

**Summer Training at
PricewaterhouseCoopers (PwC) Private Limited,
Bengaluru**

**Going beyond Technology: Understanding the Digital Drive in Healthcare a
Qualitative Study**

**By
Hanvitha Khambampati**

**Under the guidance of
Dr. Sandeep Narula**

**MBA Hospital and Health Management
2015-2017**



**The IIHMR University, Jaipur
2016**

CERTIFICATE

To Whomsoever It May Concern

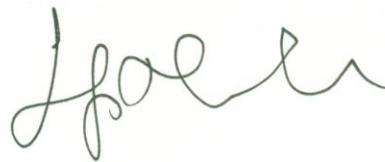
This is to certify that **Dr. Hanvitha Khambampati**, student of MBA- Hospital and Health Management (2015-17), from the IIHMR University, Jaipur, has undergone Summer Training at **PricewaterhouseCoopers Private Limited, Bengaluru** from 4th April to 3rd June, 2016.

The candidate has successfully carried out the study designated to her during summer training and her approach to the study has been sincere, scientific and analytical. This training is in fulfillment of the course requirements.

I wish her success in all her future endeavors.



Col (Dr.) Ashok Kaushik
Dean, Academics and Student Affairs
The IIHMR University, Jaipur



Dr. Sandeep Narula
Associate Professor
The IIHMR University, Jaipur



June 3, 2016

To Whomsoever It May Concern

This is to certify that **Ms. Dr Hanvitha Khambampati (Emp Id: 726257)** has undergone her training with the **Advisory** division, **Bangalore** from **April 04, 2016** to **June 03, 2016**. She was associated with the **Consulting** SBU.

She has exhibited a keen interest in learning and has positive attitude. She is sincere and hard working. The efforts put in by her for the project and the analysis of the subject carried out during the training was outstanding.

We wish **Dr Hanvitha Khambampati**, the best in her future endeavors.


Vijayalaxmi B
Assistant Manager-Human Capital

PricewaterhouseCoopers Pvt. Ltd., 6th Floor, Tower 'D', The Millenia, 1 & 2 Murphy Road, Ulsoor,
Bangalore - 560 008
T: +91 (80) 40796000, F: +91 (80) 40796222, www.pwc.com/india

CIN : U74140WB1983PTC036093

Registered Office : Plot No. Y-14, Block EP, Sector V, Salt Lake, Kolkata 700 091

TABLE OF CONTENTS

Serial No.	Contents	Page No.
1	List of Abbreviations	1
2	Acknowledgement	2
3	About the Organization	3
4	Section 1- An Overview	6
	<i>1.1 Introduction</i>	6
	<i>1.2 Rationale</i>	7
	<i>1.3 Objectives</i>	7
	<i>1.4 Methodology</i>	8
5	Section 2- The Heart of the Matter	9
	<i>2.1 Embracing 'Change'</i>	9
	<i>2.2 Changing Concepts- From 'Healthcare' to Wellness'</i>	10
	<i>2.3 From 'Health' to 'Connected Health'</i>	12
	<i>2.3.1 What does 'Digital' mean, do and deliver?</i>	12
	<i>2.3.2 Current Landscape of Digital Healthcare</i>	13
	<i>2.4 Digital Healthcare- An Analysis</i>	16
	<i>2.4.1 Strengths of Digital Technology in Healthcare</i>	17
	<i>2.4.2 Shortcomings of Digital Technology in Healthcare</i>	20
	<i>2.4.3 Opportunities and Challenges in Digital Health</i>	23
6	Section 3- The Bottom line	26
7	References	27

LIST OF ABBREVIATIONS

3D	Three Dimensional
ALOS	Average Length Of Stay
BCMA	Bar Code Medicine Administration
CAGR	Compound Annual Growth Rate
CDSS	Clinical Decision Support System
CIO	Chief Information Officer
CPOE	Computerized Physician Order Entry
eHealth	Electronic Health
EHR	Electronic Health Records
EMRAM	Electronic Medical Records Adoption Model
EY	Ernst & Young
HIS	Hospital Information System
HIT	Health Information Technology
HMIS	Hospital Management Information System
HR	Human Resources
IBM	International Business Machines
ICT	Information and Communication Technology
IoT	Internet of Things
IT	Information Technology
KPMG	Klynveld Peat Marwick Goerdeler
LASER	Light Amplification by Stimulated Emission of Radiation
mHealth	Mobile Health
NCR	National Capital Region
PACS	Picture Archiving and Communication System
PHR	Personalized Health Records
PwC	PricewaterhouseCoopers
RFID	Radio Frequency Identification
SMS	Short Message Services
VP-IT	Vice President- Information Technology
WSN	Wireless Sensory Network

ACKNOWLEDGEMENT

The summer training opportunity I had with PricewaterhouseCoopers was an enriching experience; it was a great chance for learning and professional development. It helped me develop an ability to understand healthcare issues from various perspectives.

Bearing in mind the previous, I would like to take this opportunity to express my deepest gratitude and special thanks to my mentor, Dr. Sandeep Narula, Associate Professor, IIHMR University, Jaipur, for hearing, guiding and keeping me on the correct path throughout the two months of training.

It is my radiant sentiment to place on record my best regards, deepest sense of gratitude and indebtedness to Dr. Vijay Raaghavan, Principal Consultant, Healthcare Advisory, PwC Bengaluru, for his immense support and faith and for allowing me to carry out the study with ease at their esteemed organization during the training. His careful and precious guidance was extremely valuable for my study, both theoretically and practically.

I would like to acknowledge with much appreciation, the crucial role of the complete Healthcare Advisory team at PwC Bengaluru, for providing me with their experiences and all the required information that helped me with my study.

Furthermore, I would like to express my deepest thanks to Mr. Nandkishor Dhomne, CIO, Manipal Hospitals and Mr. Kumar KV, CIO, Narayana Health, who despite their busy schedule, took out time to provide their valuable insights on healthcare issues and current developments. Without their contribution, the study would have been incomplete.

I perceive this opportunity as a big milestone in my professional development. I will strive to use the gained skills and knowledge in the best possible way, and will continue to work on their improvement, in order to attain the desired career objectives.

Sincerely,

Dr. Hanvitha Khambampati

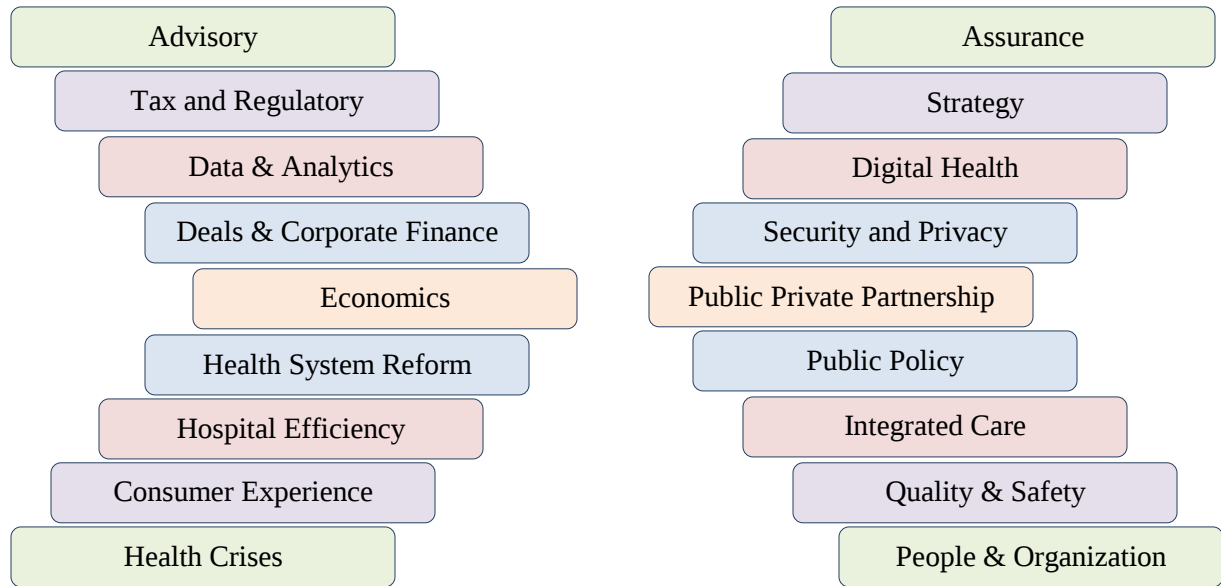


ABOUT THE ORGANIZATION

PricewaterhouseCoopers (PwC) is a multinational professional services network headquartered in London, United Kingdom. It is one of the Big Four Auditors, along with Deloitte, Ernst & Young (EY) and Klynveld Peat Marwick Goerdeler (KPMG). The firm was formed in 1998 by a merger between Coopers & Lybrand and Price Waterhouse. The trading name was shortened to 'PwC' in 2010, as a part of rebranding, focused on creating value and building relationships. Today, PwC is a network of firms in 158 countries across 756 locations. The organization offers a comprehensive portfolio of Advisory, Assurance and Tax & Regulatory services, each, in turn, caters a basket of finely defined deliverables.

The Healthcare division at PwC is committed to helping support the improvement of health and wellbeing around the world, with a burning desire to bring a positive impact on the society. According to third party analysts, PwC is one of the largest healthcare professional services firms that lead in each of the key sectors of Payer, Provider and Government Healthcare Consulting. The firm helps clients across the healthcare field- from payers to providers, policy makers, investors and new entrants- keep pace with the rapidly transforming industry. Its global network of professionals includes leading minds in medicine, biological sciences, clinical operations, Information Technology, business administration and health policy. PwC's thought process and extensive research gives its engagement teams- access to competitive intelligence, perspective on leading practices & policies and analysis of trends affecting the healthcare industry. Also, the firm's breadth of experience in various industries is highly valuable to clients as healthcare industry becomes increasingly interconnected with other industries such as manufactured goods, retail, information and communication systems etc. Needless to mention, PwC has a proven track record in working with clients to improve operational performance in many functional areas.

Services provided by PwC Healthcare



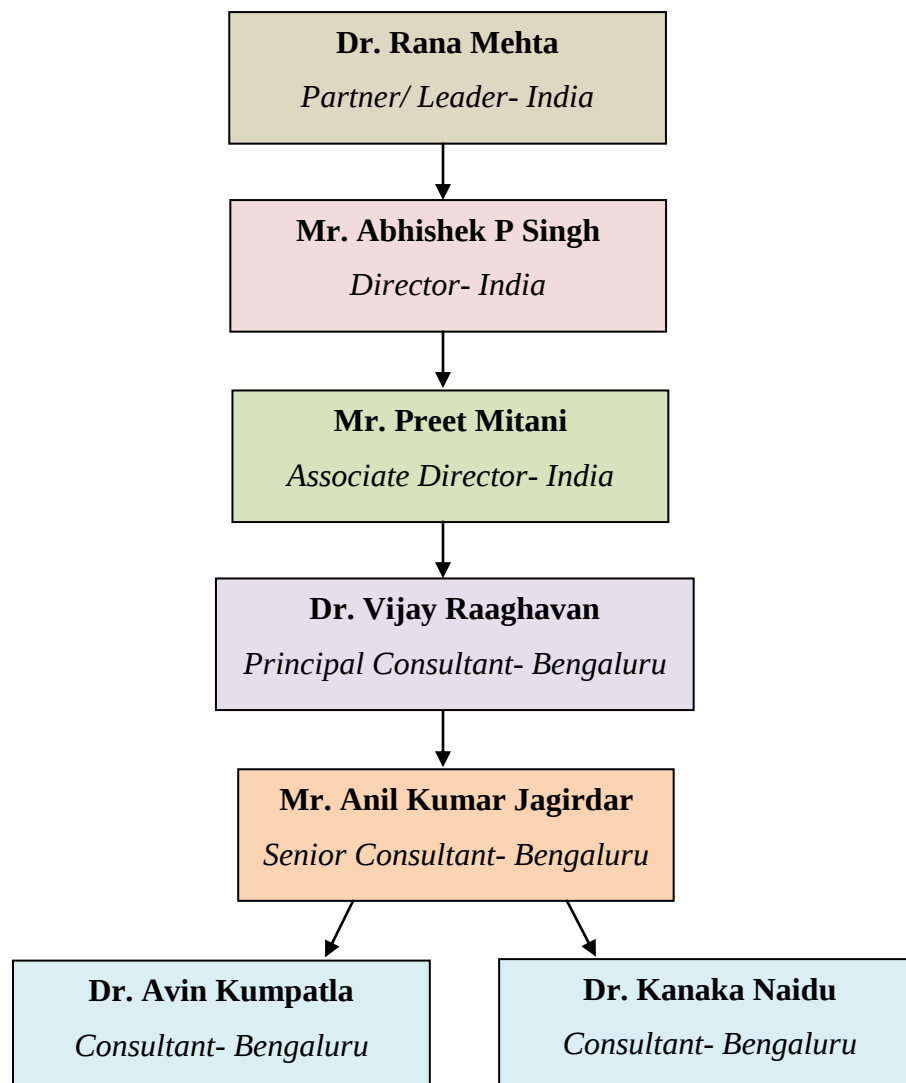
PwC India

Currently located in the cities of Ahmedabad, Bengaluru, Bhubhaneshwar, Chennai, Delhi NCR, Hyderabad, Kolkata, Mumbai and Pune, the firm's highly qualified professionals help organizations solve their business issues as well as identify and maximize the opportunities they seek. Well understanding the Indian healthcare environment as well as the dynamics that drive it, the Healthcare Advisory division helps governments implement major health reforms and public health policy initiatives and private enterprises implement strategies and solutions to achieve their performance objectives. Some of its services are listed below:

- **Enterprise strategy and business development:** Organizational design and building start-ups; healthcare feasibility studies and business plans; competitor assessment and strategy; clinical service planning mix; financial and operational restructuring etc.
- **Medical equipment management:** Assistance in selection; procurement and commissioning; cost-benefit analysis; redundancy and replacement planning etc.
- **Operational optimization:** Patient flow redesign and throughput; inventory management; facility management; patient satisfaction index etc.

- **Transaction services:** Identification of opportunities and deals; business due diligence; post- investment performance assessment etc.
- **Information Technology:** Business transformation and Enterprise Resource Planning services; Information Technology and business strategy alignment; eHealth, social networking, telehealth and Electronic Health Records implementation etc.
- **Manpower rationalization:** Manpower planning; assistance in developing skill sets; organization behavior and change management etc.
- **Education and Research:** Creation of teaching and faculty models; resource identification to establish research facilities; affiliations for patient care, teaching and research etc.

PwC Healthcare Advisory Team, Bengaluru



Section 1 - An Overview

1.1 Introduction

Healthcare organizations have diverse clinical, financial and operational data required for effective decision making. Earlier, when such data was collected, it was customarily left buried in archaic, paper based filing systems and more often than not, these records resurfaced only when required. Needless to mention, this practice presented itself with a myriad of problems such as massive storage & maintenance costs, delayed retrieval of information, security and confidentiality issues etc. – which often jeopardized the operational efficiency and quality of service provided.

Over the years, the sheer amount of data has grown exponentially, but the aforesaid issues hardly exist! With ‘Digital’ being the buzz word, there has been an exemplary transformation in the healthcare industry. Promising technologies, such as social media, analytics, mobility, game mechanics and the Internet of Things (IoT) have been the game-changers, which have remodeled ‘Health’ into ‘Connected Health’. Care providers have spent a considerable amount of time in digitizing medical records. In addition, there is now information collected from telemedicine interactions, wearable devices & fitness trackers, health monitors and more. The current practices are aimed at enhancing quality, improving efficiency, increasing access and reducing costs. Therefore, a digitally enabled healthcare system seems no longer a ‘nice-to-have’, but rather a ‘fundamental business essential’.

Today, every health system is turning digital. The contemporary changes in the business of healthcare- emergence of value-based care, consumer pressure for a ‘retail’ experience with convenience, transparency & freedom of choice and a competitive push to improve service quality & reduce costs- have forced the care providers to make significant investments in new business models. There are a wide range of cross-cutting digital technologies available in the industry. Yet, health systems face a difficult assignment in striking the balance between adopting the right technology and reaping sufficient benefits out of it. Efficiency and effectiveness- the necessary parts of this balancing act, can be achieved by adopting a thought based approach to demand management, by restructuring the healthcare delivery

model and by optimizing the operational processes. Thus, it is imperative to understand that the investments on digital and Information Technology (IT) must be driven by the business requirements and the capabilities needed to deliver upon them, keeping in mind the perspectives of multiple stakeholders within and outside the system, who act as end-users of such technology.

With an aim of gaining an in-depth understanding of digital and Information Technology (IT) in healthcare, this report is structured as follows:

- Section I- *An Overview*
- Section II- *The Heart of the Matter*
- Section III- *The Bottom line*

1.2 Rationale

There has been a considerable international discussion on latest digital innovations and their positive impact on service delivery in healthcare. However, only a few studies reflect on their relevance, applicability or cost-effectiveness in true sense. While there is rampant adoption of technology across the industry, it is critical to cut through two schools of thought- a) essentially doing the same old things, but digitally, i.e. simply replacing paper with digital technology and b) realizing the role of digital technology as an ‘enabler’ rather than as an ‘essential’, i.e. focusing less on mere implementation of the system and more on understanding the system from a multi-dimensional perspective throughout the cycle- before, during and after its implementation. This study aims to explore the nuances in the subject of interest, which is essential to gain clarity in the decision making process by health systems in the years to come.

1.3 Objectives

The purpose of the study is to

- Understand the changing concepts in healthcare
- Understand the current landscape of digital healthcare
- Analyze the strengths, weaknesses, opportunities and challenges in digital health

1.4 Methodology

Review of Literature

As one of the research methods of this study, a systematically structured search of literature was applied to generate peer-reviewed academic articles. The search was limited to full paper articles published in English. For this purpose, electronic databases such as ResearchGate, SpringerLink, International Journal of Medical Informatics, Journal of Medical Systems, Health Affairs and Sage Journals online have been utilized by using a combination of keywords such as ‘health’, ‘digital technology’, ‘Information and Communication Technology’ etc. Furthermore, the review is also supplemented by articles of PricewaterhouseCoopers Health Research Institute.

Interviews with Chief Information Officers (CIOs)

As the other research method of this study, interviews (unstructured) with Chief Information Officers (CIOs) were conducted at two major hospitals in Bengaluru. The respondents were selected based on purposive sampling. The interviews were conducted with an intention to gain insight into the purpose, functioning and impact of digital technology in health systems. The details of the respondents are given below:

a) *Mr. Nandkishor Dhomne- VP-IT & CIO, Manipal Health Enterprises*

Mr. Nandkishor has more than two decades of experience in Information Technology, with key expertise in areas such as IT strategic planning and roadmap for digital hospitals, hospital software applications implementation/integration, streamlining connectivity across group hospitals, executive dashboards, patient portals etc.

b) *Mr. Kumar KV- VP-IT & CIO, Narayana Health:*

Mr. Kumar has over fifteen years of technology experience, ranging from strategy to execution planning across various industry verticals. His key areas of expertise include digital strategies, business service management, IT service management, enterprise application architecture, information security etc.

Literature review and interviews were conducted over a period of two months, from April 03 to June 03, 2016. The study has its limitation, as it is based on literature and experts’ insights of only two CIOs.

Section 2 - The Heart of the Matter

2.1 Embracing 'Change'

Throughout the healthcare industry, a call for 'change' is being heard- 'change' in the way care needs to be delivered. This change is inevitable, due to a set of drivers that are constantly exerting a great 'push and pull' to the delivery system. With these drivers on the wheel, the industry faces the gargantuan task of revamping the modus operandi.

Table 1: Drivers of Change in Healthcare Industry

<i>Politico-Legal</i> • Growing pressure on healthcare providers to cut down on pricing • Medical Regulations • Public Private Partnership • Medical tourism • Medical Errors and clinical safety	
<i>Economical</i> • Growing per capita expenditure on health, Out-Of-Pocket Expenditure • Higher insurance premiums • Increasing investments in healthcare sector • Inflation • High tax rates • Professional shortages • Increasing capital and operational expenditure on health systems	<i>Socio-demographic</i> • Changing patient profile – ageing, emergence of chronic diseases • Sedentary lifestyle habits • Increase in patient awareness and concern • Demand for healthcare quality, accessibility and transparency – consumerism
<i>Technological</i> • Emerging digital and Information Technology (IT) opportunities • Customized healthcare	<i>Environmental</i> • Emergence of new diseases • Competition in the industry • Green Technology

2.2 Changing Concepts- From ‘Healthcare’ to ‘Wellness’

For the modern healthcare industry, ‘Accountable Care’ is the name of the game. Terms like ‘quality’, ‘affordability’ and ‘accessibility’ are often considered synonymous with ‘healthcare’ in today’s colloquial sense. Though a good goal to pursue, a complete transformation towards such care seems like a tall order. Nevertheless, over the past few years, health systems have taken incremental steps in bringing a radical shift in the very concept of healthcare. Interestingly, the approach is no longer towards ‘healthcare’; instead, it’s towards ‘wellness’. Some of the changing concepts in healthcare ⁽¹⁾ are as follows:

Shift in the Scope of Service Delivery: From Reactive/Curative to Proactive/Preventive/Maintenance

Healthcare professionals are not solely focusing on treating the sick; instead, the focus has now shifted towards preventing people from getting sick. A major push to this change is brought by the changing socio-demographic profile (Table 1). While patients save on healthcare costs, this helps the care providers in early diagnosis & treatment and building patient trust & loyalty.

Shift in the Process of Service Delivery: From Retaining Patients/Filling Beds to Discharging Patients/Emptying Beds

Revenue per bed day can be improved by reducing the Average Length of Stay (ALOS) of patients in hospitals. With the right case-mix, hospitals no longer wish to retain patients; instead, a quick and appropriate discharge is processed, so that there is better utilization of resources, while newer patients come in.

Shift in the Focus of Service Delivery: From Physician to Shared Medical Workload

Earlier, patient information in hospitals was confined to the physicians. But today, the concept of ‘Inter-disciplinary teamwork’ has gained importance in hospitals, which saves time and reduces duplication of work. Patient information is shared between the clinical (doctors, nurses) as well as the support staff (finance, HR, stores, pharmacy, blood bank, dietary, housekeeping etc.) for efficient decision making.

Shift in the Mode of Care: From Symptomatic/Episodic to Lifetime/Continuum of Care

Today, care is expanding beyond hospital doors and is reaching the community through long term care, ancillary support, rehabilitative services and education. This improves patient satisfaction and also prevents relapse and readmissions that involve high associated costs and scrutiny from health insurers and patients.

Shift in Type of Clinical Decisions: From Individual to Best Practices & Evidence Based

Earlier, the clinical decisions of healthcare providers were based on their personal experience. But today, healthcare providers also depend on proven treatments and techniques to make efficient clinical decisions, in order to improve the quality of care provided.

Shift in the Approach of Care Delivery: From Aggregation to Segmentation

Just like in marketing, healthcare is moving from its homogenous approach to highly targeted approach that recognizes and focuses on heterogeneous needs. While demographic dimensions (age, sex, race etc.) can be considered, healthcare providers are now depending on psychographic factors such as patient's needs, values and preferences.

Shift in the Model of Reimbursement of Care Providers: From Volume-Based-Pay to Value-Based-Pay

Earlier, providers had incentives to 'do more', i.e. the more patients they saw, the more tests they ordered, the more procedures they performed- the more they were paid. But today, quality is preferred over quantity. For patients, this means safe, appropriate and effective care at reasonable costs. For providers, it means employing ideal care that takes into account the patients' wishes and preferences.

Shift in the Profile of the Patient: From Patient to Enlightened, Engaged and Empowered Consumer

Today, the patient no longer follows the 'treatment-as-usual' approach. Patients increasingly want to participate in their own care alternatives and share in decision making. They demand 'retail like' services, informed choice and transparency in pricing. Hence, the entire paradigm is shifting towards patient centric care delivery model.

2.3 From ‘Health’ to ‘Connected Health’

Ten years ago, did one imagine that mobile phones could be used as medical devices? Five years ago, did one imagine that people could have virtual online visits to their doctors? Two years ago, did one imagine that a contact lens could monitor blood glucose? Today, one can re-imagine health in a new dimension. Entrepreneurs around the world are steering existing medical and technological expertise towards frugal innovations that are benefiting a multitude of stakeholders in the industry.

‘Connected Health’ is an umbrella term which involves health technology, digital, media and mobile communications. Connected health solutions allow societies to maintain personalized healthcare in an environment of reduced resources and increasing demand. They gather, link and interpret data from many different sources to enable informed, patient-centered care decisions. In short, ‘connected health’ puts the right information in the right hands at the right time. This helps in understanding another changing concept in the healthcare industry:

Shift in Systems of Operation: From Paper to Digital

Health systems are highly data driven. Data storage in paper based systems comes with its own set of challenges with respect to investment, time, security and maintenance. Hence, many health systems have shunned paper and have adopted Information and Communication Technology (ICT). Devices like computers, mobiles & tablets implemented with secure communication networks provide the benefits of saving costs, time and seamless flow of information.

2.3.1 What does ‘Digital’ mean, do and deliver?

“Today, every hospital is keen to adopt technology. But before turning ‘digital’, it is essential to understand it’s meaning in the first place”, says Mr. Kumar, CIO, Narayana Health. While the dictionary definition of ‘Digitization’ refers to the process of converting analogue data (images, text, video, sound) into digital form (digital bits of 1s and 0s), its operational definition refers to something that makes things easier. It must reduce costs, save time and improve outcomes. It must deliver value, purpose and experience to every stakeholder in the health system.

2.3.2 Current Landscape of Digital Healthcare

Digitizing healthcare is a vision aimed at making the world an even smaller place by bringing the patient, provider, payer and producer closer to each other, if not physically, virtually. Currently, there is a widespread adoption of ICT in the industry. When this functionality is combined with other advances such as Wireless Communication, Radio Frequency, Geospatial Positioning, Mobile Communication, Wearable Devices, Biosensor Technology, Bioinformatics etc., one can envisage an array of integrated applications of digital technology.

There is a rapidly changing healthcare landscape globally, where digital and Information Technology is being increasingly normalized into everyday healthcare delivery. The diversity of different technological applications and their interaction can be hard to comprehend. A brief glimpse at healthcare advancements so far throws light on the eventual progress that has taken place in the realm of digitization, such as, the shift from paper-based to computer-aided processing and storage of data in healthcare settings; the shift from department/institution centered Hospital Information System (HIS) to a regional/global HIS; inclusion of patients/consumers as HIS users, besides healthcare professionals and administrators; use of HIS data for healthcare planning and research ⁽²⁾ etc. Recent applications in the form of Electronic Health Records (EHR), Telemedicine, Video- Conferencing, mHealth, Cybermedicine, Health Kiosks, Barcodes, Radio Frequency Identification (RFID), Wireless Sensory Network (WSN), Cloud Computing, Clinical Decision Support System (CDSS), Picture Archiving and Communication System (PACS) etc., have buoyed up the expectations of the unending potential digital technology can offer in the near future.

A macro-level overview of the current digital landscape (Figure 1) puts the patient-facing technologies at the centre, reflecting the impact of self-monitoring and decision support on quality of care and patient experience. Other technologies can be broadly classified as professional-facing and organization-facing, depending upon their value in improving outcomes and efficiency of care. The Electronic Health Records, which is the foundation upon which many other applications are built, percolates the system as a whole.

Figure 1: An Overview of the Digital Healthcare Landscape

(Source: 'Digital Health: heaven or hell?' - kpmg.com/healthcare)

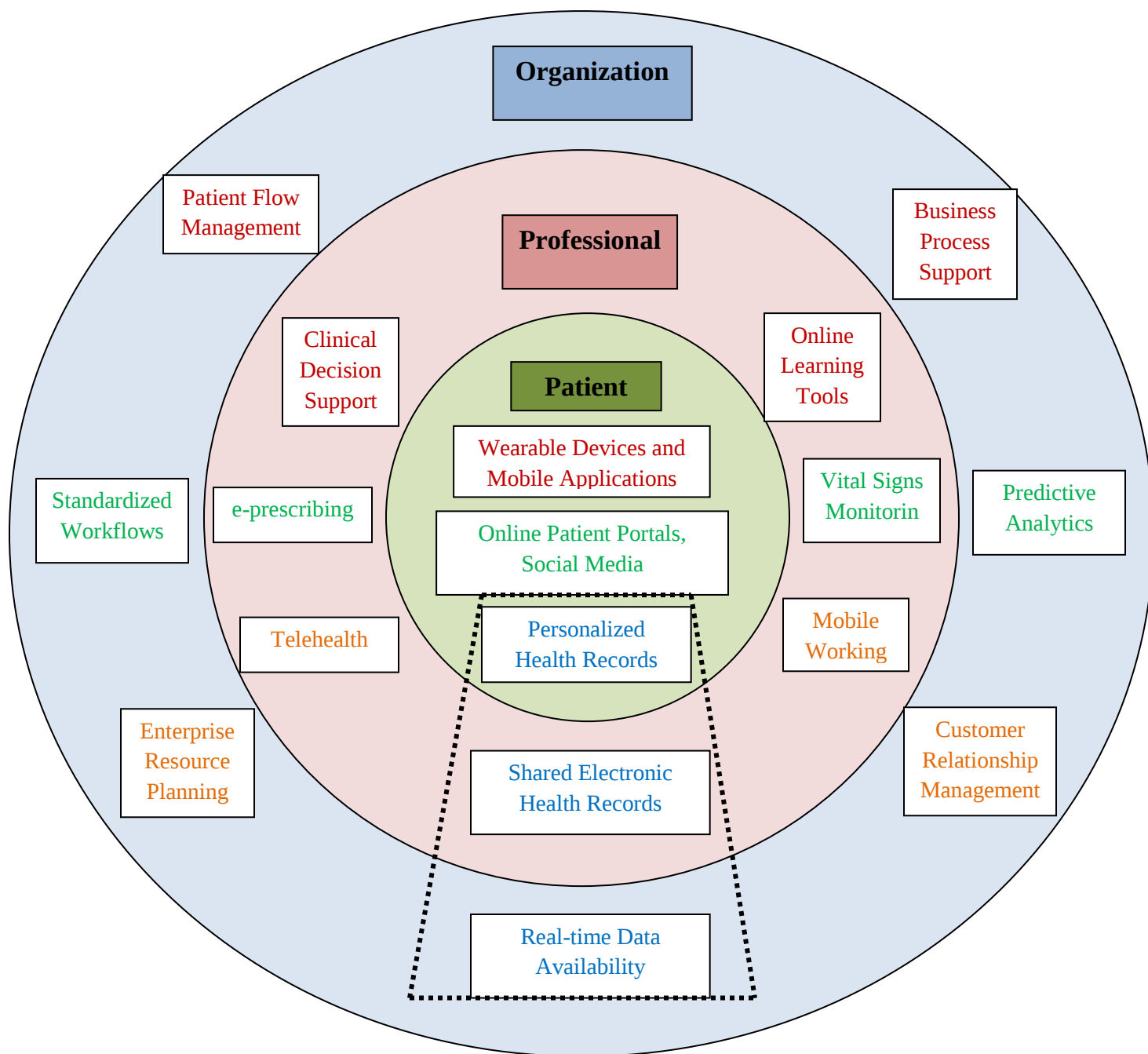


Figure 2: Major Trends in Digital Healthcare

(*Source: <http://hitconsultant.net/2015/03/16/infographic-sxsw-health-tech-trends>)



Electronic Health Records & Hospital Information Systems

Instant secure access to patient information, including history and previous test results, thus reducing physical storage space and manpower required. They also support further enhancements like PACS and CDSS, making systems more integrated for easier flow of data and accurate patient care.

**Globally, 71% of physicians adopted EHRs (2015).*



Wearable Devices

They can track and analyze information about one's health. They can remotely monitor data such as blood glucose and blood pressure, and can alert both the physician and the patient when the levels are alarmingly low or high.

**More than 80% of the users worldwide said that wearables have the potential to make healthcare convenient (2015).*



Mobile Technology

Instantaneous connect between the patient & the provider, without having to visit the hospital; also 24x7 availability of services, that reduces patient footfall and allows doctors to focus on serious cases.

**Globally, 71% of the millennials wished their physicians to use mobile apps (2015).*



Telemedicine

Currently the best available solution in terms of accessibility, especially in Tier II, Tier III and rural areas, where there is shortage of medical staff.

**Globally, 70% of the patients are comfortable communicating with their healthcare physicians viz. text, email or video, in lieu of seeing them in person (2015).*



Cloud Computing

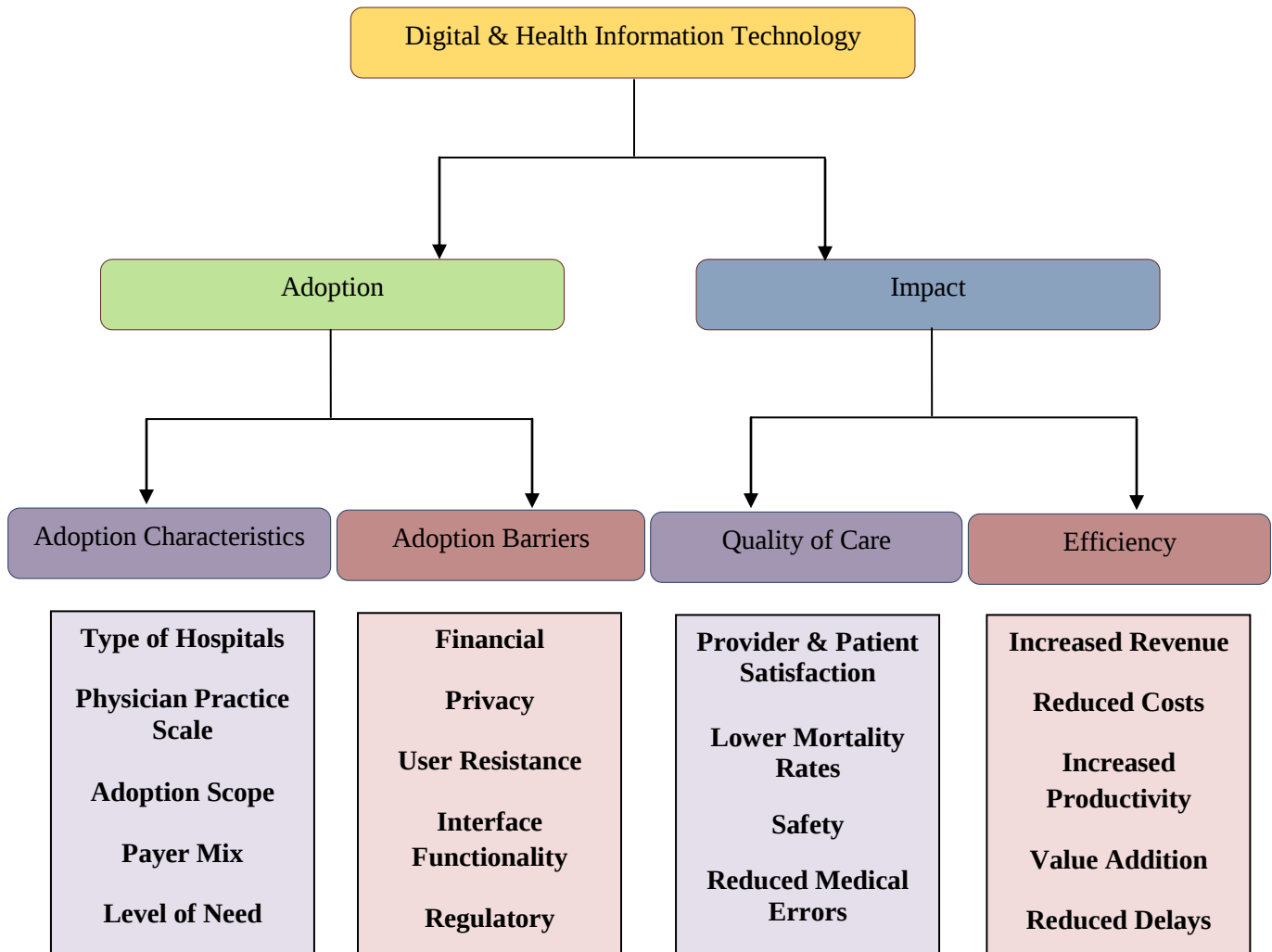
Beneficial in eliminating physical space required to store servers, thus reducing maintenance costs and also preventing damage to servers in calamity prone areas.

**Cloud Computing is expected to grow at 20% annual rate by 2017, when it will reach the market size of \$5.4 billion globally.*

2.4 Digital Healthcare- An Analysis

When compared to other information intensive industries, healthcare sector is at least a decade behind in the use of ICT to increase productivity and quality⁽³⁾. With the various issues and variables surrounding healthcare IT investment, a framework for better understanding of the current situation is essential. The functionality of Health Information Technology (HIT) revolves mainly around two main aspects: Adoption and Impact of technology on the organizations.

Figure 3: Adoption and Impact of Health Information Technology
(Source: The Digital Transformation of Healthcare: Current Status and the Road Ahead, Ritu Agarwal and Guodong Gao)



Several studies have examined the characteristics of hospitals that affect the adoption of HIT such as hospital ownership and teaching status (Cutler et al. 2005)⁽⁴⁾, size and location (Kazley et al. 2007)⁽⁵⁾ and payer mix (Shin et al. 2012)⁽⁶⁾. Hospitals are also concerned with the functionality of currently-available HIT solutions (England et al. 2000)⁽⁷⁾, which leads to user resistance, a factor more extensively studied by Bhattacharjee et al. 2007⁽⁸⁾. High cost (Poon et al. 2006)⁽⁹⁾ was yet another factor that restricted the adoption of HIT by hospitals.

Improvements in healthcare quality are clearly a core component of the value expected from HIT, such as lower mortality rates (Amarasingham et al 2009)⁽¹⁰⁾ and patient safety (Parente et al. 2009)⁽¹¹⁾. In terms of efficiency, studies indicate that HIT leads to lower costs (Hillestad et al. 2005)⁽¹²⁾, higher revenue (Ayal and Seidmann 2009)⁽¹³⁾, and higher productivity (Lee et al 2010)⁽¹⁴⁾.

2.4.1 Strengths of Digital Technology in Healthcare

Digital and ICT are seen as ways to promote quality, safety and efficiency in healthcare by providing vital links, catering decision support to the point of care and closing open loop systems. Also, they can reduce operating costs and medical errors, boost patient confidence and reinforce patient trust in caregivers. The need for easy access, storage and integrated management system of clinical data is an important driver for adoption of ICT in healthcare.

Digital and IT play a vital role in tackling the changing concepts in healthcare (discussed earlier). Clinical Decision Support Systems can systemize care and reduce variation, thereby improving the accuracy of decision making. Powerful analytics can not only allow providers to intervene early and keep people from falling sick, but also in customizing care for varied patient profile. Easier access to providers through mobile technology helps in catering continuum of care, thereby reducing patient readmissions. Self management tools for patients, such as wearable devices and health apps create meaningful participation of users and reduce workload of staff. Well integrated Hospital Information Systems can help prevent the costs and harms of fragmented and duplicative services by coordinating care and supporting the staff to collaborate more effectively.

A recent study on mobile health technologies suggests that mHealth offers several advantages to its users such as patient education, health promotion, disease self-management, decrease in healthcare costs, and remote monitoring of patients (Alghamdi et al. 2015)⁽¹⁵⁾. RFID helps the healthcare industry to increase the operating income by reducing working capital through reductions in inventory level and lowering appropriate costs (Mehrjerdi, 2010)⁽¹⁶⁾. Personalized Health Records (PHRs), when integrated with Electronic Health Record systems, provided patients the ability to track their diseases in conjunction with their providers, promoting earlier interventions when they encounter a deviation or problem (Tang et al. 2006)⁽¹⁷⁾. A study on PACS suggested significant savings in radiological report turnaround time after the implementation of the communication system (Twair et al. 2000)⁽¹⁸⁾.

Table 2: Strengths of Digital Technology in Healthcare

Improve Healthcare Outcomes • Information transparency • Reduce medical errors • Coordinated and integrated care • Improve quality of care • Pay for performance instead of service	Reduce Healthcare Costs • Reduce readmissions • Early diagnosis • Care at low-cost settings (homecare) • Improve operational efficiency
Enhance Patient Experience • Increase patient self-literacy and self-management • Patient information transparency • Assess patient feedback • Improve patient satisfaction	Meaning in Work of Healthcare Staff • Improve work flow • Reduce burn-out • Improve staff experience • Increase readiness

Successful Case Studies in India

- *Max Healthcare (2012) was the first hospital in India and only sixth in Asia to achieve 'Stage 6' on the Electronic Medical Record Adoption Model (EMRAM) ⁽¹⁹⁾. It implemented an open source EHR solution, with Computerized Physician Order Entry (CPOE), Clinical Decision Support System (CDSS) and Bar Code Medicine Administration (BCMA).*

Four of the Apollo group of hospitals achieved this stage during 2013-14. This greatly benefitted the hospitals in terms of provider convenience, patient satisfaction and financial savings.

- *Narayana Hrudayalaya was the first hospital in India to deploy the entire HMIS application on cloud based architecture. This enabled the hospital in having a centralized database- a single point of information access for its hospitals across the country ⁽²⁰⁾.*
- *Manipal Hospital uses a mobile app, coupled with a wearable sensing device that provides pregnant women and the doctors with real-time access to data such as fetal heart rate patterns, labor progress and uterine activities ⁽²¹⁾. This helps physicians make informed decisions and also improves patient experience.*
- *Columbia Asia hospital has a proprietary HMIS called 'Care 21', which operates at each of its hospitals, enabling seamless record keeping and workflow ⁽²²⁾.*

2.4.2 Shortcomings of Digital Technology in Healthcare

Lack of well integrated systems is found to be a major drawback in digital health applications. Patient's treatment involves services from multiple units in a hospital and integration of information systems is essential for efficient service delivery. In most of the hospitals, clinical, administrative and financial systems either work in silos or are partially integrated, leading to unnecessary duplication of data. Also, system integration need not be confined to a single facility. Moreover, it is essential for the hospitals to change their lens from 'outside-in' to 'inside-out' approach. Health systems are often tempted to implement a variety of digital solutions available in the market. However, it is essential to identify and adopt the right solutions which suit the requirements of the facility.

Though hospitals have adopted various forms of digital and IT solutions, issues still persist that are not captured by the systems. This is because the hospitals fail to utilize the existing technology effectively. Patient leakage, accountability of instruments, lack of sound referral communication etc. are such issues, which when resolved, can save on costs; improve revenue and overall operational efficiency. One such example is given below:

A major issue for hospitals is a break in the continuum of care. It is often noticed that people who enter the hospital with a particular medical problem, do not continue their treatment till the end. The reasons for such behavior could be many – lack of awareness, lack of motivation, problems with accessibility, affordability etc. Most hospitals are efficient in treating the patients who do not break the chain. However, if there is a break in this continuum, hospitals fail to record the reasons and pull the patients back to the flow. This causes patient leakage and reduced revenues, which could be avoided if the existing digital technology is utilized to its full potential.

Data analytics and digital technology can play a vital role in this regard. Seeking patient feedback and providing timely information such as SMS reminders, alerts on treatment and pricing options can help in gaining their trust and loop them back into the continuum of care. The example is explained with the help of flowcharts in Figures 4 and 5.

Figure 4: Example- Break in the Continuum of Care
(Source: PwC India)

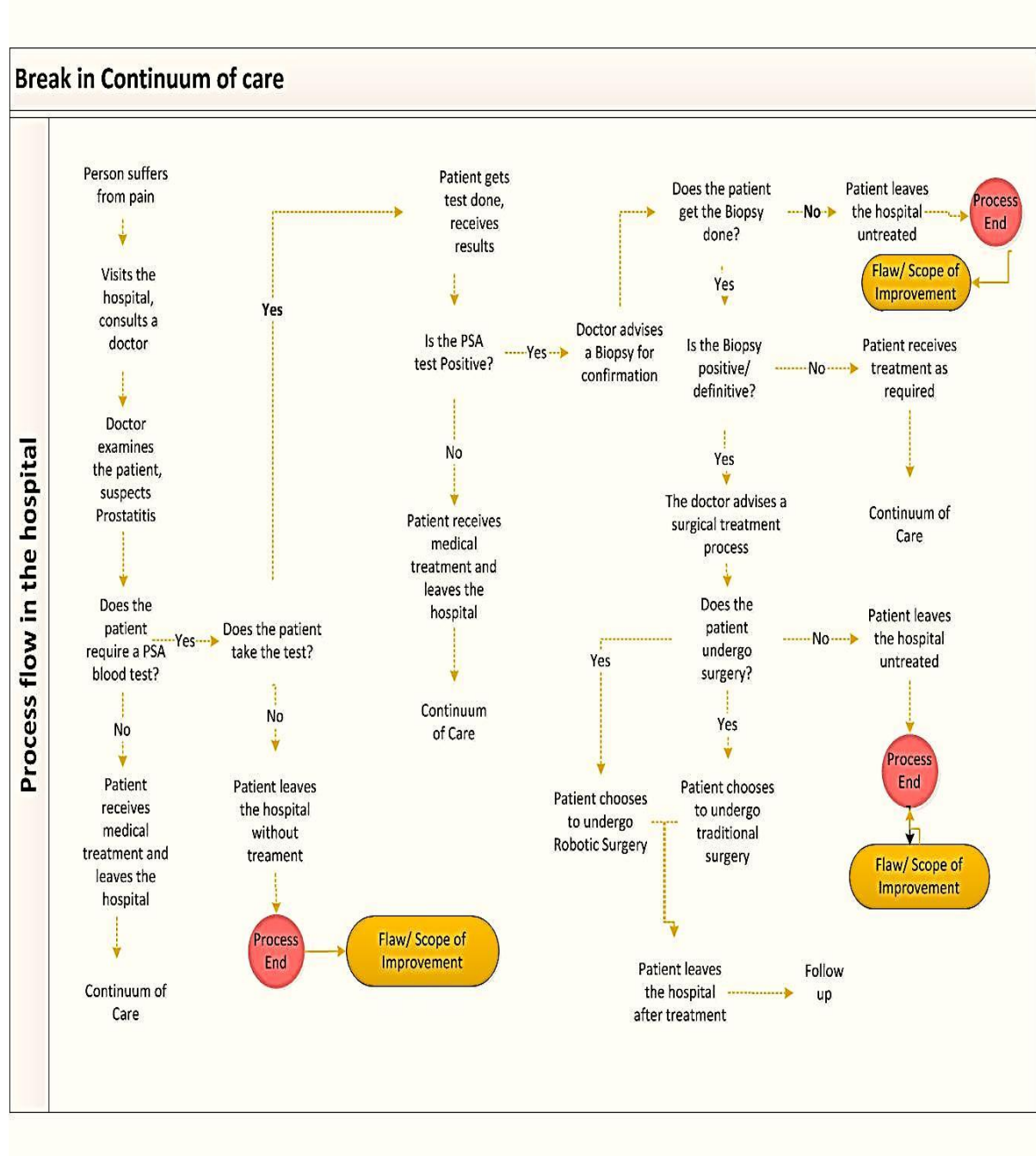
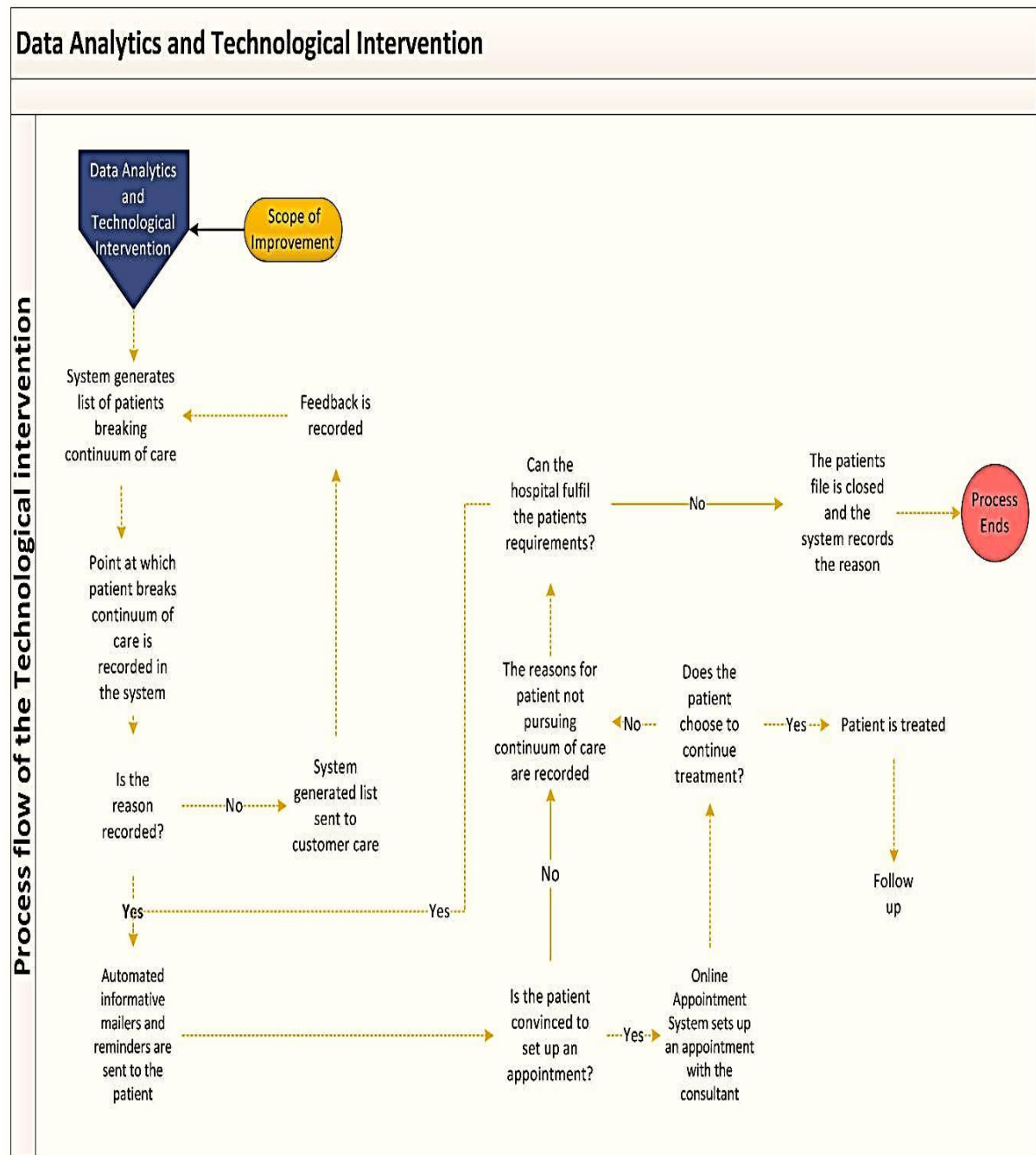


Figure 5: Technological Intervention to address Break in the Continuum of Care
(Source: PwC India)



User resistance, more commonly known as user acceptance, is yet another loophole that is not new to the IT industry. *“The best way to stand out through the use of digital technology is by standing in the shoes of all those stakeholders who would be benefited with the use of such technology”*, says Mr. Nandkishore Dhomne, CIO of Manipal Group of Hospitals.

Digital health is just not confined to patients and providers. There are various other stakeholders involved in healthcare delivery, like the hospital support staff, insurance providers, Government and community agents. The users must be engaged throughout the cycle when a new technology comes up.

The reasons for user resistance could be many ⁽²³⁾:

- Concerns over data security and privacy
- Concerns over patient safety, quality and liability
- Complexity of technologies
- Cultural resistance
- Concerns over capital costs
- Lack of clear legal & regulatory framework
- Lack of confidence & interest
- Lack of educational training in deploying technology
- Confusion regarding selection of the right technology from a sea of available applications
- Connectivity problems etc.

2.4.3 Opportunities & Challenges in Digital Health

Traditionally, healthcare has been slow to adopt digital and IT when compared to other industries. Talking about developing countries like India, the investment in Information Technology is still nascent. Indian health IT market is expected to reach \$1454.7 million in the year 2018, growing at 22% CAGR ⁽²⁴⁾.

While sustainable innovations play their part, there is a whole new gamut of disruptive technologies emerging worldwide. The concept is all about how complicated, expensive products are eventually converted into simpler, inexpensive ones. Currently, the healthcare industry is on this path of transformation.

Figure 7: Market Size of ICT in Indian Healthcare

(Source: <http://www.asianhnm.com/healthcaremanagement/from-drawers-to-digital>)

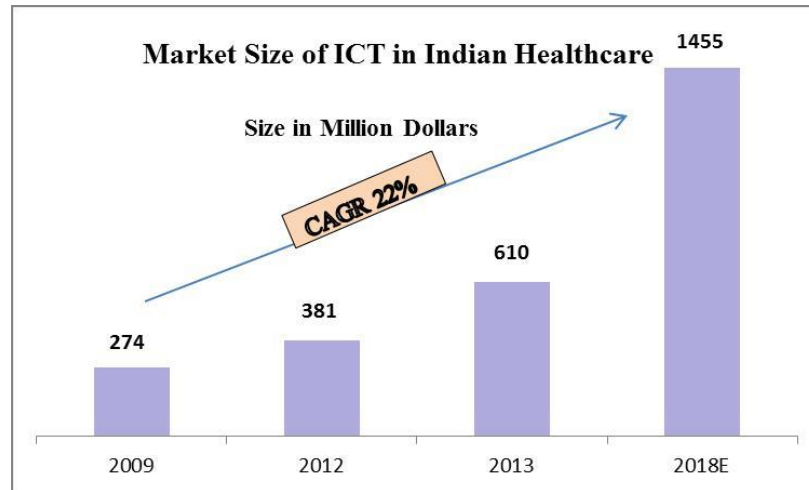


Table 3: The Past, Present and Future of Digital and ICT in Healthcare

(Source: The Guide to the Future of Medicine- By Bertalan Mesko)

Available	In Progress	Future
- Electronic Health Records - Hospital Information Systems - Digital Literacy in Medical Education - Virtual Dissection - Digestible Sensors - Smart Watches - Personalized Genomics - Telemedicine - Artificial Intelligence in Clinical Decision Support - LASER technology	- Robotic Nurse Assistant - Wearable e-skins - Embedded sensors - mHealth - Customized mobile apps 3D Printed Biomaterials - Social Media - Artificial Organs - PACS - RFID - Geospatial Positioning - Wireless Sensory Networks - Barcode Systems	- Big Data Analytics - Gamification Based Wellness - Full Physiological Simulation - Humanoid Robots - Nanobots in Blood - Remote Touch - Virtual Reality Applications - Recreational Cyborgs - Redesigned Hospital Experience

Case Studies on Disruptive Technologies in Healthcare

Manipal Hospitals has adopted IBM's Watson, an advanced computing power and intelligent systems to augment human intelligence for disease detection and treatment in the field of Oncology⁽²⁵⁾.

Oscar Health, an insurance company, works with the wearable maker Fitbit. Insured people can submit their Fitbit data and if they reach their fitness goals, they get \$1 every day. It helps keep people healthy and motivated with a simple but quantifiable reward⁽²⁶⁾.

Novartis signed an agreement with Google to develop and market the digital contact lens that Google patented in 2014. The idea is to use the lens for measuring blood glucose levels from tears. The technology could transform diabetes management⁽²⁶⁾.

Though digital and IT promises many opportunities, healthcare industry faces its own set of challenges. Health systems must balance stringent security and privacy regulations with a pressing need to improve technological infrastructure and a mandate to implement effective digital solutions, all amid the political blaze of healthcare reform, constrained budgets, consumerism, increasing pressure to cut costs, reluctance among users to trust technology and a shortage of both medical and IT talent in the industry.

Table 4: A Brief Overview of Landscape of Digital Technology in Healthcare

Strengths • Improve healthcare outcomes • Reduce healthcare costs • Enhance patient experience • Provide meaning in work	Weaknesses • Lack of well integrated systems • User Resistance • Incomplete use of existing technology • Confusion due to innumerable, complex technological applications
Opportunities • Disruptive Technology • Predictive Analytics • Robotics • Virtual Reality	Challenges • Political pressures • Constrained Budgets • User Reluctance • Consumerism

Section 3 – The Bottom line

With emerging trends in technology, there is a lot of interest in new models of care. In today's world, digitization is considered to be a catalyst to development. At the end of this discussion, it is important to understand what technology means for health systems in the years to come. While a few researchers interpret that digital and ICT in healthcare would transform the industry from an inefficient system to a more streamlined, clear and consistent world, there are skeptics on the other end, who question the complexity of the existing and upcoming technologies in healthcare, where clinicians are burdened with a sea of data to be interpreted and the patients are left obsessed and confused with self-management tasks.

Thus, it is essential to understand that going 'digital' simply does not mean rushing into random adoption of automated technological solutions. It is just not about becoming 'paper-free'. Experience suggests that there is no single solution that would work out in all the settings. The real big benefits come from utilizing the right technology, by doing work more efficiently, with fewer errors and in ways that are convenient for users. This requires transformation within the people and organizations, multiple iterations and continuous learning.

The best way ahead is to follow a thought-based approach in gradually introducing, testing and refining new initiatives in those areas of healthcare where there is a reasonable possibility of enhancement in the efficiency and efficacy of service delivery. The focus, therefore, out of absolute necessity, is laid upon performance improvement with a multi-faceted perspective.

REFERENCES

1. <http://www.slideshare.net/DrVijayBhushanam/healthcare-information-technology-33248809>
2. Peter L. Reichertz. *Hospital information systems—Past, present, future*. International Journal of Medical Informatics, Volume 75, Issues 3–4, March–April 2006, Pages 282-299.
3. <https://home.kpmg.com/xx/en/home/insights/2016/03/digital-health-heaven-or-hell.html>
4. Cutler DM, Feldman NE, Horwitz JR. *U.S. Adoption of Computerized Physician Order Entry Systems*. Health Affairs. 2005; 24(6): 1654-1663.
5. Kazley, Abby, and Yasar Ozcan. 2007. *Organizational and Environmental Determinants of Hospital EMR Adoption: A National Study*. Journal of Medical Systems 31, no. 5 (October 1): 375-384.
6. Shin, D. Y., Menachemi, N., Diana, M., Kazley, A. S., & Ford, E. W. (January 01, 2012). *Payer mix and EHR adoption in hospitals. (Electronic Health Records)(Report)*. Journal of Healthcare Management, 57(6), 449-50.
7. England, Ian, Don Stewart, and Sue Walker. 2000. *Information technology adoption in health care: when organisations and technology collide*. Aust. Health Review 23, no. 3 (January 1): 176-185.
8. Bhattacharjee, Anol, Neset Hikmet, Nir Menachemi, Varol O. Kayhan, and Robert G. Brooks. 2007. *The Differential Performance Effects of Healthcare Information Technology Adoption*. Information Systems Management 24, no. 1: 5.
9. Poon, Eric, Ashish Jha, Melissa Christino, Melissa Honour, Rushika Fernandopulle, Blackford Middleton, Joseph Newhouse, et al. 2006. *Assessing the level of Healthcare Information Technology adoption in the United States: a snapshot*. BMC Medical Informatics and Decision Making 6, no. 1: 1.
10. Amarasingham, Ruben, Laura Plantinga, Marie Diener-West, Darrell J. Gaskin, and Neil R. Powe. 2009. *Clinical Information Technologies and Inpatient Outcomes: A Multiple Hospital Study*. Archives of Internal Medicine 169, no. 2 (January 26): 108-114.
11. Stephen T. Parente and Jeffrey S. McCullough. *Health Information Technology And Patient Safety: Evidence From Panel Data*. Health Affairs March/April 2009, vol. 28, no. 2: 357-360
12. Hillestad et al. *Can Electronic Medical Record Systems Transform Health Care? Potential Health Benefits, Savings And Costs*. Health Affairs September 2005 vol. 24, no. 5: 1103-1117
13. Moshe Ayal, Abraham Seidmann W. E. Simon. *On The Economic Role of RIS/PACS in Healthcare*. <https://www.researchgate.net/publication/228233564>

14. Lee, J., McCullough, J., and Town, R. (2010). *The Impact of Health IT on Hospital Productivity*, Working paper, University of Minnesota.
15. Alghamdi M , Gashgari H , Househ M. *A Systematic Review of Mobile Health Technology Use in Developing Countries*. *Studies in Health Technology and Informatics* [2015, 213:223-226]
16. Yahia Zare Mehrjerdi, (2010). *RFID-enabled healthcare systems: risk-benefit analysis*, *International Journal of Pharmaceutical and Healthcare Marketing*, Vol. 4 Iss: 3, pp.282 – 300.
17. Tang et al. *Personal Health Records: Definitions, Benefits, and Strategies for Overcoming Barriers to Adoption*. <http://dx.doi.org/10.1197/jamia.M2025.121-126>.
18. Twair et al. *Significant savings in radiologic report turnaround time after implementation of a complete picture archiving and communication system (PACS)*. *Journal of Digital Imaging*, November 2000, Volume 13, Issue 4, pp 175-177
19. <http://www.himssanalyticsasia.org/emram/stage6hospitals.asp>
20. <http://www.cxotoday.com/story/narayana-hrudayalaya-deploys-cloud-based-his-to-deliver-efficient-healthcare/>
21. <http://www.cio.in/feature/manipal-hospitals-use-wearables-to-empower-doctors-and-aid-patients>
22. <http://ehealth.eletsonline.com/2011/05/we-aim-to-create-an-it-enabled-network-of-specialised-hospitals-jagannath-ms-columbia-asia-hospitals/>
23. <http://www2.deloitte.com/uk/en/pages/life-sciences-andhealthcare/articles/connected-health.html>
24. <http://www.asianhbm.com/healthcaremanagement/from-drawers-to-digital>
25. <http://health.economictimes.indiatimes.com/news/hospitals/manipal-hospitals-adopts-ibms-supercomputer-watson-for-oncology/50017369>
26. <http://medicalfuturist.com/2016/05/03/from-ibm-to-google-10-surprising-companies-you-didnt-expect-to-embrace-disruptive-health-innovation/>