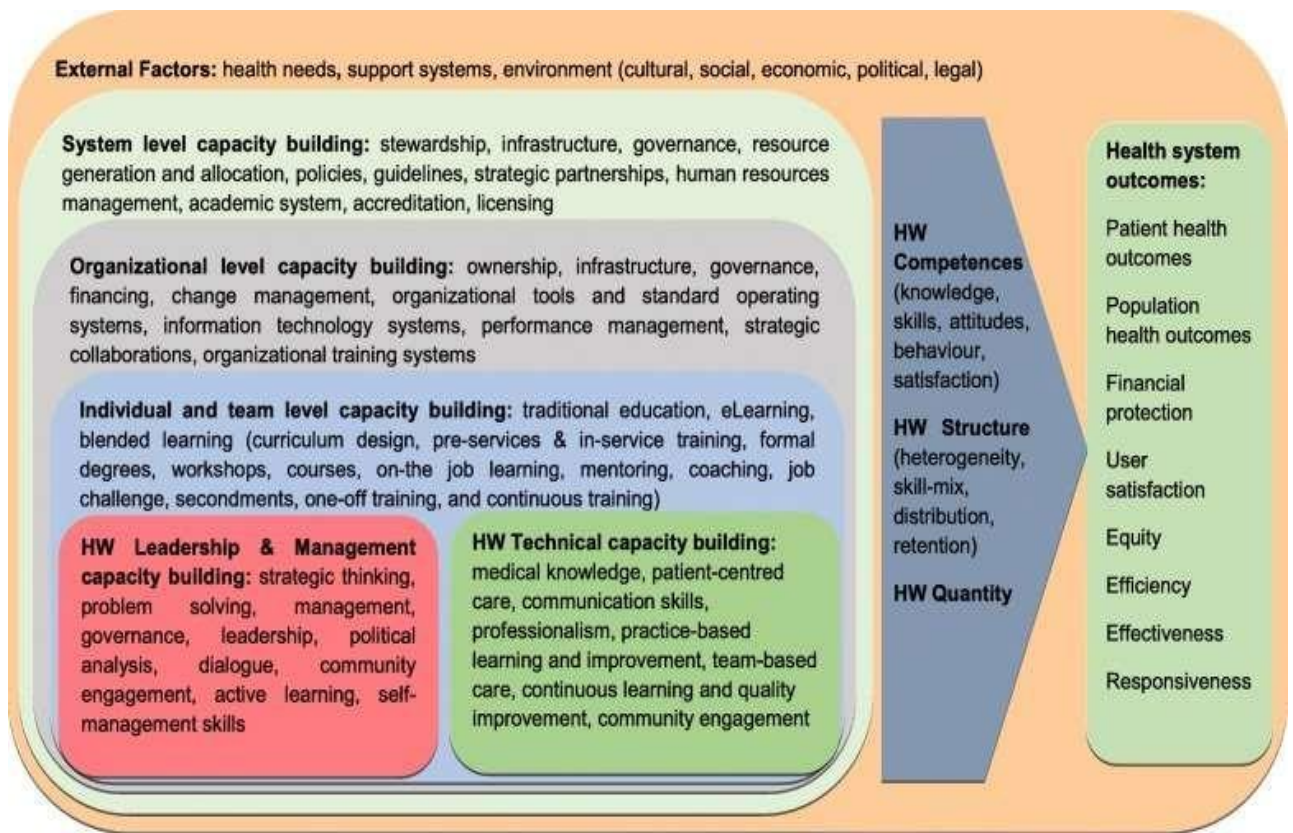
2.1.7 Digitalisation of Healthcare Pre and Post Covid – The Known and the Unknown:

COVID-19 pandemic occurred in an era of massive technological advancement where digital tools effectively supported institutions during the pandemic by facilitating the immediate widespread distribution of information, tracking transmission in real time, creating virtual venues for meetings or day-to-day operations, and providing telemedicine visits for patients (Fagherazzi *et al.*, 2020).

Health care organizations like the educational organizations have responded to the COVID-19 pandemic through the rapid adoption of digital solutions and advanced technology tools. During a pandemic, digital technology can mitigate or even solve many challenges, thus improving health care delivery. It is necessary to understand which digital technologies have been adopted to face the COVID-19 crisis and whether and how they can still be useful after the emergency phase.

The Healthcare system is trying to keep pace with the evolving times and the pressures have encouraged the acceptance and speed of adoption of digitalization. But it encounters various challenges in the process like the competency of Health care professionals, opportunities and challenges of digital health care management team, and the system preparedness and organizational culture supporting the adoption of digital health care. Hence there is a need to get to the bottom of these challenges and take steps to resolve them.

Figure 2: Illustrating the complexity of the digital transformation of health services.

Source: Expert Panel on Investing in Health, European Commission, 2018.

2.2 Summary

Digitalization has dwarfed all the traditional systems available in every field known to mankind. Healthcare in no exception and has surrendered to its dominance. These changes were most inevitable during the Covid 19 pandemic. Digitalisation and technological advancements like telemedicine, Covid based mobile apps, data analysis and tracking systems, sensor-based patient intervention and monitoring devices, the sudden bloom of social media and much more contributed in bringing the pandemic to control.

Though it seems Digitalization is the way ahead, challenges are inexorable at every level of its utilization. At the Consumer level acceptability of digital solutions may face challenges due to potential conflicts with users' cultural, moral, and religious backgrounds. Data privacy and cyber security comes at a cost and a segment of vulnerable population could be left behind.

Rapidly changing technologies and new modes of digital communication have increased the frequency at which the healthcare professional who is the next level consumer of Digital healthcare, must update their skill set to provide a patient-centric care. Alternatively, the Healthcare Management too have equipped themselves in the introduction, implementation, use and funding of digital health technologies which also need to be carefully evaluated and monitored. This will help them in easing the complexities involved in the process of digitalisation and provide a better and high-minded healthcare to their consumers.

While the technological advancements are rapid, it is vital to analyze whether the human resources involved in digital health care have kept pace with the change. There is an urgent need to identify the challenges and opportunities in the existing scenario to optimize the utilization of digital health care. Digital health care also throws up ethical and legal questions in terms of data ownership, data privacy in the patient centered care system.

CHAPTER III:

METHODOLOGY

3.1 Overview of the Research Problem

Exploring the competency, opportunities, pitfalls, and system preparedness for digitalization in the healthcare industry is crucial. As identified in the review of literature, it provides for enhanced patient care. Digitalization allows for better patient care through improved access to medical records, remote monitoring, and telemedicine. It enables healthcare providers to offer more personalized and timely treatments. Digital systems streamline administrative tasks, reducing paperwork and improving operational efficiency. This can potentially lower healthcare costs and improves resource allocation.

Digitalisation enables the collection of vast amounts of healthcare data. Analyzing this data can lead to valuable insights into patient trends, disease patterns, and treatment effectiveness, ultimately improving healthcare outcomes. Digital systems facilitate better communication and collaboration among healthcare providers. Interoperable systems ensure that patient information can be easily shared between different institutions, leading to more coordinated care. Digital health tools empower patients by providing them with access to their health information, enabling them to take a more active role in managing their own health.

However, while the benefits are significant, there are pitfalls and challenges. With the digitization of health records comes the risk of data breaches and privacy concerns. Safeguarding sensitive patient information is crucial to maintaining trust in digital healthcare systems. Not all healthcare systems or professionals may be equipped with the

necessary technology or skills to fully leverage digital tools. This can lead to disparities in access to digital healthcare services. Compliance with various regulations, such as HIPAA in the United States or GDPR in Europe, poses challenges for healthcare organizations in adopting digital solutions while ensuring legal compliance. Some healthcare professionals may resist adopting new digital technologies due to a lack of familiarity or concerns about disrupting established workflows.

Assessing the readiness and competency of healthcare systems involves evaluating the existing infrastructure, technological capabilities, workforce readiness, and willingness to adapt to digital changes. It's crucial to address these challenges systematically to harness the full potential of digitalization while mitigating associated risks.

The scarcity of empirical evidence and evaluation regarding the effectiveness and sustainability of digital health initiatives is an obstacle to public and private heath care systems alike in policymaking, development, and implementation of health care digitalization, especially in the Indian context. Hence it is integral to identify the opportunities and obstacles, assets and liabilities, strengths and weakness of various factors impacting digitalization of healthcare. Particularly from the Indian context, we do not have research evidence which explores the health care workers competency and the challenges faced by health care administrators, who both together form the crucial axis for effective implementation of digital health care. We seek to address this gap in research evidence, by exploring the three research questions from the Indian context.

3.2 Operationalization of Theoretical Constructs

The theoretical constructs for this research can be categorized into three groups.

3.2.1. Study population:

We will provide the operational constructs with respect to the study population in the beginning. Two explore the two poles on the digitalisation axis; we have considered the health care workers such as doctors, nurses, technicians etc and the health care administrators such as medical superintendent, general managers, clinical administrators' directors etc. The hospitals we are considering are located in Tier 1 and Tier 2 cities of India. We are categorizing the hospitals into three categories. The first refers to the competency of health care workers such as doctors, nurses, technicians etc. who work in large bedded, medium bedded and small bedded hospitals across Tier 1 and Tier 2 cities of India

3.2.2. Competency of health care professionals with respect to digitalisation of health care

The knowledge, skills, ease of digital use, impact of digital technology use on patient management, ethical issues related to patient safety, team-based health care, health equity, job satisfaction, preparedness, motivation, attitudes, challenges and system support are considered to explore the self-rated competency and preparedness of health care workers.

3.2.3. Opportunities, challenges, barriers, pitfalls and system preparedness from the hospital administrators' perspective

To explore this construct, we have included the hospital policy on digitalisation adoption particularly with respect to preparation of health care workers and patient safety. We have also explored the knowledge, skill; ease of use of digital health care technologies by the health care administrators, ethical issues related to patient safety, team based health care, health equity, job satisfaction, preparedness.

The next area of focus has been in identifying the opportunities, challenges, barriers and pitfalls with respect to the technology, administrative, financial, human personnel and patient related aspects of the digital health care domain.

The system preparedness has been explored by surveying the strategic measures adopted by the leadership in health care administration. The focus was on the change in policy, budgetary allocation for procurement and implementaion, training of human resource, strategies for change management, patient data privacy and patient compliance measures.

3.3 Research Purpose and Questions

This research seeks to address the three key elements pertaining to competency of Health care professionals, opportunities and challenges of digital health care management team and the system preparedness and organizational culture supporting the adoption of digital health care in the pre- and post-Covid era.

3.3.1. Research question or hypothesis

Research question 1:

What is the current competency and preparedness of health care professionals in transitioning to digital health care systems in the pre- and post-covid period in the Indian context?

Research question 2:

What are the opportunities, challenges, barriers, and pitfalls in digitalisation of health care amongst hospital management in the Indian context?

Research question 3:

What is the system preparedness and organizational ecosystem supporting digitalisation of health care in the pre- and post-Covid era in the Indian context?

Hypothesis:

As an exploratory study, the primary aim is to do a situation analysis. In terms of comparison between the pre- and post-Covid eras, we will be identifying which period fared better with respect to the three research questions under consideration.

Research hypothesis:

The period post-Covid supported adoption of digital technology and there were minimal challenges.

Alternate hypothesis:

The period pre-Covid supported adoption of digital technology and there were minimal challenges.

Null Hypothesis:

There was no difference between the two periods towards adoption of digital technology and its accompanying challenges.

3.3.2. Aim

To identify HCP competencies and explore the opportunities, challenges, barriers, and pitfalls of the tsunami of digitalisation of health care in the pre-Covid and post - Covid era and its impact on the Indian health care industry.

Objectives:

Analyzing the self-rated competency and preparedness among the Indian Health Care Professionals in transitioning to digital health care systems such as Patient management systems, HIS, Telemedicine etc., in the pre-Covid and post-Covid era

Analyzing the opportunities, challenges, barriers, and pitfalls of digitalisation of healthcare amongst hospital managements in the pre- and post-Covid era

System preparedness and existing ecosystem in supporting digitalisation of health care in the pre- and post-Covid era.

3.4. Research Design

The RQs and Objectives of the study require a mixed methods approach i.e., a combination of quantitative and qualitative approach to collecting data. We will be using both close ended and open-ended questions in the survey. In a single survey tool, we have used close ended and open-ended survey questions; hence a parallel mixed-methods design has been adopted.

3.5. Population and Sample

3.5.1. Population

The Population for the study would be all the hospitals in tier 1 and tier 2 cities in India as these hospitals has seen the greatest impact of Digitalisation in healthcare post Covid.

Total number of hospitals in India (Public & Private)   -   69,000.

No. of tier 1 cities (70% of hospitals are present here)   -   8

No. of tier 2 cities   -   104

For the purpose of this study, we have classified the hospitals into

More than 300 beds as large hospitals,

Between 100-300 as medium-sized hospitals, and

Less than 100 as small hospitals.

The number of **HCPs** in these hospitals ranges on an average from 350 in large multi-specialty hospitals located in tier 1 cities to an average of 20 in relatively small multi-specialty hospitals located in tier 2 cities.

The number of management personnel/ administrative in these hospitals ranges from 50-70 in large multi-specialty hospitals located in tier 1 cities to 3-5 in relatively small multi-specialty hospitals located in tier 2 cities.

3.5.2. Sampling:

The sampling strategy followed is multi-stage random sampling.

Stage 1: Cities selection:

All the 8 tier 1 cities (Mumbai, Delhi, Kolkata, Chennai, Hyderabad, Bengaluru, Ahmedabad, and Pune) were included in the study.

A 10% of 104 tier 2 cities i.e., 14 cities were selected by simple random sampling.

Stage 2: Hospitals selection:

Number of hospitals in each city in all the 3 categories was identified from this sampling frame.

From this large pool, 10% of hospitals were selected in each category randomly.

3.6 Participant Selection

The health care professionals and management team were drawn from these selected hospitals by random sampling methods. The sample size was estimated using the formula.

Sample size was calculated by using the formula.

$N = Z_\alpha^2 \, pq / d^2$

Where $Z_\alpha = 1.96$ at 95% confidence level p= prevalence q= 100-p d= relative precision

With 95% confidence level, sample size comes to be 145 for RQ 1, 52 for RQ 2 and 20 for RQ 3.

3.7. Instrumentation

Data collection was done by using 3 different tools exploring the three Research Questions (RQs) in an online survey format developed for the purpose.

3.7.2 Development of the Questionnaire:

Initially a common framework was developed to align the aims and objectives of the study with that of the questionnaire.

Then the Questionnaire was developed in 3 phases:

PHASE 1:	Conducting Literature search for item pool generation
PHASE 2:	Development of the Questionnaire
PHASE 3:	Face , Content validation and pilot testing of the developed questionnaire

3.7.3 Phase 1: Conducting Literature search for item pool generation

Items in accordance with the three domains targeting the 3 different groups were generated from a rapid review of relevant literature. The numbers of questions per tool were decided based upon the aim and objectives of the present study.

3.7.4 Phase 2: Development of the Questionnaire:

From the themes and item pool derived from the thorough review of the literature, a large pool of statements were prepared and categorized into three different groups for the 3 RQs. The statements were then adapted and compiled for framing items with various response scales like multiple choice questions, 5 point likert scale and open ended questions.

All the three tools for three RQs had four main sections under which the questions were organized.

➢ Section 1- Demographic details

➢ Section 2: Type of digital health care technology in your organization

➢ Section 3: Self-reported competencies and attitude towards adoption of digital health care systems

➢ Section 4: Preparedness and organizational support for digital health care technology adoption

3.7.5 Phase 3: Face and Content validation of the developed Questionnaire

Face validation: A 10-point criterion as indicated by J A Oluwatayo (Oluwatayo, 2012) was used to assess the face validity of the developed questionnaire. Accordingly, the face validity of the questionnaire was 'Good' by the research team with a mean score of 3.4 out of 4 as the maximum value.

Content validity: Content validity of the tools was calculated using Aiken's index by the research team and the index value given was 0.8 indicating the questionnaire to be very valid.

Pilot testing: The tool was then pilot tested among 6 participants from the target population. Based on the feedback, a few corrections were made to improve the comprehension of the questionnaire.

Following item pool generation, validation and pilot testing of the tool, items related to the domains and subdomains listed in Table 1were retained.

Table 1: Comparison of items in the instruments used to collect data for the three research questions

Domains	Research Question-1	Research question -2	Research Question-3
Demographic details	7 items Age, Gender, Work position, category	7 items Age, Gender, Work position, category	7 items Age, Gender, Work position, category

	of hospital, years of practice	of hospital, years of practice	of hospital, years of practice
Digital health care technology in your organization	3 items Type of digital health care technology, data privacy and safety	3 items Type of digital health care technology, data privacy and safety	3 items Type of digital health care technology, data privacy and safety
Self-reported competencies and attitude towards adoption of digital health care systems	9 items Knowledge, skill and ease of use of digital technology, ethical issues, patient safety, impact on team-based health care, impact on health equity, job satisfaction	9 items Knowledge, skill and ease of use of digital technology, ethical issues, patient safety, impact on team-based health care, impact on health equity, job satisfaction	4 items Knowledge, skill and ease of use of digital technology, ethical issues
Preparedness and organizational	6 items Preparation before and after covid	14 items Opportunities Organizational	9 items Organizational preparedness

support for digital health care technology adoption	Organizational support Attitudes Motivation Challenges	preparation and support Motivation Attitude Challenges Barriers Pitfalls	Organizational support Motivation Atttiude Challenges Organizational ecosystem

3.8 Data Collection Procedures

Data was collected for 90 days, from August 2023 to October 2023. The data collection was done using google forms, in the electronic format. The items in the three questionnaires were transferred to the google form. It was decided to adopt an electronic format for data collection for convenience and ease of data collection.

The data was collected following the sequential steps as described below. From the selected hospitals, the target participants were contacted.

For RQ 1, to explore the self rated competency of health care workers, the health care team was contacted through personal networks and social media. A total of 450 health care workers were contacted to collect the data. Out of these 200 agreed to participate in the study. Only 151 completed the survey form in its entirety and were included in the final analysis.

For RQ 2, to explore the opportunities, challenges, barriers and pitfalls, health care administrators were contacted. A total of 154 health care workers were contacted through personal networks and social media. Out of these, 112 agreed to participate, while only 64 submitted the completed forms.

For RQ 3, to explore the system preparedness, only the leadership from the health care administration of the selected hospitals was contacted. A total of 45 in leadership positions were contacted. 32 consented to participate in the study. 25 respondents submitted the completed form.

Multiple methods were adopted to contact the participants. Participants were contacted in person/ over phone/ email/ over social media messaging platforms such as WhatsApp, LinkedIn and Instagram messenger. Each potential participant was contacted a minimum of four times and 5 reminders were sent for completion of form. The research team found the response rate to be lower due to the tight work load and schedules of the target group. Informal conversations also revealed that participants were not keen on sharing/ mentioning their institutional policies on patient safety and data privacy.

3.9 Data Analysis

Since we had both close ended and open ended items in our tools, the analysis of both quantitative and qualitative data was done.

The Quantitative data obtained was analyzed using Descriptive and Analytical statistical tests. Descriptive statistics like mean and percentages was used to describe demographics and prevalence. Inferential statistics – Chi-square test and ANOVA

was used to compare the 3 types of hospitals, in tier 1 and 2 cities, in the pre-Covid and post-Covid era.

The Qualitative data from the open-ended questions was analyzed using inductive data analysis. The open-ended questions were inductively coded. The codes were then categorized into subthemes and themes. The data was then interpreted for any reoccurring themes throughout and highlighting any similarities and differences in the data.

3.10 Research Design Limitations

The target population by their very nature of the work profile as health care workers or health care administrators was found to be always occupied. They found it difficult to complete the survey forms in one sitting and devoting 20 minutes for it. Though the study used an online survey format for the convenience of the participants, we could not assure the response rates from the participants. The survey method, while relevant and indicated for research questions of this nature, is often fraught with low response rate, social desirability bias. Anticipating these, we strategized effectively to ensure that we meet the estimated sample size.

Mechanisms to assure the quality of the study.

Selection bias – eliminated by robust sampling strategy and randomization.

Recall bias -Since the participants have to self-report their practices from the pre-Covid era, we anticipated recall bias. To minimize recall bias, we structured the questionnaire with multiple choices and ranges for quantification of responses.

Performance bias and social desirability bias was minimized by ensuring anonymity of hospitals and participants.

Data safety – the data obtained was **anonymized and coded to remove all measures of personal identification. Data** is **safely stored in the personal cloud of the PI** and only the statistician has access to the anonymized data**. No third party** has **access to the data other than the research team.**

3.11. Ethical considerations

The Ethical principles of concern in this study are Autonomy and Confidentiality. This describes acknowledgement of the right of the individual to determine their own course of action in accordance with their own wishes and plans. Autonomy therefore underlies the need for informed consent. An informed consent form was obtained from the participants before participating in the study and is enclosed here with. The participants were clearly informed about the purpose and nature of study. They were assured of confidentiality. The researcher informed them about voluntarily participating in the study and participation involved no harms/ benefits to them. Participants were free to leave the study at any point in time with no adverse effects.

3.11 Conclusion

The mixed method study employed a cross-sectional design. The instruments for data collection were developed following a rigorous scientific methodology for questionnaire development. To ensure a representative sample, participants were selected randomly from the different categories of hospitals located in tier 1 and tier 2 cities of India. Anonymization and informed consent ensured that no ethical

principles were violated. By following the recommended methodological rigor, we ensured that adequate number of responses, to fulfill the sample size estimates were achieved. The quantitative data was subjected to statistical analysis, while the qualitative data was subjected to inductive coding and thematic analysis.

4.1 Research Question One

The first research question was "What is the current competency and preparedness of health care professionals in transitioning to digital health care systems in the pre- and post-Covid period in the Indian context?"

The objective 1 was related to this particular research question. The objective 1 was "Analyzing the self-rated competency and preparedness among the Indian Health Care Professionals in transitioning to digital health care systems such as Patient management systems, HIS, Telemedicine etc., in the pre-Covid and post-Covid era."

To address RQ 1, we contacted a total of 450 health care workers to collect the data. Out of these 200 agreed to participate in the study. Only 151 completed the survey form in its entirety and was included in the final analysis. The sample size estimate was 145, while the final number of participants were 151, thus fulfilling the sample size estimates.

To explore the self-rated competency and preparedness of Indian health care professionals with respect to digital health care systems, a questionnaire with close-ended and open-ended questionnaire, described in detail in the methodology section was used. The questionnaire had 4 domains 1. Demographic details 2. Digital health care technology in your organization 3. Self-reported competencies and attitude towards adoption of digital health care systems and 4. Preparedness and

organizational support for digital health care technology adoption. The results are presented in 4 sections. The findings from each section are presented descriptively and analytically.

4.1.1 Domain 1: Socio-Demographic characteristics of the participants

The socio-demographic characteristics of the participants are presented in Table 2. The statistical findings are described below.

Of the total 151 responses, 59% were from female HCPs and 41% were male. Most of the participants (39.7%) were in the age group of 36-45 years of age followed by (31.1%) in the 25-35 years age group. The distribution of their Health professional roles is depicted in chart 1. Nursing personnel accounted for 31%, while doctors and quality control personnel formed 18.5% and 19.9% respectively. It shows that around 28% of the participants had 10-15 years of experience followed by 22% of participants who had more than 20 years of experience. The experience is fairly equally distributed among the distributed categories.

These participants were from private and public hospitals, largely from Tier 1 cities. A total of 70% of the hospitals were in tier 1 cities whereas in tier 2 and tier 3, 17.2% and 16.6% of the hospitals were located respectively. 86.8% of them belonged to the private sector and only 13.2% belonged to the public sector. 39.7% belonged to large sized hospitals, 35.8% belonged to medium sized and 24.5% belonged to small sized. There was no statistically significant difference between the respondents from the three different categories of hospitals or in the gender. There was a statistically

significant difference among the respondents based on the years of experience and health care role. There are more female participants than males, with the majority falling within the age group of 36 to 45 years. Furthermore, among female participants, there is a clear trend indicating that as age increases, so does the average level of professional experience. Additionally, a significant portion of the participants are employed in medium-sized hospitals located in tier 1 cities, and they predominantly hold positions related to Infection Control Nursing, Quality Control, or Staff Nursing.

Table 2: Socio-demographic characteristics of participants

Socio-demographic characteristic	Categories	Percentage
Gender	Females	59%
	Males	41%
Age group	36-45 years	39.7%
	25-35 years	31.1%
Professional role	Doctor	18.5%
	Nursing	20.5%
	Nursing director	10.6%
	ICN/Quality Control	19.9%
	Senior Manager	5.3%
Years of practice	>20 years	21.9%
	15-20 years	19.2%
	10-15 years	27.8%

	5-10 years	13.2%
	<5 years	17.9%
Location of hospital	Tier 1	70%
	Tier 2	17.2%
	Tier 3	16.6%
Hospital category	Large sized hospital	39.7%
	Medium sized hospital	35.8%
	Small sized hospital	24.5%
Public & Private sector	Public Hospitals	13.2%
	Private sector	86.8%

Chart 1: Distribution of the role of Healthcare professionals who answered tool 1.
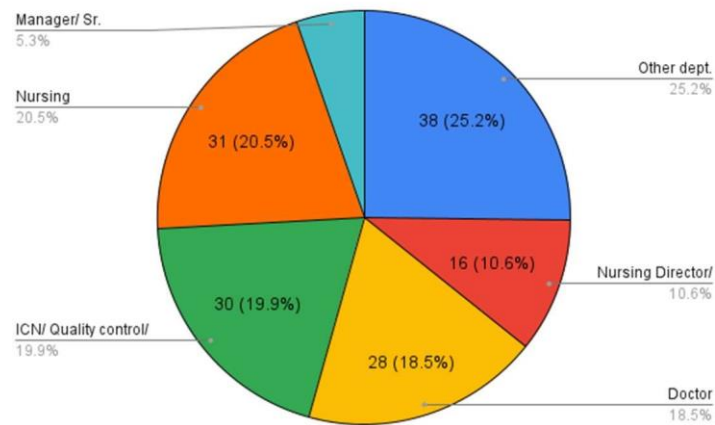
Chart 2: Distribution of the participants' years of experience in their relevant field.

Years of practice

5-10 years
13.2%

13.2%

10-15 years
27.8%

27.8%

15-20 years
19.2%

19.2%

17.9%

>20 years
21.9%

21.9%

< 5years
17.9%
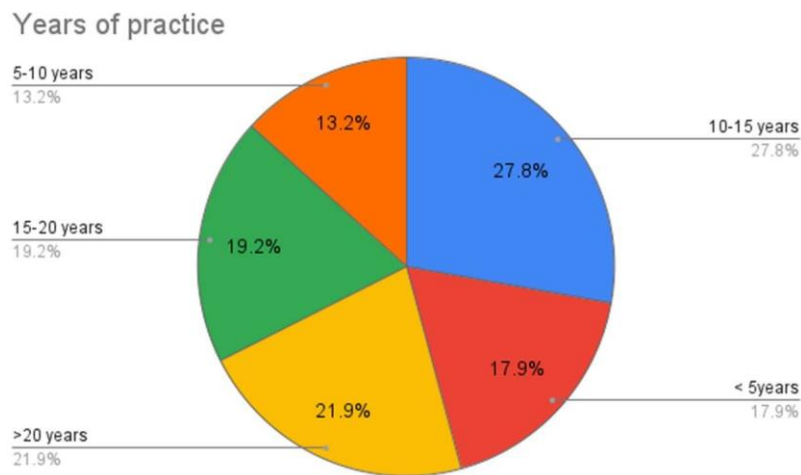
4.1.2 Section 2: Digital health care technology in your organization

There were three questions in this domain, which explored the type of digital health care facilities available in hospitals before and after Covid, and issues related to data privacy and measures available for ensuring data privacy.

When asked about the type of digital health care technologies that were adopted in your organization before and after Covid, most of the participants mentioned that the adaptation to various digitalisation methods in their workplace have increased after Covid which is portrayed in Fig 3.

Health care organizations have adopted electronic health records, virtual health care and telemedicine widely post-Covid. *There has been statistically significant increases data analytics, health apps and wearables post-Covid.*

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While telemedicine, virtual health care, electronic health records were reported to be available by nearly 65% to 75% of the hospitals, in the pre-Covid era. AI, health apps and wearables, data analytics, interoperability were less than 23% in the pre-Covid era. In the post-Covid era, the health apps and wearables increased to nearly 80%, data analytics increased to nearly 55%. *AI and interoperability, while showing an increasing trend, still has a lot of catching up, with the rest of the digital health care facilities. This increasing trend in the range of digitalisation of health care seems to have hastened post-Covid.*

In this backdrop, it is important to understand that 81% of participants reported the presence of data privacy policy, while 12% said maybe and 7% said no, they did not have a data privacy policy. When we probed the type of data privacy measures in place, the most widely reported was Health information system, followed by data encryption and IT support and pass code system. 63% of participants reported that they personally had no idea and believed the IT team to be aware of data privacy issues.

Chart 3: The Adoption of the type of Digitalization before and after Covid.
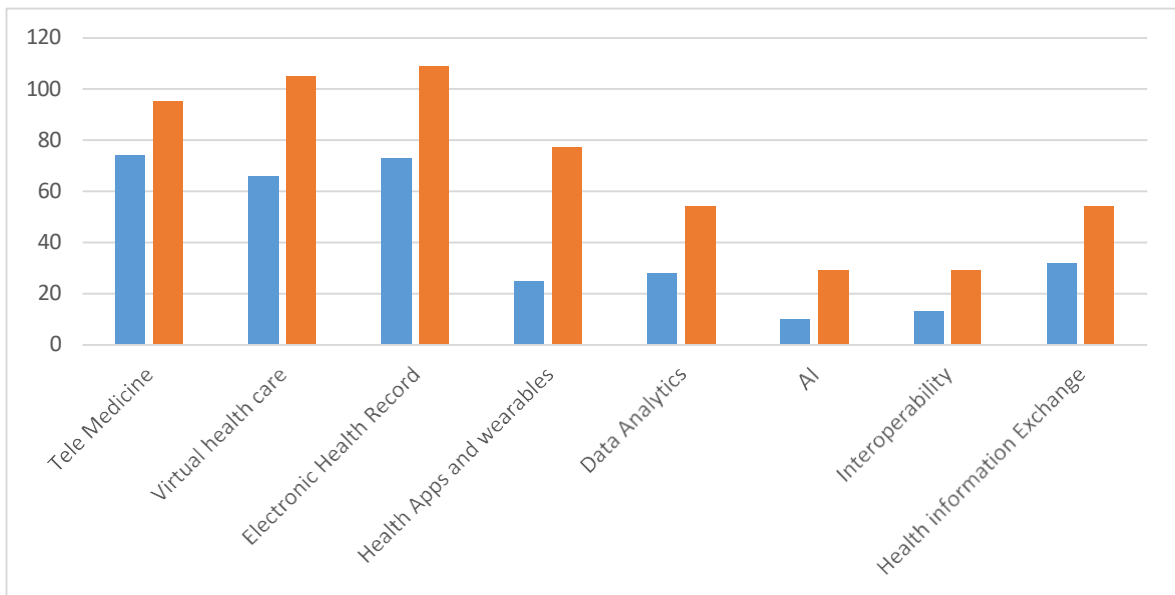
4.1.3 Section 3: Self-reported competencies towards adoption of digital health care systems

In this section we explored the self-reported competencies, impact on patient interaction, patient safety, patient data privacy, and health equity and job satisfaction in relation to digital health care systems.

4.1.3.1. Self-reported knowledge, skill, ease of use of digital technology and job satisfaction

The participants were asked to rate their knowledge, skill and ease of use of digital health care technology on a scale of 1-5, before and after Covid (with 1 being lowest and 5 being highest).Chart 4 shows that the knowledge, skill and ease of use of digital technology by the HCPs have improved tremendously after Covid as they were motivated to adopt the technologies.

Table 3: Change in self-reported competency and job satisfaction of health care

workers.

	Before Covid	After Covid
Change in knowledge level	Level 2- 25%*	Level 2 -12%
	Level 3-28%	Level 3-25%
	Level 4- 19%*	Level 4- 33%
	Level 5 –14%*	Level 5 -28%
Change in Skill	Level 2- 25%*	Level 2 -12%
	Level 3-31%	Level 3-26%
	Level 4- 22%*	Level 4- 33%
	Level 5 –9%*	Level 5 -27%
Change in ease of use	Level 2- 22%*	Level 2 -12%
	Level 3-28%	Level 3-26%
	Level 4- 23%*	Level 4- 33%
	Level 5 –11%*	Level 5 -26%
Job satisfaction	Level 2- 29%*	Level 2 -13%
	Level 3-26%	Level 3-25%
	Level 4- 25%*	Level 4- 33%
	Level 5 –13%*	Level 5 -26%

4.1.3.1. 1. Descriptive statistics

The self-reported knowledge levels were rated closer to level 2 and 3 pre-Covid, while these shifted to level 4 and 5 in the post-Covid era. This increase in self-

reported knowledge change was statistically significant with p<0.005. A comparative analysis clearly identified that in the post-Covid era, the percentage of participants reporting level 2 decreased significantly, while there was an increase in level 4 and 5. These hint at the probable increase in familiarity given the duration of use. Further research is required to explore the reasons for the increase in knowledge, skill and use in the post-Covid era. The reasons for the increase could be the increasing number of years of use, or the sudden need for digital health care during the Covid pandemic, or whether it was due to prioritization of digital health care as a policy by hospitals.

4.1.3.1.2. Inferential statistics:

A preliminary co-relation analysis showed an interesting data trend which can hint at the areas for research. With respect to occupational groups, the data distribution across competency levels post Covid, belief categories, and other variables reveals interesting insights. For instance, doctors primarily belong to competency level 3 post Covid, whereas nursing directors exhibit a more balanced distribution between levels 3 and 4. When it comes to belief in improvement, the majority of respondents across all occupational groups express positivity with "Yes" responses.

However, the stance on ethical issues varies significantly, with "No" responses being more prevalent among higher competency levels (4 and 5) but "Maybe" responses showing a more even distribution.

When we consider variables like years of experience and workplace settings, it becomes apparent that more experienced professionals tend to express stronger

beliefs in improvement, and those working in academic, or research settings lean toward a more cautious "Maybe" response regarding ethical dilemmas.

Further with respect to Age, the data indicates that on average, competency level increases after Covid across all age categories suggesting that there is a positive impact on competencies, and the extent of improvement may vary depending on the initial competency level and age group. Age category 36-45 years predominately has a positive impact on self-related competency post Covid.

Knowledge After is positively associated with Policy Type (0.43463), the Location of the Hospital (0.17122), Hospital Size (0.15268), and Healthcare Technology post Covid (0.09710).Ease of Use after Covid shows a positive correlation with Policy Type (0.18635).Job satisfaction increases with the Location of the Hospital (0.08212) and Hospital Size (0.09318).

Chart 4: Self-reported knowledge, skill and ease of use of digital health care technology
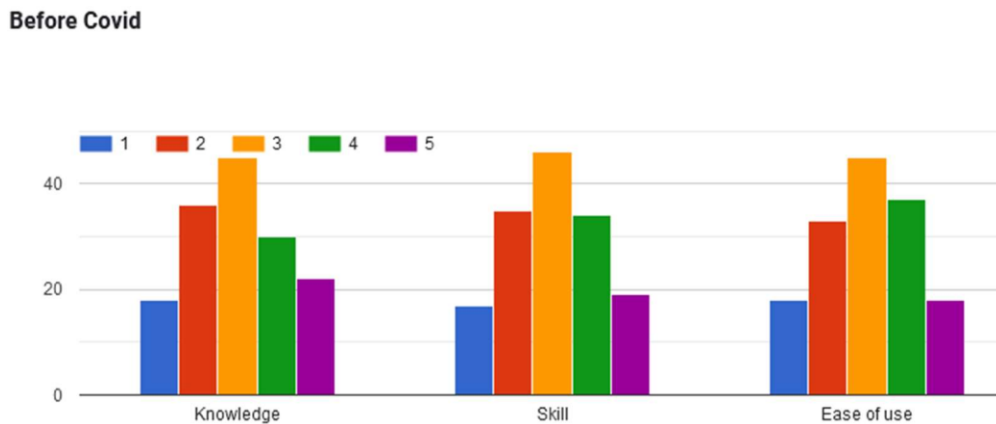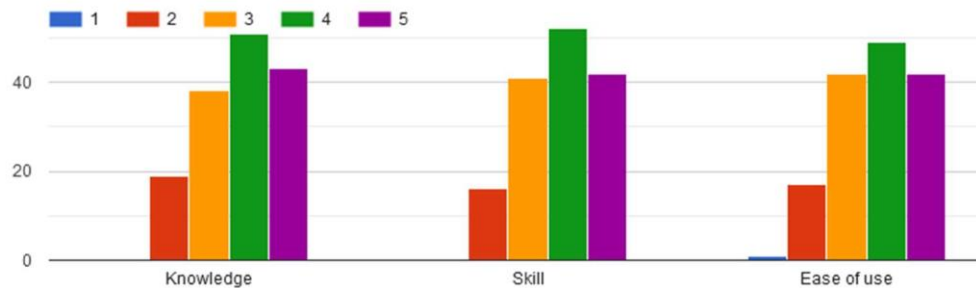
Chart 5: Change in job satisfaction levels in HCPs pre and post Covid
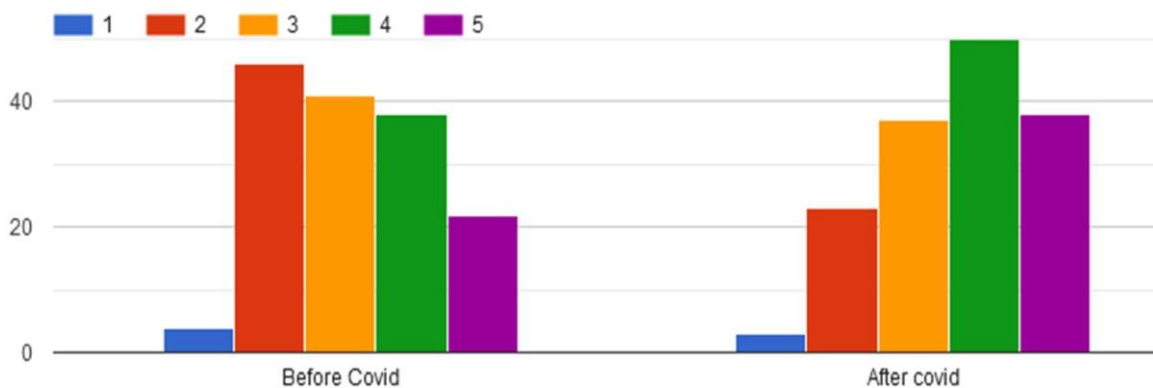
4.1.3.1.3. Qualitative analysis:

A thematic analysis of the participants' responses to four questions on impact of digital health care on patient interaction, patient safety, team-based health care and health equity identified the following themes.

The responses to the open-ended questions were coded; sub themes were categorized into major themes to explore the pattern of responses.

Table 4: Qualitative analysis of participant responses on perceived impact of digital health care pre-Covid and post-Covid

Themes	Sub-themes	Quotations
Theme 1: Impact of digital health care technology on patient interaction:	1. Digital health care technology was a breakthrough	"Cost effective and time efficient" "boon for geriatric and home bound patients" "increased convenience"
	2. Digital health care made progress	"Patients have started accepting this change and are more open to such technologies post Covid" "My skills have improved"
	3. Digital health care poorly impacted patient interaction.	"Decreased the physical assessments of patients"
	4. Ethical issues	"data privacy issues and patient data being compromised"
Theme 2: Impact of digital health care technology on patient safety, pre-	1. Improved patient safety	"saves nursing time", "helped in infection control", "remote patient monitoring made easy" "better patient tracking system"

and post-covid.	2. No change	did not notice any change in patient safety
	3. Safety at risk	"Patients missed medication doses", "doctors took more time completing EMR and less time on patient care".
Theme 3: Impact of digital health care technology on team-based health care	1. Strengthened	"Helped reach many people at the same time", "made things little more systematic", "could share project tools", "and strengthened public health measures during pandemics".
	2. No change	"don't see much change here"," Collaboration has always been there, with or without technology", "comfortable in traditional way as we learnt that way throughout our career", "Virtual connects doesn't have better connect and understanding".
Theme 4: Impact of digital health care on health equity	1. Improved equity in health care	"has increased accessibility to healthcare immensely", "health consultation and diagnostic you can now do at your home with some similar or cheaper cost",

		"Access and availability has improved greatly".
	2. Decreased equity in health care	"costing more post digitization", "Affordability has improved to only some extent, not everyone is digitally sound in India, specifically in remote areas"
	3. Lack of funding	"no significant change as it is a government funded body" "funding is crucial for such changes to become effective"

Theme 1: Impact of digital health care technology on patient interaction:

Sub-themes:

1. Digital health care technology was a breakthrough

2. Digital health care made progress

3. Digital health care poorly impacted patient interaction.

4. Ethical issues

Most of the participants who seemed satisfied with the evolution of digitalisation in healthcare mentioned, "Cost effective and time efficient", "boon for geriatric and home bound patients", "increased convenience". Some participants were happy about

the fact that "patients have started accepting this change and are more open to such technologies post Covid". However, a percentage of participants felt that these technological shifts have "decreased the physical assessments of patients" which are a challenge in diagnosis of diseases. Almost 70% of the HCPs have come across some ethical issues with digital health care technology and have mentioned them as "data privacy issues and patient data being compromised" while the rest 20% found no ethical issues and remaining 10% not sure of the situation.

Theme 2: Impact of digital health care technology on patient safety, pre- and post-covid.

Sub themes:

1. Improved patient safety

2. No change

3. Safety at risk

When asked how has digital health care technology impacted patient safety pre and post Covid, which was an open ended question, the responses of the HCPs can be broadly placed under three themes: 'Improved patient safety', 'No change at all 'and 'Safety at risk'. Most of the participants who agreed that patients' safety has improved quoted, "saves nursing time", "helped in infection control", "remote patient monitoring made easy", "better patient tracking system". HCPs who disagreed to the statement quoted "patients missed medication doses", "doctors took more time completing EMR and less time on patient care". A negligent percentage of

participants did not notice any change in patient safety pre and post Covid with respect to digitalisation.

Theme 3: Impact of digital health care technology on team-based health care

Sub-themes:

1. Strengthened

2. No change

The next question was on **how digital health care had impacted team-based health care** which was also an open-ended question to which a vast majority of the participants agreed that technology had improved their teamwork experience. The responses can be grouped under the themes, 'strengthened' and 'no different'.

HCPs who felt the positive change had quoted "Helped reach many people at the same time", "made things little more systematic", "could share project tools", "strengthened public health measures during pandemics".

On the contrary some participants felt that digitalisation have reduced their human touch and have quoted, "don't see much change here"," Collaboration has always been there, with or without technology", "comfortable in traditional way as we learnt that way throughout our career", "Virtual connects doesn't have better connect and understanding".

Theme 4: Impact of digital health care on health equity

Sub-themes:

1. Improved equity in health care

2. Decreased equity in health care

3. Lack of funding

On the question about **how digital health care has impacted health equity**, a good percentage of participants supported that technology has improved equity in healthcare by quoting, "has increased accessibility to healthcare immensely", "health consultation and diagnostic you can now do at your home with some similar or cheaper cost", "Access and availability has improved greatly".

However equal number of participants said that technology has decreased equity in healthcare especially in the vulnerable population. Some HCPs quoted, "costing more post digitization", "Affordability has improved to only some extent, not everyone is digitally sound in India, specifically in remote areas". Some have also mentioned "no significant change as it is a government funded body" and "funding is crucial for such changes to become effective".

4.1.4 Section 4: Preparedness and organizational support for digital health care adoption

Preparedness of personnel and organizational support is critical for translation of digital health care technology to a meaningful action. We explored the preparedness of personnel specifically in terms of the training provided and their motivation levels. Organizational support was explored in terms of what facilities are available and what to the health care workers need to further enhance their abilities.

4.1.4.1. Preparedness for digital health care adoption -Training

Preparedness for digital health care adoption was mainly through training. Before Covid, most of our participants reported that they received only basic training (50%), while 18% received no training. 13% reported that they received in-depth training, while 19% reported receiving training on the job. Post-Covid the scenario changed for all the categories. The number of participants who received no preparation dropped to 3% while 45% received training on the job. 33% received in depth training, while 19% received basic training. As we can see the number of participants who received in-depth training went up from 13% to 33%. Number of participants who received basic training dropped from 50% to 19%. The number of participants who received on the job training increased from 19% to 45%. The number of participants who received no training, dropped from 18% to 3%.

Chart 6: Levels of preparedness for adopting digital health care technology

The mean difference in preparedness level after Covid is 0.2715, with a standard deviation of 1.4092. This indicates that, on average, there is a slight increase in preparedness level after Covid, although there is variability in the responses.

Hypothesis Testing: p-value for the Student's t-test is 0.0192, indicating that there is a statistically significant difference in preparedness level before and after Covid. Similarly, the p-values for other normality tests (Shapiro-Wilk, Kolmogorov-Smirnov, Cramer-von Mises, Anderson-Darling) are all smaller than 0.005, suggesting that the data significantly deviates from a normal distribution.

Confidence Intervals: The 95% confidence interval for the mean difference in preparedness level ranges from approximately 0.0449 to 0.4981.

4.1.4.2. Preparedness for digital health care adoption -Motivation

When asked to **rate their motivation towards digital health care technology pre and post Covid,** the participants have rated high levels of motivation post Covid. Percentage of participants who rated their motivation high, medium and low, before and after Covid was 18% & 52%; 64% & 38%; 18% & 10%

The inferential analysis of Change in Motivation indicates that there was a statistically significant increase in motivation levels among participants after the COVID-19 (0.4238 M, p<0.0001). Despite the data not following a normal distribution, the various statistical tests confirmed that the change in motivation levels is meaningful and not likely due to random chance (CI 0.2946 to 0.5531). This suggests that the COVID-19 had a positive impact on the motivation levels of the participants.

Chart 7: Motivation levels of HCPs towards digital health care technology
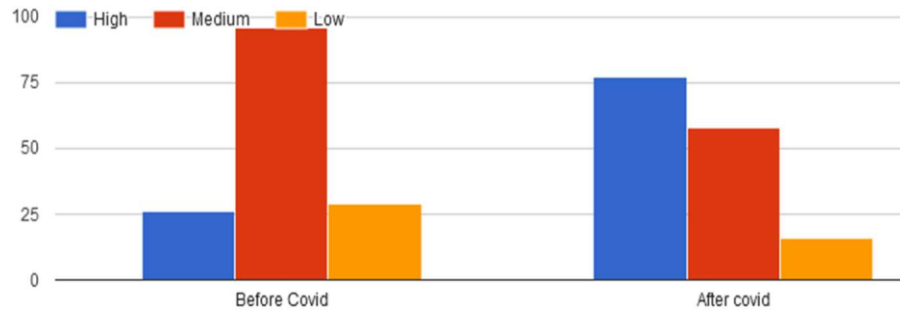
4.1.4.3.   Organizational support - Facilities

For the question on **the type of support your organization provided for up-skilling to digital health care technology** about 78% of the participants mentioned an organized training was given by the organization followed by 12.6% mentioning about incentives being given. 11.9% had paid time while 12.6% not given any support.

Chart 8: Type of support provided by the organization for up-skilling to digital health care technology
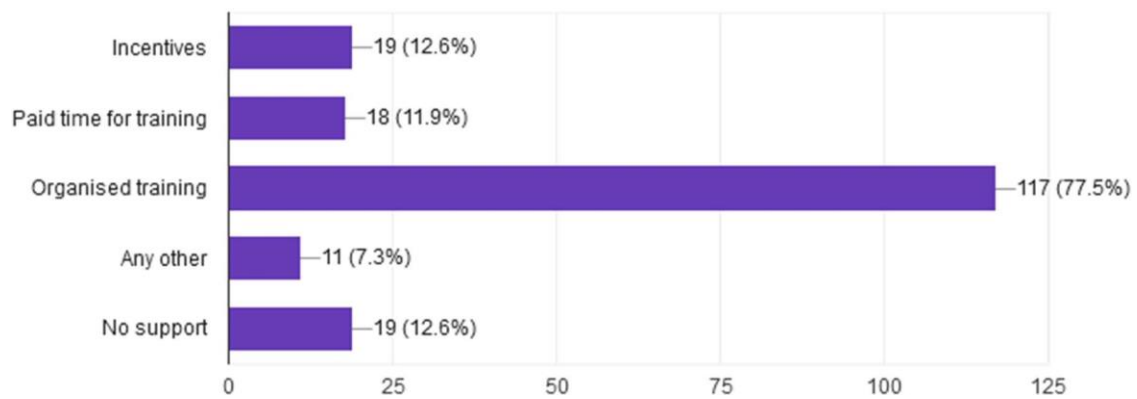
4.1.4.4. Organizational support –Challenges and support needed

The challenges and support required were listed as open-ended questions. Participants reported facing challenges with 'Data privacy', 'limited resources' 'Less human touch' and 'limited training'. Participants expressed that they needed 'In-depth and frequent training', 'Budget and 'manpower allocation', 'Active monitoring and awareness' for improving their digital health care delivery competence.

4.2   Research Question Two

The second research question was "What are the opportunities, challenges, barriers, and pitfalls in digitalisation of health care amongst hospital management?" This research question was linked to objective 2 which stated "Analyzing the opportunities, challenges, barriers, and pitfalls of digitalisation of healthcare amongst hospital managements in the pre- and post-Covid era"

For RQ 2, to explore the opportunities, challenges, barriers and pitfalls, health care administrators were contacted. A total of 154 health care workers were contacted through personal networks and social media. Out of these, 112 agreed to participate, while only 64 submitted the completed forms. The sample size estimate for RQ 2 was 52, while we had 64 participants.

To explore the opportunities, challenges, barriers, and pitfalls of digitalisation of healthcare amongst hospital managements in the pre- and post-Covid era, a questionnaire with close-ended and open-ended questionnaire, described in detail in the methodology section was used. The questionnaire had 4 domains 1. Demographic details(Age, Gender, Work position, category of hospital, years of practice) 2. Digital health care technology in your organization (Type of digital health care technology, data privacy and safety) 3. Self-reported competencies and attitude towards adoption of digital health care systems (Knowledge, skill and ease of use of digital technology, ethical issues, patient safety, impact on team-based health care, impact on health equity, job satisfaction) and 4. Preparedness and organizational support for digital health care technology adoption (Organizational preparation and support

Opportunities, Motivation, Attitude, Challenges, Barriers, Pitfalls). The results are presented in 4 sections. The findings from each section are presented descriptively and analytically.

4.2.1 Domain 1: Socio-Demographic characteristics of the participants

The socio-demographic characteristics of the participants are presented in Table 4. The statistical findings are described below. Of the total responses 51.6% were from female participants and 48.4% were male. Most of the participants (35.5%) were in the age group of 36-45 years of age followed by(29%) in the 46-55 years age group and 22.6% in 56-65 year age group. The distribution of their Health professional roles is depicted in Chart 9.

HOD accounted for 35.5%, while CEO and Medical Admin formed 19.4% and 9.7% respectively. Deputy General Managers were 12.9%. 51.6% of the participants had >20 years of experience followed by 25.8% having experience of 10-15 years and 16.1% having 15–20 years of experience in their relevant field.

These participants were from private and public hospitals, largely from Tier 1 cities.45.2% belonged to large sized hospitals, 45.2% belonged to medium sized and the remaining belonged to small sized hospitals. A total of 58.1% of the hospitals were in tier 1 cities whereas in tier 2 and tier 3, 9.7% and 29% of the hospitals were located respectively. Also, among the hospitals 90.3% of them belonged to the private sector and only 9.7% belonged to the public sector.

While the gender distribution among respondents shows a commendable balance, offering insights from both male and female perspectives, the majority of data leans towards those in senior positions, specifically CEO/COO and HODs. This indicates that the feedback primarily comes from the decision-making echelons of healthcare institutions. A significant emphasis is observed on Tier 1 city-based, large to medium-sized private hospitals. This potentially narrows the scope of understanding to urban, private healthcare settings. To foster a comprehensive understanding of the entire healthcare landscape, there is a palpable need to also encompass perspectives from small-sized hospitals, those situated in Tier 2 and Tier 3 cities, and public sector healthcare institutions.

Table 5: Socio-demographic characteristics of participants

Socio-demographic characteristic	Categories	Percentage
Gender	Females	51.61%
	Males	48.39%
Age group	36-45 years	35.5%
	46-55 years	31.1%
	56-65 years	22.6%
Professional role	HOD	35.5%,
	CEO	19.4%
	Deputy general manager	12.9%
	Medical Admin	9.7%

Years of practice	>20 years	51.6%
	15-20 years	16.1%
	10-15 years	25.8%
Location of hospital	Tier 1	58.7%
	Tier 2	9.7%
	Tier 3	29%
Hospital category	Large sized hospital	45.2%
	Medium sized hospital	45.2%
Public & Private sector	Public Hospitals	9.7 %
	Private sector	90.3%

Chart 9: Distribution of the role of Healthcare Management professionals who answered tool 2.
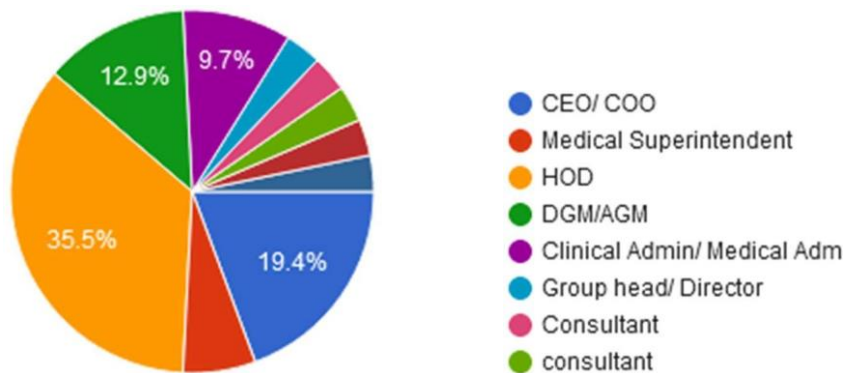
Chart 10: Distribution of the participants' years of experience in their relevant field.
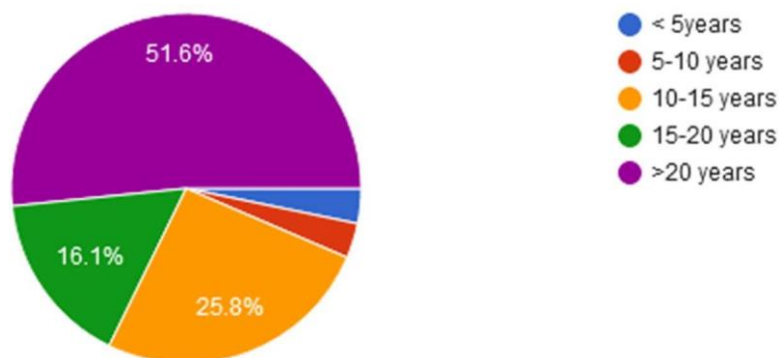
4.2.2 Section 2: Digital health care technology in your organization

There were three questions in this domain, which explored the type of digital health care facilities available in hospitals before and after Covid, and issues related to data privacy and measures available for ensuring data privacy.

When asked about the type of digital health care technologies that were adopted in your organization before and after Covid, most of the participants mentioned that the adaptation to various digitalisation methods in their workplace have increased after Covid which is portrayed in Chart11 and Table 5.

Telemedicine and electronic health records were widely adopted pre-Covid. Post-Covid, there has been a statistically significant increase in virtual health care, data analytics, health information exchange, health apps and wearables. AI is still catching up, with only 16% respondents reporting it in their hospitals.

In this backdrop, it is important to understand that 77.4%% of participants reported the presence of data privacy policy, while 19.4% said maybe and 3.2% said no, they did not have a data privacy policy. When we probed the type of data privacy measures

in place, the most widely reported was 'Electronic health record, 'password protected' and few stated that they were 'not sure'.

Table 6: Digital health care technology adopted by organizations before and after Covid

Type of Technology	Before Covid	After Covid
Telemedicine	64%	80%
Virtual health care	38%	74%
Electronic health record	67%	74%
Health apps and wearables	12%	32%
Data analytics	19%	41%
AI	3%	16%
Interoperability	9%	16%
Health information exchange	12%	32%

Chart 11: Type of digital healthcare technologies adopted in your organization
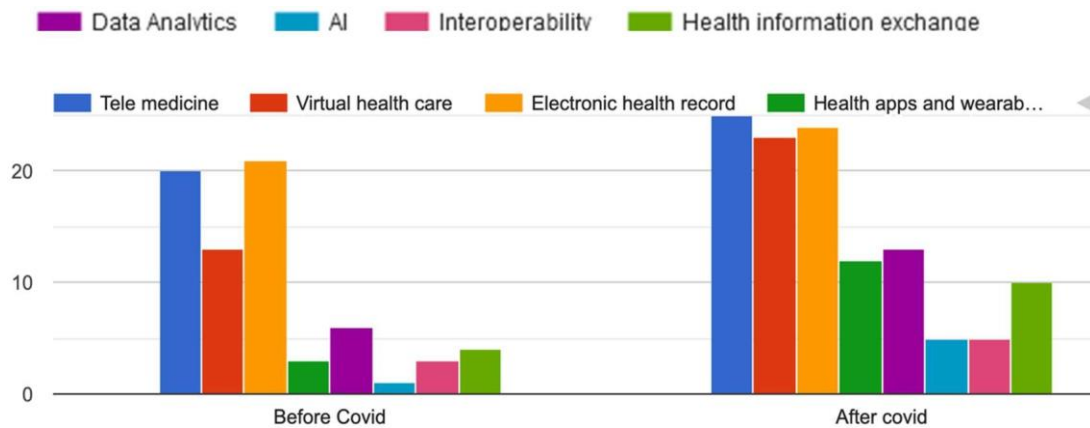
Telemedicine

4.2.3 Section 3: Self-reported competencies towards adoption of digital health care systems

In this section we explored the self-reported competencies, impact on patient interaction, patient safety, patient data privacy, health equity and job satisfaction in relation to digital health care systems.

4.1.3.1. Self-reported knowledge, skill, ease of use of digital technology and job satisfaction

The participants were asked to rate their knowledge, skill and ease of use of digital health care technology on a scale of 1-5, before and after Covid (with 1 being lowest and 5 being highest).Chart 4 shows that the knowledge, skill and ease of use of digital technology by the HCPs have improved tremendously after Covid as they were motivated to adopt the technologies.

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Table 7: Change in self-reported competency and job satisfaction of health care workers.

	Before Covid	After Covid
Change in knowledge level	Level 1- 23%	Level 1- 0%
	Level 2- 23%	Level 2 -25%
	Level 3-19%	Level 3-22.5%
	Level 4- 23%*	Level 4- 27%
	Level 5 –19%	Level 5 -22.5%
Change in Skill	Level 1- 16%*	Level 1- 0%
	Level 2- 27.4%	Level 2 -24%
	Level 3-27.4%	Level 3-27%
	Level 4- 16%*	Level 4- 32%
	Level 5 –9%	Level 5 -12%
Change in ease of use	Level 1- 19%*	Level 1- 0%
	Level 2- 24%	Level 2 -22%
	Level 3-24%*	Level 3-32%
	Level 4- 19%*	Level 4- 27%
	Level 5 –9%*	Level 5 -16%
Job satisfaction	Level 2- 65%*	Level 2 -31%
	Level 3-64%	Level 3-59%
	Level 4- 63%*	Level 4- 78%
	Level 5 –31%*	Level 5 -59%

4.2.3.1. 1. Descriptive statistics

The self-reported knowledge levels were rated closer to level 2 and 3 pre-Covid, while these shifted to level 4 and 5 in the post-Covid era. This increase in self-reported knowledge change was statistically significant with $p<0.005$. A comparative analysis clearly identified that in the post-Covid era, the percentage of participants reporting level 2 decreased significantly, while there was an increase in level 4 and 5. While there was level 1 pre-Covid, these disappeared in the post-Covid data component. This hints at the probable increase in familiarity given the duration of use. Further research is required to explore the reasons for the increase in knowledge, skill and use in the post-Covid era. The reasons for the increase could be the increasing number of years of use, or the sudden need for digital health care during the Covid pandemic, or whether it was due to prioritization of digital health care as a policy by hospitals.

Chart12: Self-reported knowledge, skill and ease of use of digital health care technology
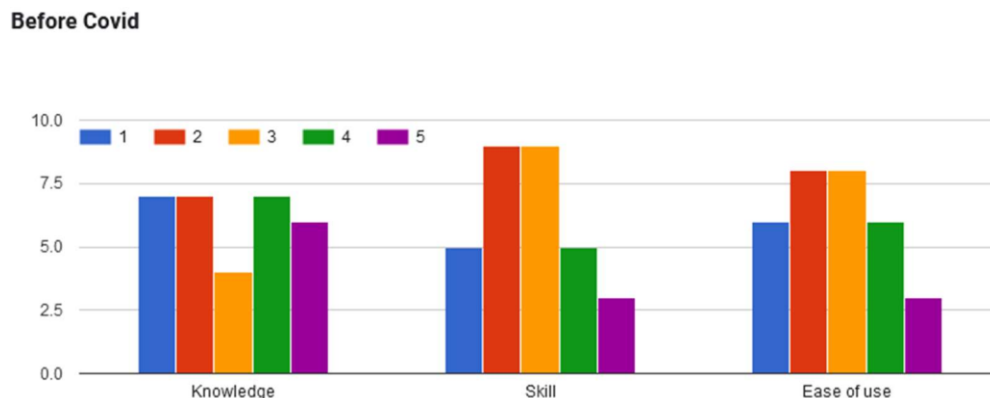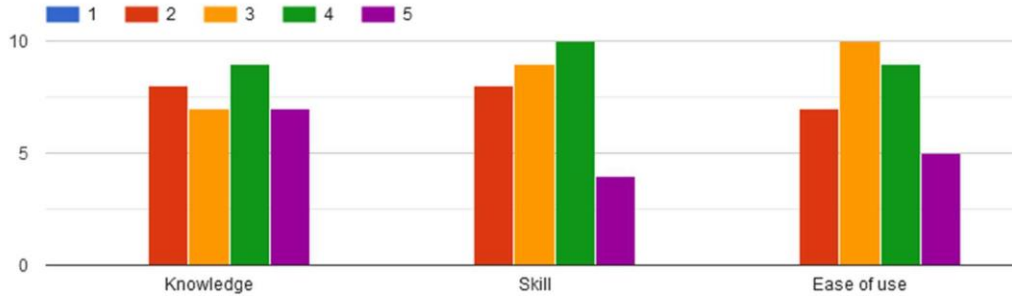
Chart13: Change in job satisfaction levels in HCPs pre and post Covid
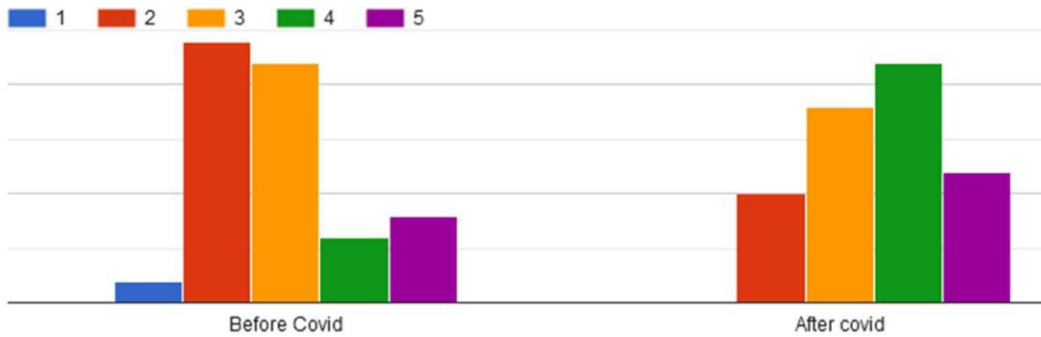
4.2.3.1.3. Qualitative analysis:

A thematic analysis of the participants' responses to five questions on impact of digital health care on patient safety, team-based health care and health equity identified the following themes.

The responses to the open-ended questions were coded; sub themes were categorized into major themes to explore the pattern of responses.

Table 8: Qualitative analysis of participant responses on perceived impact of digital health care pre-Covid and post-Covid

Themes	Sub-themes	Quotations
Theme 1: Impact of digital health care technology on patient safety, pre- and post-Covid.	1. Improved patient safety	"Virtual concepts which do not expose patient to hospital infection, since data is available at fingertips there is no need for repeated visits,' 'Improved audit implementation and this has definitely improved patient safety positively'.
	2. Improved access	"has improved access to healthcare', Covid has taught us some things can be done even offline',
	3. Ethical issues	"Sharing of data with government agencies as well as NGOs authorized by government, which does not necessarily respect privacy rights of patients"," Using others, ID, untimely documentation".
Theme 2: Impact of digital health	1. Communication	'digitalization has made it possible to attend these meetings and coordinate

care technology on team-based health care	improved	with other team members readily at your comfort zone'
	2. Reduced teamwork	Though the communication is better due to availability of data, I feel the teamwork has reduced due to less human interaction".
Theme 3: Impact of digital health care on health equity	1. Improved equity in health care	That accessibility had improved but not affordability
	2. Decreased equity in health care	"Access to care to all segments was not possible due to lack of budget and infrastructure", "vulnerable sections and tier 3 regions are yet to see the impact".

Theme 1: Impact of digital health care technology on patient safety, pre- and post-Covid.

Sub themes:

1. Improved patient safety

2. Improved access

3. Ethical issues

On the question, how has digital health care technology impacted patient safety, which was an open ended question, the participants quoted, 'has improved access to healthcare', Virtual concepts which do not expose patient to hospital infection, since data is available at fingertips there is no need for repeated visits,' Covid has taught us some things can be done even offline', 'improved audit implementation and this has definitely improved patient safety positively'.

When the participants were asked if they had **come across any ethical issues with digital health care technology**, 58.1% answered 'no', 32.3% answered 'maybe' and only 9.7% mentioned 'yes'. The participants who answered 'yes', quoted "Sharing of data with government agencies as well as NGOs authorized by government, which do not necessarily respect privacy rights of patients", "Using others ID, untimely documentation".

Theme 2: Impact of digital health care technology on team-based health care

Sub-themes:

1. Communication improved

2. Reduced teamwork

The next question was on **how digital health care had impacted team-based health care** which was also an open-ended question to which most of the participants said that there is improved communication among the team members because of digitalization post Covid. They have quoted, 'digitalization has made it possible to attend these meetings and coordinate with other team members readily at your comfort zone'.

On the contrary some participants have felt that, "though the communication is better due to availability of data, I feel the team work has reduced due to less human interaction".

Theme 3: Impact of digital health care on health equity

Sub-themes:

1. Improved equity in health care

2. Decreased equity in health care

For the question on **how digital health care has impacted health equity**, most of the participants have unanimously agreed that accessibility had improved but not affordability. However, some of them have felt that a certain set of vulnerable population haven't seen any benefits and have quoted, "Access to care to all segments were not possible due to lack of budget and infrastructure", "vulnerable sections and tier 3 regions are yet to see the impact".

4.2.4 Preparedness and organizational support for digital health care technology adoption

This section presents the results with respect to organizational support, opportunities, challenges, barriers and pitfalls.

4.2. 4.1. Organizational support -Facilities

When asked about **the support your organization provided for up-skilling to digital health care** technology, 90% of the participants mentioned organized training followed by 10% mentioning about paid time for training and the remaining not

receiving any support. A question on **how your organization prepared for digital healthcare technology** in terms of, a. Change in policy, b. Budgetary allocation for procurement and implementation, c. Training of human resource, d. Strategic approach to handle resistance to change, e. Patient data privacy protocols, f. Patient compliance measures,

Most of the participants mentioned that post Covid the management swiftly worked to prepare for the technological advancements than pre Covid. Some participants quoted, "*Covid made it impossible to work without adequate technology intervention, hence policies related to digital health were quickly put into place, suitable budget allocations were made, change was literally pushed through*".

When asked what support do you need to enhance your competence in using digital healthcare technology? (From the organization, from the vendor, from the team and from self), almost all the participants wanted more collaboration, Orientation, training and resources availability.

Chart14: Organizational support for up-skilling to digital health care technology

What support did your organisation provide for upskilling to digital health care technology?
31 responses

Category	Value
Incentives	3 (9.7%)
Paid time for training	6 (19.4%)
Organised training	28 (90.3%)
Any other	4 (12.9%)
No support	1 (3.2%)
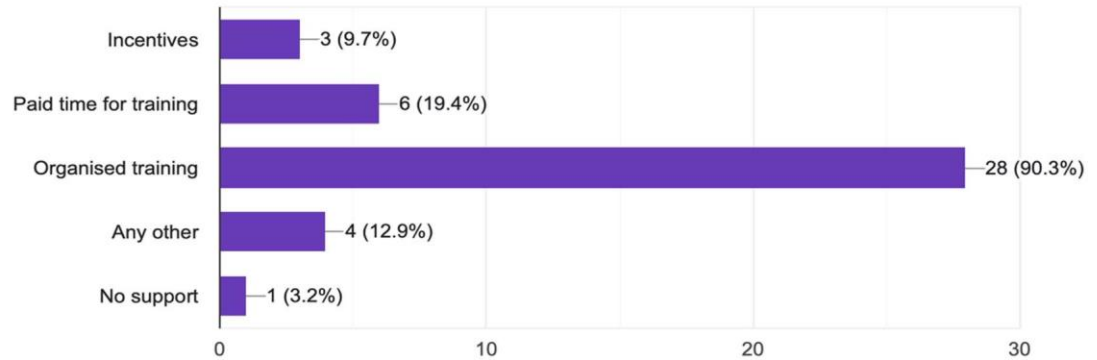
4.2.4.2.   Preparedness for digital health care adoption -Motivation

When asked to **rate their motivation towards digital health care technology pre and post Covid,** the participants have rated high levels of motivation post Covid. The following chart summarizes the change in motivation levels towards digitalisation of healthcare in the management personnel pre and post Covid.

Chart 15: Change in job motivation levels in management personnel pre & post Covid
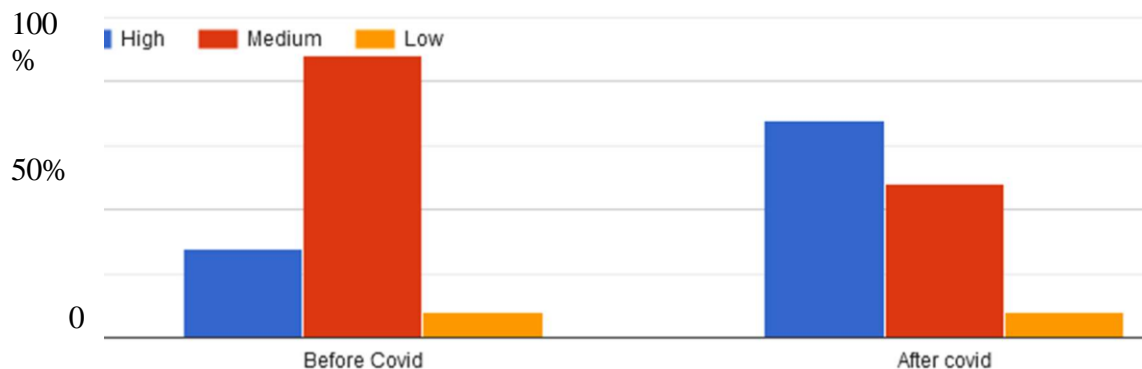
4.2.5 Opportunities, challenges, barriers and pitfalls

4.2.5.1. Opportunities with digital health care technology

When asked about **the opportunities that opened up with digital healthcare technology** for the participants related to Technology, Administrative, Financial, Human resource, Patient related pre and post Covid, most percentage of the participants mentioned reduced opportunities in every field pre Covid and post Covid mostly they had technological, human resource and patient related opportunities being opened up.

In the **pre-Covid period**, there were clear indications of growth expectations in Technological and Administrative sectors, suggesting the sector anticipated technology's potential to address existing healthcare challenges. Patient data privacy and strategic changes to handle resistance were highlighted, emphasizing the belief in a proactive approach towards the digital transformation of healthcare.

The potential of technology in addressing key challenges seemed to grow **post-Covid**, with opportunities related to technology surging to 29.03%.The pandemic led to an increased focus on patient acceptance, signaling successful interventions and possibly a higher demand for digital health solutions. Preparedness initiatives stressed the importance of budgeting, implementation, and rapid technology adoption, indicating the perceived value of digital solutions in managing a healthcare crisis.

4.2.5.2. Challenges with digital health care technology

When asked what the challenges are **you face with digital health care technology pre and post Covid** related to a. Technology, b. Administrative, c. Financial, d. Human resource related and e. Patient related, almost all the participants mentioned about challenges faced in almost all the areas mentioned. Some quoted 'unfriendly and limited technology, administrative bias towards management issues, budgetary outlays and expensive solutions, medico legal restriction and acceptance, patient acceptance', pre Covid. Post Covid most participants found less challenges with respect to technology.

In the **pre-Covid period**, technology surfaced as a significant challenge, especially in terms of its efficiency and the delays in outcomes, constituting 19.35% of reported issues. Financial and Administrative challenges were close contenders, with each contributing to 16.13% of the challenges faced.

In the **post-Covid period**, financial challenges appeared to amplify, possibly due to the strain on healthcare resources caused by the pandemic and the increased demand

for rapid digital solutions. Human resource management became a more pronounced category, emphasizing the challenges in up skilling and training staff quickly to adapt to new digital tools and solutions.

4.2.5.3. Barriers and pitfalls with digital health care technologies

When asked about the **barriers and pitfalls you face with digital health care technology pre and post Covid** related to a. Technology, b. Administrative, c. Financial, d. Human resource related and e. Patient related, most participants felt issues in all areas pre Covid while post Covid their barriers and pitfalls were all related to human resources and finance.

In the **pre-Covid era**, Human Resource issues were repeatedly highlighted as barriers, both independently and in relation to other challenges. This indicates that while the digital transformation was underway, the human element's readiness and adaptability to these changes remained a concern. Specific barriers included the availability, acceptability, and affordability of digital solutions. Technological pitfalls, such as limited support, almost negligible patient acceptance, limited application, clinical management bias, and high costs, were evident. Financial concerns were equally prevalent, suggesting that financial constraints could hinder the pace and scope of digital transformation.

In the **post-Covid era**, despite the pandemic's onset, technology-related pitfalls like overuse, complexity, and challenges in integration continued to be problematic. Human resources, especially in relation to training and resistance to change, persisted as barriers to fully realizing the potential of digital healthcare solutions. The financial

pitfalls of digitalization became more evident with concerns about affordability, especially given the pandemic's economic impact.

Table 9: Opportunities, challenges, barriers, pitfalls for digital health care technology adoption in the pre-Covid and post-Covid era

	Pre-Covid	Post-Covid
Opportunities	Growth expectations in Technological and Administrative sectors Patient data privacy and strategic changes to handle resistance	Potential of technology Patient acceptance Budgeting, Implementation, and Rapid technology adoption
Challenges	Technology efficiency Financial challenges Administrative challenges	financial challenges Training and up-skilling
Barriers	Availability, acceptability, and affordability of digital solutions. Human element's readiness and adaptability	Technology related :overuse, complexity, and challenges in integration Human resources - resistance to training
Pitfalls	Limited support, almost negligible patient acceptance, limited	Financial -affordability of technology

	application, clinical management bias, and high costs,	

4.3 Research Question Three

The third research question was "What are the system preparedness and organizational ecosystem supporting digitalisation of health care in the pre- and post-Covid era?" This research question was linked to objective 3 which stated, "System preparedness and existing ecosystem in supporting digitalisation of health care in the pre- and post-Covid era."

For RQ 3, to explore the system preparedness and existing ecosystem in supporting digital health care, only the leadership from the health care administration of the selected hospitals were contacted. A total of 45 in leadership positions were contacted. 32 consented to participate in the study. 25 respondents submitted the completed form. Our sample size estimate was 20.

To explore the system preparedness of digitalisation of healthcare amongst hospital managements in the pre- and post-Covid era, a questionnaire with close-ended and open-ended questionnaire, described in detail in the methodology section was used. The questionnaire had 4 domains 1. Demographic details(Age, Gender, Work position, category of hospital, years of practice) 2. Digital health care technology in your organization (Type of digital health care technology, data privacy and safety) 3. Self-reported competencies and attitude towards adoption of digital health care systems (Knowledge, skill and ease of use of digital technology, ethical issues, patient safety, impact on team-based health care, impact on health equity, job satisfaction) and 4. System Preparedness and organizational support for digital health care technology adoption (Organizational preparedness, Organizational support,

Motivation, Atttiude, Challenges and Organizational ecosystem,). The results are presented in 4 sections. The findings from each section are presented descriptively and analytically.

4.3.1 Domain 1: Socio-Demographic characteristics of the participants

The socio-demographic characteristics of the participants are presented in Table 10. The statistical findings are described below. Of the total responses 44% were from female participants and 56% were male. Most of the participants (52%) were in the age group of 46-55 years of age followed by (32%) in the 36-45 years age group and 16% in 56–65-year age group. The distribution of their Health professional roles is depicted in Chart 15.

Medical Admin formed 40%. HOD's and Medical superintendent accounted for 16%. CEO is 12% and Group heads and directors formed 8%. 36% of participants had 15-20 years, while 32%% of the participants had >20 years of experience. 28% had experience of 10-15 years.

These participants were from private and public hospitals, largely from Tier 3 cities.40% belonged to large sized hospitals, 36% belonged to medium sized and the remaining belonged to small sized hospitals. A total of 48% of the hospitals were in tier 3 cities whereas in tier 2 and tier 1, 28% and 24% of the hospitals were located respectively. Also, among the hospitals 96% of them belonged to the private sector and only 4% belonged to the public sector.

Tier 1 cities such as Delhi, Mumbai, and Bengaluru are hubs for large-sized hospitals with capacities exceeding 300 beds. Interestingly, these institutions predominantly

have male professionals at the helm. Contrarily, Tier 3 cities lean towards housing smaller healthcare setups, most having fewer than 100 beds.

In terms of professional roles and expertise, individuals with a robust 10-20 years of experience majorly occupy Clinical and Medical Admin positions. Whereas leadership roles like HODs and CEO/COOs are more synonymous with hospitals in Tier 1 cities. A closer look at age group distributions reveals that while women prominently lead in the 36-45 age bracket, the 56-65 age categories often finds representation in top-tier roles like CEO and COO.

Table 10: Socio-demographic characteristics of participants

Socio-demographic characteristic	Categories	Percentage
Gender	Females	44%
	Males	56%
Age group	36-45 years	35.5%
	46-55 years	31.1%
	56-65 years	22.6%
Professional role	HOD	16%,
	CEO	12%
	Medical superintendent	16%
	Medical Admin	40%
Years of practice	>20 years	32%

	15-20 years	36%
	10-15 years	28%
Location of hospital	Tier 1	24%
	Tier 2	28%
	Tier 3	48%
Hospital category	Large sized hospital	40%
	Medium sized hospital	36%
Public & Private sector	Public Hospitals	4 %
	Private sector	96%

Chart 16: Distribution of the role of Healthcare Management professionals who

answered tool 3
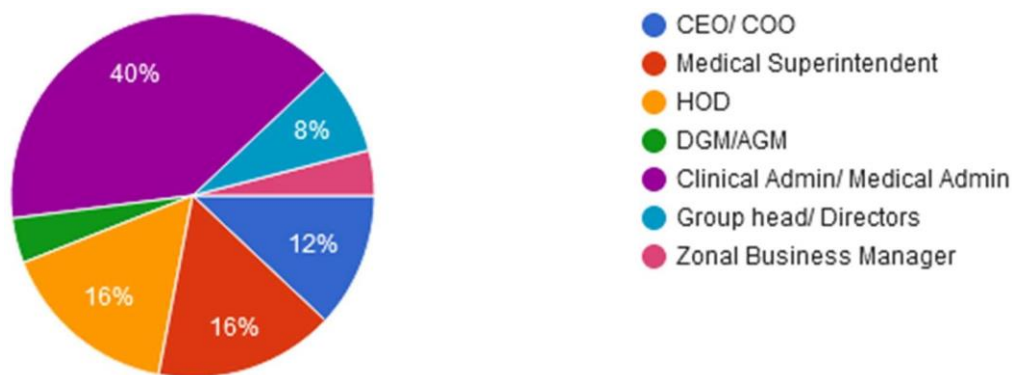
Chart 17: Distribution of the participants' years of experience in their relevant field.
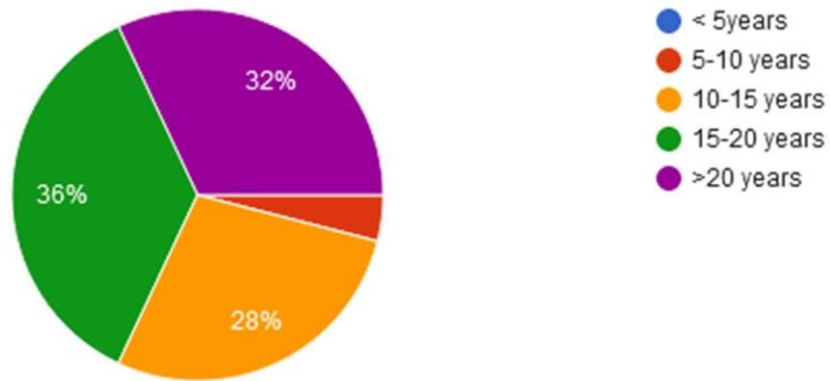
4.3.2 Section 2: Digital health care technology in your organization

There were three questions in this domain, which explored the type of digital health care facilities available in hospitals before and after Covid, and issues related to data privacy and measures available for ensuring data privacy.

When asked about the type of digital health care technologies that were adopted in your organization before and after Covid, most of the participants mentioned that the adaptation to various digitalisation methods in their workplace have increased after Covid which is portrayed in Chart17 and Table 11.

Telemedicine, virtual health care, electronic health records were widely adopted pre-Covid. Post-Covid, there has been a statistically significant increase in virtual health care, telemedicine, electronic health records, data analytics, health information exchange, health apps and wearables.

In this backdrop, it is important to understand that 84%% of participants reported the presence of data privacy policy, while 16% said no, they did not have a data privacy

policy. While we probed the type of data privacy measures in place, the most widely

reported were 'Electronic health record, 'encrypted IT' and few stated that they were

'not sure'.

Table 11: Digital health care technology adopted by organizations before and after Covid

Type of Technology	Before Covid	After Covid
Telemedicine	56%	72%
Virtual health care	54%	84%
Electronic health record	54%	86%
Health apps and wearables	4%	56%
Data analytics	0%	62%
AI	0%	38%
Interoperability	0%	38%
Health information exchange	16%	38%

Chart 18: Type of digital healthcare technologies adopted in your organization
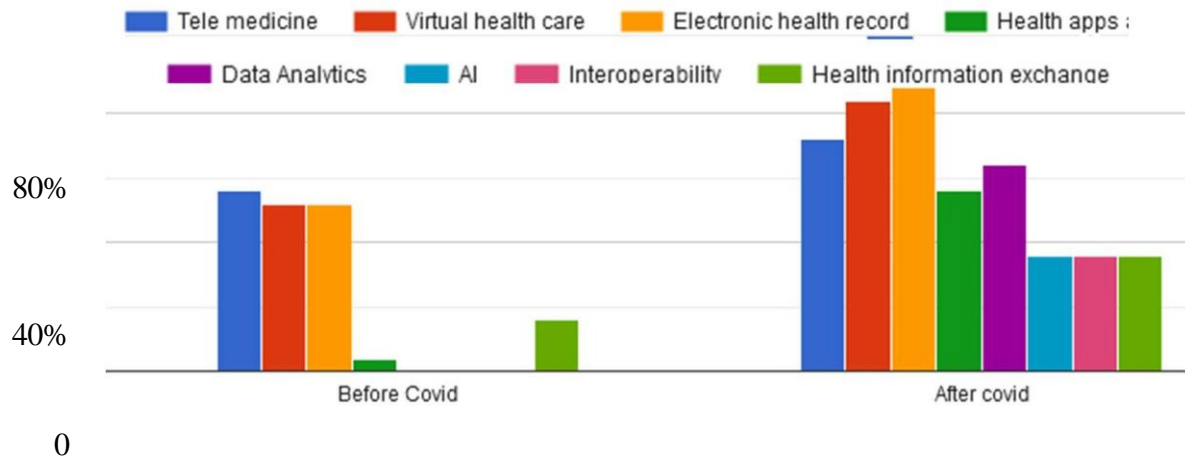
Inferential statistics:

The post-COVID era has been instrumental in accelerating the adoption of digital healthcare tools. The post-COVID era marks a watershed moment, with a surge in the adoption of tools like Telemedicine, Virtual Healthcare, and Electronic Health Records (EHRs). Such adoption isn't universal; Tier 1 city hospitals are at the forefront.

As we delve deeper into the nuances of this digital revolution, we observe a diversified approach, from health apps and wearables to the integration of data analytics.

Chart 19. Data safety measures for digital health care

Chart caption axes: Percent of Frequency (y-axis); "How is data safety maintained in your organization?" (x-axis). X categories: Data secured in a HIPA complaint HIS, EHR, EMR, Encrypted, Encrypted IT, HIS, IT, NA, On internal servers, Separate server, Software with proper fire walls, dont know.

Legend — Your hospital is: ■ Large sized (>300 beds) ■ Medium-sized (100-300 beds) ■ Small-sized (<100 beds)
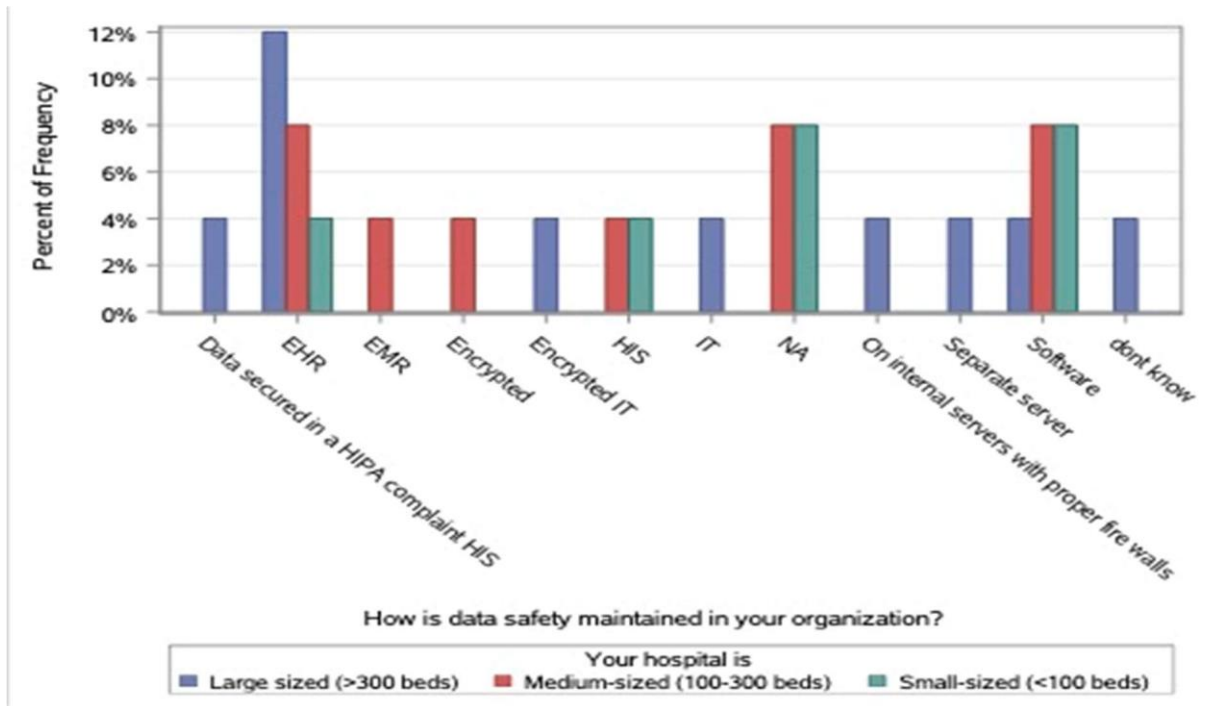
4.3.3 Section 3: Self-reported competencies towards adoption of digital health care systems

In this section we explored the self-reported competencies, and patient data privacy, in relation to digital health care systems.

4.3.3.1. Self-reported knowledge, skill, ease of use of digital technology and job satisfaction

The participants were asked to rate their knowledge, skill and ease of use of digital health care technology on a scale of 1-5, before and after Covid (with 1 being lowest and 5 being highest).Chart18 shows that the knowledge, skill and ease of use of

digital technology by the HCPs have improved tremendously after Covid as they were
motivated to adopt the technologies.

Table 12: Change in self-reported competency and job satisfaction of health care

workers.

	Before Covid	After Covid
Change in knowledge level	Level 1- 36%*	Level 1- 0%
	Level 2- 48%*	Level 2 -24%
	Level 3-4%*	Level 3-24%
	Level 4- 8%*	Level 4- 32%
	Level 5 –4%*	Level 5 -25%
Change in Skill	Level 1- 44%*	Level 1- 0%
	Level 2- 36%	Level 2 -24%
	Level 3-12%*	Level 3-24%
	Level 4- 4%*	Level 4- 24%
	Level 5 –4%*	Level 5 -28%
Change in ease of use	Level 1- 28%*	Level 1- 0%
	Level 2- 52%*	Level 2 -24%
	Level 3-12%*	Level 3-24%
	Level 4- 4%*	Level 4- 32%
	Level 5 –4%*	Level 5 -20%

4.3.3.1. 1. Descriptive statistics

The self-reported knowledge levels were rated closer to level 1 and 2 pre-Covid, while these shifted to level 3, 4 and 5 in the post-Covid era. An interesting revelation from the dataset is the statistically significant upswing in healthcare professionals' ease of use, knowledge, and skills concerning these digital tools post-COVID, as indicated by paired t-tests.

A comparative analysis clearly identified that in the post-Covid era, the percentage of participants reporting level 2 decreased significantly, while there was an increase in level 4 and 5. While there was level 1 pre-Covid, these disappeared in the post-Covid data component.

These hint at the probable increase in familiarity given the duration of use. Further research is required to explore the reasons for the increase in knowledge, skill and use in the post-Covid era. The reasons for the increase could be the increasing number of years of use, or the sudden need for digital health care during the Covid pandemic, or whether it was due to prioritization of digital health care as a policy by hospitals.

Chart 20: Self-reported knowledge, skill and ease of use of digital health care technology

Before Covid
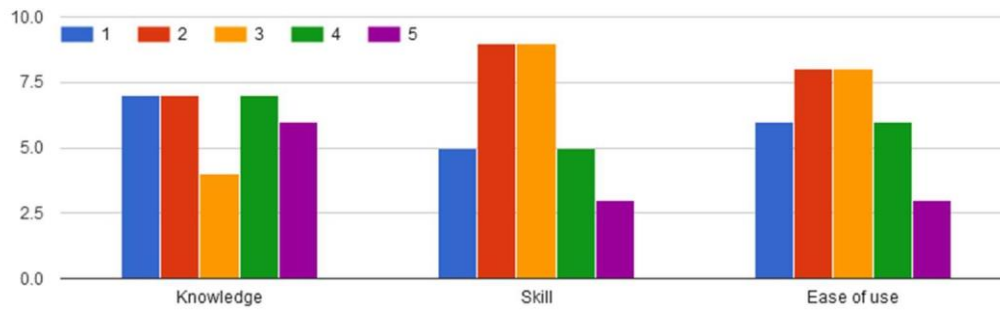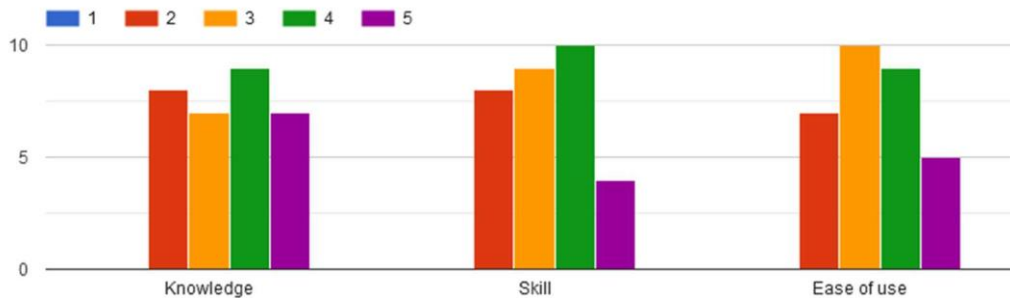
After covid

4.3.3.1.2. Inferential statistics:

Knowledge and Skills:

Self-assessed competencies in knowledge and skills before and after COVID-19 have been statistically examined. The mean difference observed was 1.52, on a scale of 0 to 4, with a standard deviation of 1.1225. The 95% confidence interval for the mean difference spanned from 1.0567 to 1.9833. Normality tests revealed that these

differences are significantly non-normal, with all p-values below the 0.005 threshold. The Q-Q plots for these variables exhibited deviations from a straight line, confirming the non-normal distribution and implying a skewed distribution or the presence of outliers.

The t-test provided a t-value of 6.77, and the p-value registered was less than 0.0001, affirming a statistically significant increase in knowledge and skills post-COVID. This is further substantiated by sign and signed rank tests, which corroborate the t-test's findings with p-values indicating high statistical significance.

Ease of Use:

The 'Ease of Use' of digital healthcare technologies has shown a parallel trend. The mean difference for 'Ease of Use' after COVID-19 stands at 1.44 with a standard deviation of 0.9609. The data does not conform to a normal distribution, as indicated by the normality tests, with the Shapiro-Wilk test recording a p-value of 0.0002. The Student's t-test for this variable resulted in a t-value of 7.49, with a p-value of less than 0.0001, again suggesting significant changes in the ease with which healthcare professionals use digital tools post-pandemic.

4.3.3.2. Patient data safety

When the participants were asked if they had **come across any ethical issues with digital health care technology**, 84% answered 'no', 8% answered 'maybe' and 8% mentioned 'yes'. The participants who answered 'yes', quoted, 'Patient confidentiality and data sharing particularly in apps.'

4.3.4 Preparedness and organizational support for digital health care technology adoption

This section presents the results with respect to organizational preparedness to transform to digital health care, organizational support, organizational ecosystem, challenges, motivation and support required.

4.3.4.1. Organizational Preparedness – before and after Covid

In the pre-Covid period, organizational preparedness was mainly through Patient data privacy protocols, Change in policy and Budgetary allocation for procurement and implementation. In the post-Covid period, in addition to budgetary allocation the shift in focus was towards training of resources and strategic approach to handle resistance to change. Patient data privacy protocols and patient compliance measures were further enhanced.

4.3.4.2. Organizational support – before and after covid

When asked about the support your organization provides for up skilling to digital health care technology, the participants mentioned improved incentives, paid time for training and organized training which increased from 20% to 60%, 32% to 72%, and 44% to 88% from pre-Covid to post Covid respectively. This is a highly significant increase and suggests the prioritization of human resource training for effective use of digital health care. However, this identifies the self-reported change and does not detail the magnitude of change in budgetary allocation for human resource development.

Chart. 21. Organizational support before and after COVID
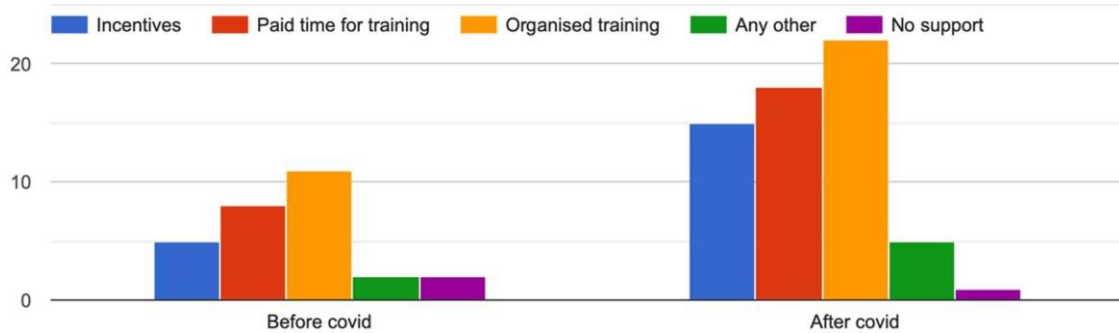
4.3.4.3. Organizational ecosystem for digital health care technology

The organizational ecosystem was explored through an open-ended question. Participants said they had clear SOPs to support, along with training, compliance reporting, budgetary monitoring, adoption of new technology and collaborative initiatives. While organizations variably adopted this, it was evident that more than one ecosystem existed to support digital health care transformation.

4.3.4.4. Organizational support – Challenges

In the Pre-Covid era, the challenges were mainly related to technology, human resource and patient related aspects. While in the post-Covid -financial, administrative, human resource, patient-related and technology were reported. While these challenges were identified, there needs to be a deeper exploration of what were the specifics of the challenge.

4.3.4.5. Preparedness for digital health care adoption -Motivation

When asked to **rate their motivation towards digital health care technology pre and post Covid,** the participants have rated high levels of motivation post Covid.

Chart 22: Change in job motivation levels in management personnel pre & post Covid
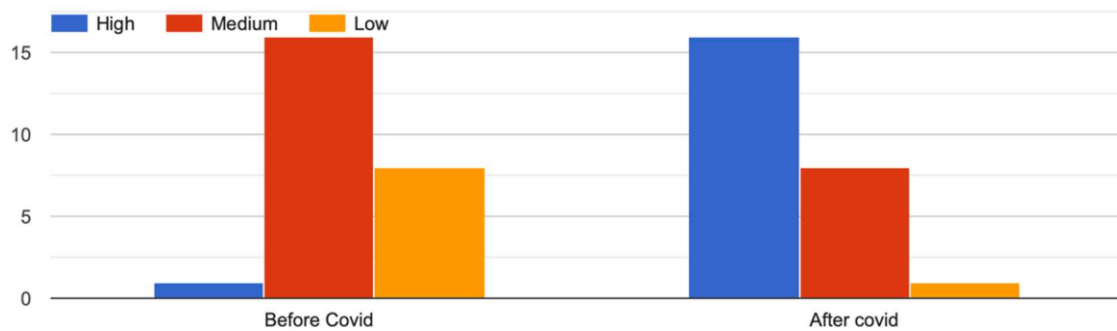
4.3.4.6.   Organizational support – What do the administrators want?

When asked **what support you need to enhance digital health care technology** adoption which was an open-ended question, the following themes were generated.

Theme	Subtheme	Quotation
Theme -Support for enhancing digital health care adoption	Budget	"Financial support from management, vendor should be able to train and fix bugs, compliance from

		the team, learning newer technology from self"
	Technology	"Higher personalization and easy to implement tech like voice to text"
	Training	"Repeatedly doing training and following up"
	Collaboration	"Top to bottom collaboration approach"
	Administrative	"Experienced staff"

4.4 Summary of Findings

The results to the three research questions have clearly demonstrated the increase in digital health care technology adoption in the post-covid period. The knowledge skills and ease of use of digital health care technology has definitely seen an upward trend with both health care workers and health care administrators.

The health care personnel report higher levels of motivation and job satisfaction in the post-covid era. However they face challenges with digital health care technology adoption, need for enhanced training and support with patient compliance.

Majority of the respondents agree that patient data privacy is a key concern. Howwever, the individual respondents are not clear on the measures adopted for patient data safety management, which has to be addressed in earnest.

4.5 Conclusion

While technology adoption rises, so does the emphasis on training. Post-pandemic, the focus isn't just on using technology but managing it holistically. Up skilling is a priority with organizations actively nurturing their human resources. Alongside, the establishment of support mechanisms like standardized procedures, collaborations with tech vendors, and a push towards user-friendly technologies ensures a smoother transition.

But, with digital transformation come challenges. Post-COVID, the industry grapples with administrative, financial, and human resource challenges. Yet, the spotlight remains firmly on patients – ensuring their seamless adaptability to new digital tools

CHAPTER V:

DISCUSSION

5.1 Discussion of Results

The COVID-19 pandemic favored the rapid adoption of digital solutions and advanced technology tools in health care. The implementation of digital solutions is also happening with unprecedented speed and impact. The digital technology also helped in reducing the workload and enabled patients to receive early diagnoses and timely treatments (Golinelli*et al.*, 2020). There was tsunami of changes in digitalisation that occurred in healthcare post Covid especially in the Indian scenario. Hence this study was done to understand these changes and to know how the healthcare professionals, management and the system are riding parallel with these changes. The results will be discussed as per our research questions.

5.2 Discussion of Research Question One

The first research question was "What is the current competency and preparedness of health care professionals in transitioning to digital health care systems in the pre- and post-Covid period?" We had 151 participants responding which was above the sample size estimation of 145. The participants were fairly equally distributed across different health care worker domains, across large, medium and small sized hospitals, located in tier 1, 2 and 3 cities. Here we discuss our findings with respect to the three domains- Self perceived competency, impact of digitalisation on patient health care and organizational preparedness.

5.2.1 Self perceived competency of the Healthcare professionals:

According to our findings, we found that there was no significant difference in opinion between the respondents from the three different categories of hospitals or between the gender but a statistically significant difference among the respondents based on the years of experience and health care role was found. The results of the study suggest that HCPs who are higher in the career ladder and have more work experience are more open to digitalization in their field. These findings were similar to a study done by (Jarva*et al.*, 2022)which aimed to provide insight into healthcare professionals' lived experiences of digital health competence. In their study, some participants perceived that they had sufficient digital health competence, while others stressed that they should improve their digital health competence, some of the participants reported that they have insecurities about their competence and their competence needs further development and some participants identified specific areas that need improvement (Jarva *et al.*, 2022).

According to our study, only the senior HCPs and doctors knew the organization's procedures and protocols for data security. The nursing professionals and other category HCPs were unaware of such safety protocols. It was disappointing to find that they did not place high priority on patients' data safety. A general understanding of the challenges and highlights of digitalization of healthcare should be offered to all executives of HCPs before an in-depth training. This will strengthen their positive approach and remove the insecurities on the technological evolution in healthcare.

Researchers have found that healthcare professionals accept digitalization when it is perceived as a way to improve patient care and support workflow processes, while negative attitudes and experiences, coupled with a lack of competence, lead to frustration and resistance to adopting new technologies.(Konttila *et al*, 2019).

Using our study as an example, we could say that HCPs' knowledge, skill set, and ease of use of digital technology significantly improved following Covid. Perhaps this is due to the fact that digital methods and technology were the only means of communication and patient care during the pandemic which forced all the hierarchy of healthcare professionals to learn and adapt to the changing times. Having realized the benefits of digitalization, healthcare providers have made it the norm for a variety of procedures in the industry. Similar studies done on evaluating the skills on digitalisation on nurses post Covid reveals that remote management of COVID-19 or chronic patients during the pandemic, a role that has proved to be fundamental is the community and health care systems adopted novel assistance models to support patients at home and to enable decentralization of services from hospitals to the territory (Isidori *et al.*, 2022).

Among other similar studies, the area most investigated to date is self-rated competencies. In particular, this area includes among the others, competencies aimed at solving patients' health or care plan issues. This suggests that the concept of digitalisation is of interest among the scientific community and is focused in

investigating these competencies from heterogeneous perspectives (Longhini, Rossettini and Palese, 2022).

Our study findings on the impact of digitalisation in teamwork and collaboration revealed ambiguous responses. Some of the HCPs reckoned that technology has made team meetings, undemanding and effortless which were easily missed earlier because of time constraints and laboriousness of physical presence. Webinars, Zoom meetings, WhatsApp and Facetime has resolved more complications and provided solutions during the crunch of the pandemic. Although a few HCPs considered the lack of physical presence of the team members has made the meetings mechanical and boring. They perceived the inability to conclude and make uniform agreements in team discussions. This notion was mainly seen in the HCPs from the lower hierarchy and senior people who were attuned to the traditional methods of learning, which can be easily rectified with an in-depth training in the usage of the digital devices and technologies to their benefit. Similar studies done in this regard concur with the results of our study (Jarva *et al.*, 2022) (Longhini, Rossettini and Palese, 2022).

5.2.2 Impact of digitalisation on Patients' care – HCPs standpoint

Our study findings reveal that a worthy percentage of HCPs understand that confidentiality of patients' data is imperative. The fact that they would serve as role models in instructing their peers and subordinates in ethical data handling is a welcome sign. There is a small percentage of HCPs who think confidentiality of

patients' data is not an issue when it comes to cybercrimes. A basic training session on cybercrimes and penalties would provide them with a basic knowledge of the subject. Training sessions such as these will benefit HCPs generally, who will gain the ability to look at cyber bullying and cybercrime from a wider perspective.

From our study participants we are able to understand that post Covid accessibility to healthcare has increased manifold because of digitalisation. Patients who were scared of Covid spread, vulnerable population like children, senior citizens and patients with chronic illnesses, all had access to healthcare from the comfort of their own territory through teleconsultations, apps specifically developed for Covid related awareness, telemonitoring and much more. This was an invaluable resource during such a critical time of a pandemic. However, certain sections of society, such as those below the poverty line, with lower income, technologically illiterate, etc., have not been able to access healthcare through digital means. However digital revolution cannot be blamed for this. HCPs have cited lack of budgetary allowance and lack of infrastructure to be the prime reasons.

However, when it comes to affordability, all HCPs agree that the digital revolution did not affect the affordability of healthcare for patients. The Government spending on health in India is only about 1.5% of GDP. India's health sector is characterized by low government expenditure on health, high out of pocket expenditure and low financial protection from adverse health events. The majority of the Indian population

seeks care from the private sector, with two-thirds of the total health expenditure being out-of-pocket (Rajalakshmi *et al.*, 2023).The relative size of out-of-pocket spending has a huge impact on financial risk protection and access to care (Prinja *et al.*, 2017).In the wake of the surprise pandemic, insurance companies did not add digital means of healthcare to their insurance plans.

Since budget allocation is done separately for technology, the cost of healthcare had increased or remained the same post Covid.

5.2.3 Organizational support requisites

The process of making the digital revolution the new normal involves a shift in mindset and behavior. HCPs have wholeheartedly accepted the "new normal" and are eager to delve into the intricacies of digitalizing healthcare. They are prepared to enhance their skills and adopt the latest digital tools and equipment that have effectively streamlined their responsibilities .In order to assist with this, the HCPs are requesting the management for comprehensive training sessions that cover essential topics such as acquiring knowledge on emerging technologies, adapting to advancements, engaging in digital communication with patients, and effectively educating patients on the latest practices.

In order to eliminate any potential inconsistencies, it is essential to implement a standardized training program for all healthcare professionals. This module will provide a comprehensive understanding of the terminologies associated with

digitalization, ensuring that every individual is well-informed and equipped with the necessary knowledge. By doing so, we can guarantee a seamless transition towards a digitally-driven healthcare system. Creating a system for regular feedback sharing with the team is also crucial to foster improved collaboration and overcome any challenges that may arise.

Based on our research, it can be inferred that the HCPs need additional funding from the management, specifically for acquiring the necessary digital equipment and training in new technologies to ensure global standardization. Furthermore, the inclusion of proficient personnel familiar with these technologies will simplify and streamline the overall healthcare process.

5.3 Discussion of Research Question Two

In this section we discuss the findings related to the second research question "What are the opportunities, challenges, barriers, and pitfalls in digitalisation of health care amongst hospital management?" A total of 64 participants, who were from the hospital administration, participated in the study. Here we discuss the findings with respect to competencies, opportunities, challenges, pitfalls and organizational support.

5.3.1 Competency in Digitalisation among Management personnel

Our study results reveal that the types of digitalisation methods adopted in hospitals tremendously increased post Covid. During the upgrade of older technologies, the introduction of newer digital equipment and technologies was a universal occurrence. Numerous developing nations utilized these advancements to successfully overcome the challenges posed by Covid, serving as inspiration for other countries. The period was marked by a surge of groundbreaking innovations worldwide. Our study participants confirmed the marked increase in the usage of health apps and wearable devices and data analytics post Covid whereas electronic health records and telemedicine was used the most pre and post Covid.

In 2021, Chandra et al conducted a comprehensive study that delves into the intricacies of digital technologies and Industry 4.0 tools/techniques. This fourth industrial revolution involves integrating advanced manufacturing and production systems with digital technologies. The study highlights various innovative tools such

as 3D Printing, Artificial Intelligence, Cloud Computing, Autonomous Robots, Biosensors, Telemedicine services, Internet of Things (IoT), Virtual Reality, and holography. These technologies present unique opportunities for enhancing healthcare delivery, enabling online education, and fostering a productive Work from Home (WFH) environment. The implementation of these measures aimed at combating COVID-19 provided both developing and developed nations with a chance to establish a comprehensive healthcare system that can be utilized during and after the pandemic(Chandra *et al.*, 2022).

In our research, we observed a lack of significant change in the participants' self-ratings of knowledge, skill, and ease of use regarding digital technologies before and after the Covid pandemic. Despite some improvement in the post-Covid ratings, the assessments of skills and ease of use remained largely unchanged. This lack of change could be attributed to limited budget allocation and a shortage of personnel with adequate digital skills during the pandemic. Additionally, the belief that only healthcare professionals need to be knowledgeable about technological advancements, while administrative personnel do not, may have played a role. However, it is crucial for all healthcare personnel to be aware of digital technologies in order to facilitate system-wide improvements. By motivating healthcare professionals to embrace these technologies, their implementation can be made more seamless.

It is evident from our research findings that only families with higher incomes were able to access healthcare during the pandemic. Despite the presence of digital technologies, affordability remained a significant challenge. While some participants believed that technological advancements could improve access to healthcare in remote areas, they acknowledged that vulnerable populations were unable to benefit. This situation is not unique to the pandemic; even before Covid, healthcare expenses were primarily paid out of pocket in developing countries like India. Public healthcare infrastructure is often unable to address this issue due to limited funding and manpower. As a result, the average person is compelled to rely on private healthcare services.

5.3.2 Opportunities, Challenges, Barriers, and Pitfalls

The results of our study demonstrate that the hospital management's struggles with digitalization and technology significantly decreased after the Covid pandemic. Prior to the pandemic, these challenges were prevalent and widespread. However, this shift can be attributed to several factors, such as a dedicated allocation of funds, an increase in skilled personnel, and comprehensive training sessions that were seamlessly conducted during the crisis. The urgency imposed by the pandemic compelled the management to swiftly make crucial decisions and implement them, whereas these matters were previously limited to mere discussions. Consequently, the timely execution of appropriate actions has resulted in the creation of a more favorable working environment.

Researchers have made similar recommendations that align with our findings. In addition they also propose that policymakers and funding organizations should consider integrating evaluations of scalability and the effects on key aspects of healthcare performance, such as the quality of medical care, patient care, efficiency, and fairness, when exploring technological advancements (Habran, Saulpic and Zarlowski, 2018).

The Technological and Administrative sectors showed signs of anticipating growth, indicating their belief in the potential of technology to address healthcare challenges. The importance of patient data privacy and the need for strategic adjustments to overcome resistance were emphasized, highlighting a proactive approach to the digital transformation of healthcare.

The healthcare sector is grappling with an enormous and swiftly expanding volume of data, which must be gathered, processed, stored, and shared securely among various stakeholders both within the country and globally. There is evidence supporting conclusions that Cloud computing offers an ideal solution for efficiently utilizing and disseminating vast quantities of healthcare data to stakeholders such as healthcare professionals, hospitals, pharmaceutical benefit programs, medical research facilities, and national vaccination data centers. By integrating cloud computing with Internet of Things (IoT) technology, Artificial Intelligence (AI), and Machine Learning (ML), individuals will have complete authority over their health data, ensuring its security and protecting against misuse(Chandra *et al.*, 2022).

The presence of Human Resource obstacles was consistently emphasized as impediments, both separately and in connection to other difficulties. This suggests that while the process of digital transformation was in progress, the preparedness and flexibility of the human factor towards these modifications continued to be a source of worry. Notable obstacles encompassed the accessibility, approval, and cost-effectiveness of digital remedies.

5.3.3 Organizational support requirement

When examining the specific forms of support that management personnel request from the organization, it becomes clear that they seek the following:

- Integration of digital platforms to prevent redundant tasks,

- Involvement of end users in software finalization,

- Enhancements in user-friendliness and customization options,

- Training on current policies and regular refresher courses,

- Implementation of standard protocols across all levels of healthcare establishments, from primary to quaternary care.

These elements alone could lay the foundation for a thriving digital transformation of any organization's healthcare system.

5.4 Discussion of Research Question Three:

In this section, we discuss the findings from the results of third research question "What are the system preparedness and organizational ecosystem supporting digitalisation of health care in the pre- and post-Covid era?" A total of senior administrators participated in the study. We discuss the findings with respect to significance of the system and its preparedness in transforming to digital health care. The organization ecosystem and the support required are presented in this section.

5.4.1 Competency in digitalisation – The System's actuality

The backbone of any organization, known as the System, should be the first to adapt to change, which then cascades to the management and employees. Our research reveals that the healthcare system responded swiftly to the evolving pandemic. A significant portion of the budget was allocated, skilled personnel were hired, technology was upgraded, connections were established with higher authorities, and training sessions were conducted for healthcare providers and management staff. Most importantly, patient comfort during these changing times was prioritized. However, the forceful introduction of digitalization posed a challenge for some to embrace it seamlessly.

Mayo Clinic's 2019 study revealed a link between physician burnout and poor Electronic Health Record (EHR) usability. The findings suggest that enhancing EHR usability could alleviate physician burnout. This case underscores the importance of

involving clinicians in the design process, as it leads to the development of user-friendly tools that align with their work. By reducing the burden of documentation and other obligations, these tools better equip healthcare professionals to provide optimal care for their patients (jrowe, 2020).

An initiative by the National Health Authority of India in lines with the digitalization of healthcare is The Ayushman Bharat Digital Mission (ABDM) which aims to develop the backbone necessary to support the integrated digital health infrastructure of the country. It will bridge the existing gap amongst different stakeholders of Healthcare ecosystem through digital highways. On September 27, 2021, the Ayushman Bharat Digital Mission was launched aiming to enhance the accessibility and fairness of healthcare services. This mission will utilize IT and its associated technologies to assist existing health systems, prioritizing the needs of citizens. ABDM aspires to establish a digital health ecosystem that promotes universal health coverage in a manner that is efficient, accessible, inclusive, affordable, timely, and secure. By doing so, it is anticipated that the mission will enhance the efficiency, effectiveness, and transparency of healthcare services. Additionally, individuals will have the option to choose between public and private healthcare services, while healthcare professionals will benefit from improved access to patients' medical histories, enabling them to provide better care (*NHA | Official website Ayushman Bharat Digital Mission*).

5.4.2 Support from the System – the Benefactor's standpoint

As technology becomes more widely used, the importance of training also increases. In the post-pandemic world, the focus is not only on using technology, but also on managing it in a comprehensive way. Developing new skills is a top priority for organizations, as they actively support their employees. Additionally, they establish systems of assistance, such as standardized procedures, partnerships with technology vendors, and a push for user-friendly technologies, to ensure a smoother transition. However, along with the benefits of digital transformation, there are also challenges. In the post-COVID era, industries face difficulties in administration, finance, and human resources. Nevertheless, the main focus remains on the patients, making sure they can seamlessly adapt to the new digital tools.

Some recommendations from various researchers for making digitalisation in healthcare unexacting and to challenge the established beliefs of our healthcare professionals, we must prioritize the following actions:

- Utilizing measurable indicators to guide the management decisions.
- Providing consistent feedback to the teams.
- Regularly monitoring the projects in the field
- Listening to the needs and perspectives of both internal and external customers
- Ensuring that all the professionals receive comprehensive training.
- Equipping them with all the necessary tools

- Streamlining both clinical and administrative processes

- Promoting the sharing of indicators, expected outcomes, and implementation goals.

- Exploring the potential health benefits that these tools can offer.

To embrace the possibilities that lie ahead and capitalize on the positive transformations brought about by Covid, we must acknowledge and capitalize on several key lessons and opportunities, which should not be squandered. These include the need to foster a culture of intelligent healthcare and web-based solutions, particularly through the widespread adoption of tele-consultation and videoconferencing. Additionally, it is crucial to recognize that technology has made more progress in the initial three to four weeks of lockdown than it has in the past decade. Furthermore, we must acknowledge the benefits of prioritizing healthcare at both national and global levels, viewing it as a strategic imperative and a catalyst for economic recovery during this era of digital transition(Rowe, 2020)(Reddy and Sharma, 2016)(Ricciardi *et al.*, 2019)(Mihailescu and Mihailescu, 2018).

CHAPTER VI:

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

6.1 Summary

The results to the three research questions have clearly demonstrated the increase in digital health care technology adoption in the post-covid period. Health care organizations have adopted electronic health records, virtual health care and telemedicine widely post-Covid. *There has been statistically significant increases data analytics, health apps and wearables post-Covid.*

The knowledge skills and ease of use of digital health care technology has definitely seen an upward trend with both health care workers and health care administrators. A comparative analysis clearly identified that in the post-Covid era, the percentage of participants reporting their knowledge, skills, ease of use and motivation at level 2 decreased significantly, while there was an increase in level 4 and 5.

The analysis of open-ended questions identified four key themes Theme 1: Impact of digital health care technology on patient interaction, where the sub-themes which emerged were that digital health care technology has been a breakthrough and digital health care made progress. However, the key issue has been identified was that digital health care has poorly impacted patient interaction and there are ethical issues related to patient data safety.63% of participants reported that they personally had no idea and believed the IT team to be aware of data privacy issues.

There was a mixed opinion with respect to Theme 2: Impact of digital health care technology on patient safety, pre- and post-Covid, participants had a mixed opinion

with respect to improving or compromising patient safety, theme 3: Impact of digital health care technology on team-based health care and Theme 4: Impact of digital health care on health equity.

The health care workers reported that the Organizational support was in terms of basic training, incentives and paid working hours. Participants reported facing challenges with 'Data privacy', 'limited resources' 'Less human touch' and 'limited training'. Participants expressed that they needed 'In-depth and frequent training', 'Budget and 'manpower allocation', 'Active monitoring and awareness' for improving their digital health care delivery competence.

Opportunities for digital health care technology have improved in terms of the Potential of the technology, patient acceptance and budgeting. But the challenges and pitfalls are with overuse, complexity, and challenges in technology integration. The training of human resources and resistance to change is another key area of concern. Financial aspects related to affordability of technology influences the extent of adoption across different sectors of hospitals.

6.2 Implications

It is clear that there has been an increased uptake of digital health care facilities. They key concerns raised are with patient safety and data safety. While organizations have improved their training, health care workers have asked for in-depth training and increased budgetary allocation. To enhance patient safety and data safety, the digital health care ecosystem needs to be transparent regarding the policies and protocols. Health care workers should be trained in this priority area of focus.

6.3 Recommendations for Future Research

Further research is required to explore the reasons for the increase in knowledge, skill and use in the post-Covid era. We hypothesize that the probable reasons for the increase could be the increasing number of years of use, or the sudden need for digital health care during the Covid pandemic, or whether it was due to prioritization of digital health care as a policy by hospitals.

This research has highlighted aspects related to opportunities, challenges, barriers and organizational eco system. The specifics of these factors influencing the organizational adoption of digital health care technology need to explore in detail to determine the enabling and inhibitory factors.

The third focus area of research we recommend is with respect to the nuances of human resource development. Research is required to understand the priority focus areas of training, change management, organizational support etc.

The fourth key area of research is to understand issues related to patient safety and data safety. This research has identified that this was a key area of concern. Further research is required to understand the specifics of the issue and ways to mitigate these challenges.

6.4 Conclusion

While technology adoption rises, so does the emphasis on training. Post-pandemic, the focus isn't just on using technology but managing it holistically. Up skilling is a priority with organizations actively nurturing their human resources. Alongside, the

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establishment of support mechanisms like standardized procedures, collaborations with tech vendors, and a push towards user-friendly technologies ensures a smoother transition.

But, with digital transformation come challenges. Post-COVID, the industry grapples with administrative, financial, and human resource challenges. Yet, the spotlight remains firmly on patients – ensuring their seamless adaptability to new digital tools.

<div align="center">**APPENDIX A**</div>

<div align="center">**SURVEY COVER LETTER**</div>

Dear Participant,

You are being invited to participate in a research study titled "The tsunami of digitalisation of health care in the pre-Covid and post -Covid era and its impact on the Indian health care industry – situation analysis."

This study aims to explore the impact of digitalization in the healthcare sector, specifically focusing on the changes that have occurred before and after the COVID-19 pandemic. Your participation in this study will contribute to a better understanding of the role of digital technologies in healthcare delivery.

As a key stakeholder in the health care delivery system, your inputs will be valuable to understand the state and future directions of digital health care technology adoption in the Indian context.

We look forward to hearing from you on participating in this research.

Please contact me on the email id and phone number given below.

Yours sincerely

Jyoti Rao

INFORMED CONSENT

Consent Form for the Research Study on "The tsunami of digitalisation of health care in the pre-Covid and post -Covid era and its impact on the Indian health care industry – situation analysis"

[Researcher's Name/Organization]

[Contact Information]

[Date]

Dear Participant,

You are being invited to participate in a research study titled "The tsunami of digitalisation of health care in the pre-Covid and post -Covid era and its impact on the Indian health care industry – situation analysis."

This study aims to explore the impact of digitalization in the healthcare sector, specifically focusing on the changes that have occurred before and after the COVID-19 pandemic. Your participation in this study will contribute to a better understanding of the role of digital technologies in healthcare delivery.

Please take the time to read this consent form carefully before deciding whether to participate in the study. If you have any questions or concerns, you may contact the researcher using the contact information provided above.

Purpose of the Study: The purpose of this study is to investigate the changes brought about by digitalization in the healthcare sector, both before and after the COVID-19

pandemic. By collecting data on various aspects of digital technologies, such as telemedicine, remote patient monitoring, and digital health records, the study aims to identify the benefits, challenges, and potential future developments in this field. The information gathered from this research will contribute to informing healthcare policies, improving healthcare services, and enhancing patient experiences.

Procedures: If you agree to participate in this study, you will be asked to:

1.   Provide demographic information (such as age, gender, and occupation).

2.   Answer a series of questions related to your experiences and opinions regarding digitalization in healthcare.

3.   Share any relevant personal experiences, if applicable.

Risks and Benefits: There are minimal risks associated with participating in this study. Some questions may touch upon personal experiences or opinions, which may cause mild discomfort. However, you are not obligated to answer any questions that make you feel uncomfortable, and you have the right to withdraw from the study at any time without penalty.

By participating in this study, you may benefit from a greater understanding of the role of digitalization in healthcare. Additionally, your input may contribute to improving healthcare services and inform future developments in digital healthcare technologies.

Confidentiality: Your privacy and confidentiality will be strictly protected throughout the study. Any information collected during this research will be treated as strictly confidential and stored securely. Your responses will be anonymized and aggregated when reporting the findings, ensuring that your identity is not disclosed.

The data collected in this study will be used solely for research purposes and will not be shared with any third parties without your explicit consent.

Voluntary Participation and Withdrawal: Participation in this study is entirely voluntary. You have the right to withdraw your consent and discontinue participation at any time, without providing a reason, and without any negative consequences or penalty. You may also choose not to answer specific questions if you are uncomfortable doing so. Your decision to participate or withdraw will in no way affect your current or future relationships with the researcher or the institution involved.

Contact Information: If you have any questions, concerns, or would like additional information about the study, you can contact the researcher, [Researcher's Name], at [Contact Information].

By signing this consent form, you confirm that you have read and understood the information provided above, and you voluntarily agree to participate in the research study on the role of digitalization in healthcare pre and post COVID-19.

_____

[Participant's Name]

[Participant's Signature]

[Date]

Please keep a copy of this consent form for your records.

Thank you for your participation! Your contribution to this research study is greatly appreciated.

[Researcher's Name/Organization]

APPENDIX C
INTERVIEW GUIDE

QUESTIONNAIRE FOR RQ 1

Research Title:

The tsunami of digitalisation of health care in the pre-Covid and post -Covid era and

its impact on the Indian health care industry – situation analysis

Research team: Jyoti Rao,

Questionnaire for identifying the current competencies and preparedness of health

care professionals in transitioning to digital health care systems in the pre and post-

Covid period of HCPs towards digital health care systems

Section 1- Demographic details of HCPs

1. Age
2. Gender
3. You are a
    a. Doctor /Consultant
    b. Nursing Director/ CNO
    c. Nursing Supervisor/ Manager
    d. ICN/ Quality control/ Staff Nurses
    e. Manager/ Sr. Technician (OT/ CSSD/ Lab/ Diagnostic)
4. Years of practice:
    a. < 5years
    b. 5-10 years
    c. 10-15 years
    d. 15-20 years
    e. >20 years
5. Your hospital is

    a. Large sized (>300 beds)

    b. Medium-sized (100-300 beds)

    c. Small-sized (<100 beds)

6. Your hospital is located in

    a. Tier 1 city

    b. Tier 2 city

7. Your hospital is

    a. Public

    b. Private

Section 2: Digital health care technology in your organization (Tele medicine, Virtual health care, Electronic health record, Health apps and wearable device, Data Analytics, AI, Interoperability, Health information exchange)

1. What digital health care technologies were/are adopted in your organization?

a. Before Covid

b. After Covid

2. Does your organization have a policy towards data privacy with respect to digital health care systems?

Yes

No

Don't know

3. How is data safety maintained in your organization?

Section 3: Self-reported competencies towards adoption of digital health care systems

1. Rate your knowledge in digital health care technology

    a. Before Covid – 1 2 3 4 5 6 7 8 9 10

    b. After Covid -1 2 3 4 5 6 7 8 9 10

2. Rate your skills in handling digital health care technology

a. Before Covid – 1 2 3 4 5 6 7 8 9 10
b. After Covid -1 2 3 4 5 6 7 8 9 10

3. On a scale of 1 to 10, please rate how easy it is for you to use digital health care technology

    a. Before Covid – 1 2 3 4 5 6 7 8 9 10

    b. After Covid -1 2 3 4 5 6 7 8 9 10

4. How has digital healthcare technology impacted your patient interaction?

    a. Before Covid

    b. After Covid

5. Have you come across any ethical issues with digital health care technology?

    Yes   No

    If yes, can you please specify

6. How has digital health care technology impacted patient safety?

    a. Before Covid

    b. After Covid

7. How has digital health care impacted team-based health care? (Collaboration, communication, efficiency of care)

    a. Before Covid

    b. After Covid

8. How has digital health care impacted health equity (access to care, affordability and availability of care to vulnerable sections of society)?

   9. On a scale of 1 to 10, please rate your job satisfaction because of digital health care technology

       a. Before Covid – 1 2 3 4 5 6 7 8 9 10

       b. After Covid -1 2 3 4 5 6 7 8 9 10

Section 4: Preparedness and organizational support for digital health care technology adoption

1. How were your prepared for adopting digital health care technology?

a. Before Covid
b. After Covid

2. What support did your organization provide for up-skilling to digital health care technology?
a. Incentives
b. Paid time for training
c. Organized training
d. Any other
e. No support

3. Rate your motivation towards digital health care technology
a. Before Covid
b. After Covid

4. Do you believe that digital health care technology improves patient care and safety
a. Yes
b. No

5. What are the challenges you face with digital health care technology?

6. What support do you need to enhance your competence in using digital health care technology?
a. From the organization
b. From the vendor
c. From your team
d. From your self

QUESTIONNAIRE FOR RQ 2

Research Title:

The tsunami of digitalization of health care in the pre-Covid and post -Covid era and its impact on the Indian healthcare industry – situation analysis

Research team: Jyoti Rao

Research question 2: What are the opportunities, challenges, barriers, and pitfalls in digitalization of health care amongst hospital management?

Section 1- Demographic details of Management Personnel
1. Age
2. Gender
3. You are a
a. CEO/ COO
b. Medical Superintendent
c. HOD
d. DGM/AGM
e. Clinical Admin/ Medical Admin
4. Years of practice:
a. < 5years
b. 5-10 years
c. 10-15 years
d. 15-20 years
e. >20 years
5. Your hospital is

a. Large sized (>300 beds)

b. Medium sized (100-300 beds)

c. Small sized (<100 beds)

6. Your hospital is located in

a. Tier 1 city

b. Tier 2 city

7. Your hospital is

a. Public

b. Private

Section 2: Digital health care technology in your organization (Tele medicine, Virtual health care, Electronic health record, Health apps and wearable device, Data Analytics, AI, Interoperability, Health information exchange)

1. What digital health care technologies were/are adopted in your organization?

a. Before Covid

b. After Covid

2. Does your organization have a policy towards data privacy with respect to digital health care systems?

Yes

No

Don't know

3. How is data safety maintained in your organization?

care systems

9. Rate your knowledge in digital health care technology

   a. Before Covid – 1 2 3 4 5 6 7 8 9 10

   b. After Covid -1 2 3 4 5 6 7 8 9 10

10. Rate your skills in managing digital health care technology

   a. Before Covid – 1 2 3 4 5 6 7 8 9 10

   b. After Covid -1 2 3 4 5 6 7 8 9 10

3. Do you believe that digital health care technology improves patient care and safety

   a. Yes

   b. No

Section 4: Preparedness and organizational support for digital health care technology

adoption

1. What opportunities opened up with digital health care technology in for you?

   a. Before Covid

   b. After Covid

   i. Technology related

   ii. Administrative

   iii. Financial

   iv. Human resource related

   v. Patient related

2. How did your organization prepare for digital health care technology?

    a. Before Covid

    b. After Covid

   i.   Change in policy

  ii.   Budgetary allocation – for procurement and implementation

 iii.   Training of human resource

 iv.   Strategic approach to handle resistance to change

  v.   Patient data privacy protocols

 vi.   Patient compliance measures

3. How did your organization provide support for up-skilling to digital health care technology?

    a. Before Covid

    b. After Covid

         i.   Incentives

        ii.   Paid time for training

       iii.   Organized training

       iv.   Any other

        v.   No support

4. What challenges did you face in administering digital healthcare technology?

    a. Before Covid

    b. After Covid

i. Technology related

ii. Administrative

iii. Financial

iv. Human resource related

v. Patient related

5. What are the barriers towards implementing digital healthcare technology?

    a. Before Covid

    b. After Covid

    a. Technology related

    b. Administrative

    c. Financial

    d. Human resource related

    e. Patient related

6. In your opinion, what are the pitfalls of digital health care technology?

    a. Technology related

    b. Administrative

    c. Financial

    d. Human resource related

    e. Patient related

7. What support do you need to enhance your competence in using digital healthcare

technology?

a. From the organization

b. From the vendor

c. From your team

d. From your self

QUESTIONNAIRE FOR RQ 3

Research Title:
The tsunami of digitalization of health care in the pre-Covid and post -Covid era and its impact on the Indian healthcare industry – situation analysis
Research team: Jyoti Rao

Research question 3: What is the system preparedness and organizational ecosystem supporting the digitalisation of health care in the pre and post-Covid era?

Section 1- Demographic details of Management Personnel

1. Age
 	
2. Gender
 	
3. You are a
 	
    CEO/ COO
 	
    Medical Superintendent
 	
    HOD
 	
    DGM/AGM
 	
    Clinical Admin/ Medical Admin
 	
4. Years of practice:
 	
    f.   < 5years
 	
    g. 5-10 years
 	
    h. 10-15 years
 	
    i.   15-20 years
 	
    j.   >20 years

5. Your hospital is

    d. Large sized (>300 beds)

    e. Medium sized (100-300 beds)

    f. Small sized (<100 beds)

6. Your hospital is located in

    c. Tier 1 city

    d. Tier 2 city

7. Your hospital is

    c. Public

    d. Private

Section 2: Digital health care technology in your organization (Tele medicine, Virtual health care, Electronic health record, Health apps and wearable device, Data Analytics, AI, Interoperability, Health information exchange)

1. What digital health care technologies were/are adopted in your organization?

a. Before Covid

b. After Covid

2. Does your organization have a policy towards data privacy with respect to digital health care systems?

a. Before Covid

b. After Covid

Yes

No
Don't know
3. How is data safety maintained in your organization?
a. Before Covid
b. After Covid
Section 3: Self-reported competencies and attitude towards adoption of digital health care systems

11. Rate your knowledge in digital health care technology
 	
       c.   Before Covid – 1 2 3 4 5 6 7 8 9 10
 	
       d.   After Covid -1 2 3 4 5 6 7 8 9 10

12. Rate your skills in managing digital health care technology
 	
       c.   Before Covid – 1 2 3 4 5 6 7 8 9 10
 	
       d.   After Covid -1 2 3 4 5 6 7 8 9 10

3. Do you believe that digital health care technology improves patient care and safety
 	
       a. Yes
 	
       b. No

Section 4: Preparedness and organizational support for digital health care technology adoption
1. How did your organization prepare for digital health care technology? a. Before Covid b. After Covid

a. Change in policy

b. Budgetary allocation – for procurement and implementation

c. Training of human resource

d. Strategic approach to handle resistance to change

e. Patient data privacy protocols

f. Patient compliance measures

2. How did your organization provide support for up-skilling to digital health care technology?

a. Before Covid

b. After Covid

      i. Incentives

      ii. Paid time for training

      iii. Organized training

      iv. Any other

      v. No support

3. What challenges did you face in administering digital health care technology?

a. Before Covid

b. After Covid

i. Technology related

   ii. Administrative

   iii. Financial

   iv. Human resource related

v. Patient related
4. What support do you need to enhance your competence in using digital health care technology? a. Before Covid b. After Covid   i. From the organization ii. From the vendor iii. From your team iv. From your self
5. How does your organization ecosystem support digital health care technology? a. Before Covid b. After Covid

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