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TECHNOLOGICAL
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***MODELLING DIGITAL AND VALUE FLOWS
IN E-HEALTH***

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INFORMATION**

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS	II
TABLE OF CONTENTS	III
LIST OF TABLES	V
LIST OF FIGURES	VI
LIST OF ABBREVIATIONS	VII
ABSTRACT	IX
CHAPTER ONE INTRODUCTION	1
1.1 INTRODUCTION AND BACKGROUND INFORMATION.....	1
1.2 NATURE OF THE RESEARCH PROBLEM	3
1.3 PRIOR RESEARCH AND GAPS.....	4
1.4 RESEARCH QUESTIONS AND SCOPE.....	7
1.5 RESEARCH DESIGN	9
1.6 SIGNIFICANCE OF THE RESEARCH	12
1.7 ORGANIZATION OF THE THESIS	13
CHAPTER TWO LITERATURE REVIEW	15
2.1 LITERATURE REVIEW: PURPOSE AND APPROACH.....	15
2.2 E-HEALTH AS DEFINED IN LITERATURE.....	16
2.3 ELECTRONIC HEALTH RECORDS (EHR).....	17
2.4 PERSONAL HEALTH RECORDS (PHR).....	19
2.5 CLOUD COMPUTING IN HEALTHCARE	21
2.6 MAJOR BARRIERS TO E-HEALTH: A GAME THEORETIC VIEW	23
2.7 VOCABULARY OF RESEARCH CONCEPTS.....	31
2.8 SENSITIZING CONCEPTS AND SUBSTANTIVE AREAS.....	33
2.9 PATIENT-CENTRIC E-HEALTH ECOSYSTEM.....	35
2.10 E-HEALTH RESEARCHER-DEFINED	36
2.11 KEY E-HEALTH INITIATIVES AROUND THE WORLD.....	36
2.12 DEFINITION OF THE CASE OR UNIT OF ANALYSIS FOR PHASE 2	41
2.13 SELECTION OF CASES FOR PHASE 2	41
2.14 CHAPTER SUMMARY AND RECAP	42
CHAPTER THREE METHODOLOGY	44
3.1 CHOICE OF RESEARCH METHODOLOGY: RATIONALE.....	44
3.2 THE RESEARCH APPROACH.....	45
3.3 PHASE 1: DEVELOPMENT OF CONCEPTUAL MODEL OF A PATIENT-CENTRIC E-HEALTH ECOSYSTEM.....	46
3.4 PHASE 2: VALIDATION OF CONCEPTUAL MODEL IN THE FIELD.....	52
3.5 PHASE 3: CROSS-CASE ANALYSIS	60
3.6 CHAPTER SUMMARY AND RECAP.....	60
CHAPTER FOUR A CONCEPTUAL MODEL OF THE E-HEALTH ECOSYSTEM 61	
4.1 DATA, ANALYSIS AND DISCUSSION	61
4.2 CAVEATS	89
4.3 CHAPTER SUMMARY AND RECAP.....	90

CHAPTER FIVE	VALIDATION OF CONCEPTUAL MODEL: WITHIN-CASE ANALYSIS OF SINGAPORE’S NEHR.....	92
5.1	INTRODUCTION	92
5.2	SINGAPORE’S HEALTHCARE TRANSFORMATION JOURNEY.....	93
5.3	NEHR IMPLEMENTATION	97
5.4	SINGAPORE’S E-HEALTH ECOSYSTEM	103
5.5	LESSONS LEARNT.....	109
5.6	CONCLUSIONS.....	109
5.7	CHAPTER SUMMARY AND RECAP.....	111
CHAPTER SIX	VALIDATION OF CONCEPTUAL MODEL: WITHIN-CASE ANALYSIS OF THE US’ HITECH PROGRAM	113
6.1	INTRODUCTION	113
6.2	THE US’S HEALTHCARE TRANSFORMATION JOURNEY	117
6.3	HITECH ACT IMPLEMENTATION.....	118
6.4	THE US’ E-HEALTH ECOSYSTEM	128
6.5	LESSONS LEARNT.....	134
6.6	CONCLUSIONS	135
6.7	CHAPTER SUMMARY AND RECAP.....	136
CHAPTER SEVEN	CROSS-CASE ANALYSIS.....	138
7.1	E-HEALTH IN SINGAPORE AND THE US	138
7.2	HEALTH STATISTICS: SINGAPORE VS THE US	139
7.3	SIMILARITIES AND DIFFERENCES ACROSS CASES	141
7.4	OPTIMAL ECOSYSTEM: A GAME THEORETIC VIEW.....	143
7.5	EMERGENT THEMES AND PATTERNS.....	147
7.6	SUSTAINABLE E-HEALTH ECOSYSTEM: CRITICAL SUCCESS FACTORS	152
7.7	CHAPTER SUMMARY AND RECAP.....	155
CHAPTER EIGHT	CONCLUSIONS	157
8.1	SUMMARY OF KEY FINDINGS: ANSWERS TO RESEARCH QUESTIONS	157
8.2	IMPLICATIONS OF THE PRESENT STUDY	160
8.3	CONTRIBUTIONS OF THE PRESENT STUDY	162
8.4	LIMITATIONS OF THE PRESENT STUDY	163
8.5	SUGGESTIONS FOR FURTHER RESEARCH.....	164
REFERENCES	166
APPENDICES.....	191
APPENDIX A.	EXPERT INTERVIEW TEMPLATE	191
APPENDIX B.	EXPERT INTERVIEWS CODING SCHEME	198
APPENDIX C.	CASE STUDY INTERVIEW TEMPLATE	212
APPENDIX D.	CASE STUDY INTERVIEWS CODING SCHEME	213
APPENDIX E.	LIST OF PUBLICATIONS AND CONFERENCES / WORKSHOPS ATTENDED.....	228

LIST OF TABLES

Table 2.1.	EMR vs. EHR	18
Table 2.2.	Revenue Sources for E-Health Infomediaries	31
Table 2.3.	Vocabulary of Research Concepts	32
Table 2.4.	Sensitizing Concepts	33
Table 2.5.	Potential Cases for Phase 2: Key Healthcare Indicators	41
Table 3.1	Phase 1: List of Target Informants	50
Table 3.2	Phase 2: List of Target Informants	56
Table 4.1	Key Players in E-Health: Concept Matrix based on Literature Review and Industry Observations	66
Table 4.2.	Key Players in the E-Health Ecosystem and their Roles	69
Table 4.3.	Analysis of the E-Health Ecosystem Using ADVISOR	78
Table 4.4.	Validated Values Created Vs. Values Captured	83
Table 7.1.	WHO Statistics on Healthcare Indicators for 2014	140

LIST OF FIGURES

Figure 1.1.	Research Design	9
Figure 2.1.	EHR Construct Adapted from CCHIT	19
Figure 2.2.	Conceptual Model of an Interoperable PHR	20
Figure 2.3.	PHR Models	21
Figure 3.1	Research Roadmap	45
Figure 4.1.	Consumer Interface for Microsoft HealthVault	64
Figure 4.2.	The Validated E-Health Ecosystem	69
Figure 4.3.	E-health Digital Flows: a Simplified Model	74
Figure 4.4.	A Concept Map of Findings about the E-Health Ecosystem	89
Figure 5.1.	Singapore's Distribution of Healthcare Services	93
Figure 5.2	Singapore's Regional Health Systems Network	95
Figure 5.3.	A Concept Map of Singapore's E-Health Ecosystem	104
Figure 6.1.	Number of US Hospitals by Ownership Type (Total: 5627)	115
Figure 6.2.	Community Hospitals by Ownership Type (Total: 4926)	115
Figure 6.3.	A Concept Map of The US E-Health Ecosystem	129
Figure 7.1.	Unique and Common Themes from the Singapore and US Case Studies	141
Figure 7.2.	Payoff Graph for Healthcare Provider Strategies	144
Figure 7.3.	Payoff Matrix for E-Health Adoption Game	146
Figure 7.4.	Stages of Connected Health	149

LIST OF ABBREVIATIONS

ACA	Affordable Care Act / ObamaCare
ACO	Accountable Care Organizations
AIC	Agency for Integrated Care
ARRA	American Recovery and Reinvestment Act
B2B	Business-to-Business
B2C	Business-to-Commerce
B2G	Business-to-Government
BI	Business Information System
C2C	Consumer-to-Consumer
CAGR	Compound Annual Growth Rate
CCDA	Continuum of Care Document Architecture
CCHIT	Certification Commission for Healthcare Information Technology
CDS	Clinical Decision Support
CHIP	Children's Health Insurance Program
CLEO	Clinic Electronic Medical Record and Operation System
CPM	Cost Per Mille
CPOE	Computerized Physician Order Entry
eHINTS	Electronic Health Intelligence System
EHR	Electronic Health Records
EMR	Electronic Medical Records
EMRX	Electronic Medical Record Exchange
FDIC	Federal Deposit Insurance Corporation
GDP	Gross Domestic Product
GP	General Practitioner
HIE	Health Information Exchange
HIMSS	Healthcare Information Management Systems & Society
HIPAA	Health Insurance Portability and Accountability Act
HIT	Health Information Technology
HITECH	Health Information Technology for Economic and Clinical Health
HMO	Health Maintenance Organizations
HSOR	Health Services & Outcomes Research
IaaS	Infrastructure as a Service
IBM	International Business Machines
IDS	Integrated Delivery Systems
IT	Information Technology
LOINC	Logical Observation Identifiers Names and Codes
MCO	Managed Care Organizations
MOH	Ministry of Health
NCPDP	National Council for Prescription Drug Programs
NEHR	National Electronic Health Record
NGNBN	Next Generation Nationwide Broadband Network
NHG	National Healthcare Group
NRF	National Research Foundation
NTU	Nanyang Technological University
ONC or	Office of the National Coordinator for Health Information

ONCHIT	Technology
P4P	Pay for Performance
PaaS	Platform as a Service
PDPA	Personal Data Protection Act
PHR	Personal Health Record
POS	Point of Service
PPO	Preferred Provider Organizations
RHS	Regional Health Systems
RHIO	Regional Health Information Organizations
ROI	Return on Investment
SaaS	Software as a Service
SIGIDE	Special Interest Group on Interactive Digital Enterprise
SingHealth	Singapore Health Services
SNOMED	The Systematized Nomenclature of Medicine
TCM	Traditional Chinese Medicine
TDHS	Total Digital Health System
UPMC	University of Pittsburgh Medical Centre
US	The United States of America

ABSTRACT

A fair and efficient e-health network is one that provides a common platform to its key stakeholders to facilitate a sharing of information with a view to promoting cooperation and maximizing benefits. A promising platform for this critical application is the emerging ‘cloud technology’ with its offer of computing as a utility. This is an area that has attracted much scholarly attention as it is well-suited to foster such a network bringing together diverse players who would otherwise remain fragmented and be unable to reap benefits that accrue from cooperation. The fundamental premise is that the notion of value in an e-health ecosystem is brought about by the sharing and exchange of digital information.

Notwithstanding the potential of information and communication technology to transform the healthcare industry for the better, there are several barriers to its adoption, the most significant one being misaligned incentives for some stakeholders. This thesis suggests among other findings, that e-health in its true sense can become fair and efficient if and only if a regulatory body concerned assumes responsibility as the custodian of its citizens’ health information so that ‘collaboration for value’ will replace ‘competition for revenue’ as the new axiom in delivering the public good of healthcare through digital networks.

CHAPTER ONE INTRODUCTION

1.1 Introduction and Background Information

It is no exaggeration to say that “e-revolution” has radically transformed the conventional landscape of business and consumerism, as evident from the variety of e-initiatives successfully launched over the past several decades. Today, with the Internet and digital services dominating most key aspects of day-to-day living, online means of communication, entertainment, education, banking and a host of e-commerce transactions are not merely convenient but tangibly efficient, cost-effective and time-saving. However, despite the Internet having revolutionized most aspects of human life, its foray into healthcare has been relatively inconsequential possibly on account of the complexities inherent in the industry (Wickramasinghe, Fadlalla, Geisler, & Schaffer, 2005; Hill & Powell, 2009; Black et al., 2011; Kellermann & Jones, 2013).

This is quite apparent, for instance, in the way the health data of the patient seeking medical help is typically collected and stored in the present day. It is common knowledge that such vital patient information continues to get recorded, processed and stored on paper in much the same way as done a century ago without recourse to information systems, decision aids and prompts (Middleton, 2008; Serbanati, Ricci, Mercurio, & Vasilateanu, 2011; Jaroslowski & Saberwal, 2014). The danger involved in this situation is that the data stored on paper may get increasingly disjointed, incoherent or even inaccessible over a period of time as it gets passed on from hand to hand. This apart, inherent in this practice is the potential risk that any updates and changes incorporated on paper may not all come to the attention of the current healthcare provider which may, in turn, seriously compromise the quality of the healthcare provided.

The arrival of e-health may be recent, but its long-term potential is immense (Dyer & Thompson, 2001; Bulgiba, 2004; Tripathi, Delano, Lund, & Rudolph, 2009; Parmar, Mackenzie, Cohn, & Gann, 2014; Rothenhaus, 2015). A case in point is the dramatic rise in the number of people in the United States of America (US) looking for health information online, which jumped from 10 million in 2000 to 100 million in early 2007ⁱ. It was also estimated that by 2013 about 45% of US adults with a chronic condition would be using the internet to

manage their conditionⁱⁱ. This trend, needless to say, is increasingly getting conspicuous all over the world including developing countries. This may be seen as an indication of healthcare consumers' "unquenchable need for more and greater access to health information and services" (Wen & Tan, 2003, p 2).

Coupled with the above observation is the policy imperative of many governments to reform healthcare by making substantial investments in health information technology (HIT) to improve the safety, quality and value of healthcare (Clancy, Anderson, & White, 2009; Black et al., 2011; Ross, Stevenson, Lau & Murray, 2015). Such trends are gaining traction globally, as evidenced by the plethora of e-health projects that have stemmed worldwide in recent yearsⁱⁱⁱ. According to MarketsandMarkets (2015)^{iv}, the world healthcare IT market is expected to grow to \$228.7 billion in 2020 at a CAGR of 13.4% during the forecast period of 2015 to 2020.

Ideally, e-health should encompass medical informatics, public health and business, and include within its purview health services and information that are delivered and enhanced through the Internet and related technologies (Eysenbach, 2001). An integration of tele-health technologies with the Internet, e-health has the potential to enhance the quality and value of health services delivery through improved efficiencies and diminished costs thereby developing new markets (Wen & Tan, 2003; Baur, Fehr, Mayer, Pawlu & Schaudel, 2011). In essence, e-health comes with the promise of improved quality of care, greater safety, reduced costs, reduced medical errors, increased efficiency of information flow and most importantly, empowerment of healthcare consumers in their healthcare decisions (Walker, Pan, Johnston, Adler-Milstein, Bates, & Middleton., 2005; Vishwanath & Scamurra, 2007; Tripathi et al, 2009; Ebel, George, Larsen, Neal, Shah & Shi, 2012).

Although e-health envisages endless possibilities for the healthcare industry, there are several barriers to its adoption, the most significant ones being those that come from the healthcare providers' perspective. Some of the major barriers are high investment costs (Reed, 2007), uncertain returns on investment (Steele, 2006), loss of productivity (Clarke & Meiris, 2006) and, most significantly, misalignment of incentives (Glaser, 2007). Overcoming these deterrents is crucial because healthcare providers are supposedly the harbingers of the future of e-health. If the barriers faced by them go unresolved,

their participation and cooperation cannot be secured. As a result, the ideal of a patient-centric e-health system may not materialise.

1.2 Nature of the Research Problem

Currently, healthcare providers may feel that they are unduly burdened with the responsibility of promoting e-health through investments in Electronic Health Records (EHR) systems. This may be because building such a system would obviously require huge investments as well as equally huge maintenance costs. Further, costs may also come in the form of licensing and upgrading fees from time to time. Despite such investments, there is no guarantee on returns, however, owing to a lack of demonstrable evidence on the long term sustainability of an e-health system (productivity paradox). While the investment in EHRs is considerable - not only in terms of direct costs but also in terms of the time spent on staff training and the consequent loss of productivity the returns on such investment may often be disappointingly too low to warrant any justification.

To create a patient-centric e-health network, the combined power of technology and the Internet must be harnessed to foster a totally “connected” health network that encompasses all the key stakeholders, and provides a common platform for interfaces and transactions among them, seamlessly connecting them in the process for an exchange and reuse of health information. Because such a network is in fact an interconnected ‘network of networks’ that delivers a product or service through both competition and cooperation, it can be thought of as a ‘business ecosystem’. James Moore, who pioneered the concept in 1996, describes the ecosystem as being made up of “customers, market intermediaries (including agents and channels, and those who sell complementary products and services), suppliers, and of course, oneself” (Kandiah & Gossain, 1998, p. 29). In addition, such an ecosystem should be able to create value for its customers by providing additional information, goods and services, through the use of the Internet and related technologies (Kandiah & Gossain, 1998). The type of patient-centric e-health network envisaged in this thesis may be said to have the attributes that characterize a business ecosystem and may henceforth be referred to as an “e-health ecosystem”.

Such an ecosystem may however be a difficult proposition in the current lopsided scenario where one stakeholder in particular, namely the healthcare provider, views itself as creating more value than it can capture from the network, with the other stakeholders benefiting more from the value created, a phenomenon known as the “**tragedy of the commons**”.

A patient-centric e-health network is also expected to reduce information gaps in the provider-patient relationship, benefitting patients and empowering them in their healthcare decisions and choices. Such an outcome may not be desirable for healthcare providers who have been traditionally leveraging this information gap (**information asymmetry**) to their advantage. And given the huge investments they need to make in order to progress into e-health, they may feel that it is neither logical nor reasonable to have to share the benefits of their investments with others including patients.

Even though some healthcare providers may seem willing to share their patients’ health data over the network, they may only want to do so within a private network. A private network is an arrangement entered into by players (strategic decision makers) for mutual benefits. Data is strictly shareable only within the network thus restricting patients’ healthcare choices to such players as are part of the network (**information blocking**).

Issues (dilemmas) such as the ones discussed above have not, as yet, been addressed and resolved to the satisfaction of healthcare providers. In this context research has an important role to play inasmuch as it can establish the fact that a patient-centric e-health network may be feasible provided that certain conditions are met. To resolve these issues, appropriate trade-offs between conflicting notions such as fairness and efficiency must be achieved for every key player in the e-health network, particularly the healthcare provider. Fairness in this context would mean the pay-off received by a player proportionate to its contribution to the achievement of the total output, whereas efficiency would mean the benefits resulting from reduced information asymmetries.

1.3 Prior Research and Gaps

Over the last decade and a half there have no doubt been several studies exploring the potential opportunities of e-health and its resultant benefits to the

key players, but these studies were, by and large, limited in scope and findings, perhaps owing to the nascence of the field.

For example, Parente (2000) and Wen & Tan (2003) based their study on the business models of the then-existing health e-commerce websites, Aggrawal & Travers (2001) highlighted some innovative changes that could be introduced into healthcare through B2B and B2C e-commerce business models and Joslyn (2001) showed the significance of patient-centric e-health business models in the context of rising consumerism. While these studies have made a meaningful contribution inasmuch as they helped identify some of the key players in the field as well as recognize new values that are likely to be created and captured in the e-health network, they were, as a rule, narrowly focused in that they failed to take a holistic view of the e-health ecosystem, or adequately represent all the key stakeholders or players in terms of their roles and interactions.

Later, deBrantes, Emery, Overhage, Glaser & Marchibroda (2007) explored the potential of health information exchanges (HIEs) to function as economically sustainable intermediaries that could create value by reducing the information asymmetries among its customers, namely the healthcare market players, through information feedback loops. The study specifically focused on the values generated for the e-health market players through such information feedback loops, but barely touched upon business model arrangements which are necessarily a part of such systems.

Busch (2008) identified some key market players in the healthcare continuum and classified them as primary and secondary depending on how the players used health information – whether for direct and indirect patient-care related activities or for roles outside of these patient-care activities. Even though the roles of these players were clearly mapped, Busch's notion of value was from an audit perspective; it largely dealt with how a health information system should be audited for content, infrastructure and process to ensure appropriate internal controls, and not so much with how to organize the e-health ecosystem.

Raghupathi & Kesh (2009) on the other hand, examined the concept of total digital health systems (TDHS) that could offer both intra- and inter-enterprise benefits by fostering a sharing of health information among the

various healthcare delivery participants. However, the focus of the study was on the TDHS technical design issues rather than on the design of a business model to organize the players in the e-health ecosystem.

DesRoches et al. (2010) conducted a study of the US hospitals to determine the relationship between EHR adoption and key metrics like quality and efficiency, and found a strikingly weak relationship between them. This led them to acknowledge the lack of evidence on how best to implement the EHR to achieve maximum gains in healthcare. Mensink and Birrer (2010) discussed the case of the Dutch Electronic Health Record, the progress of which they found to be slow, one of the reasons being the strategic considerations of the various players involved.

Paun et al. (2011) recognized the significance of both local and global interoperability of EHRs, as health data must be accessible to patients anytime and anywhere, and advocated an openEHR. The scope of their study was limited to a technical modelling of the openEHR for the Romanian healthcare system, without much discussion on business model arrangements within the ecosystem.

Wiedemann (2012) once again broached the topic of lack of evidence in favor of EHRs, and attributed that to unintended consequences of implementing and using EHRs that might create new risks and threaten patient safety. In conclusion, she raised the question whether a central agency would be needed to monitor the EHRs so as to prevent any negative consequences of EHR implementation and use by healthcare organizations. Here again, the focus was confined to EHR implementation and use-related issues within a healthcare provider setting.

Kellermann and Jones (2013) found the performance of Health IT in the United States ‘disappointing’ with reality being a far cry from what was projected and hoped for; seven years after RAND Corporation’s projection in 2005 that \$81 billion annual savings could be achieved with Health IT adoption, the annual healthcare expenditure in the United States actually grew by \$800 billion. Some technical reasons suggested as being responsible for this phenomenon were sluggish health IT adoption, adoption of non-interoperable systems and failure to re-engineer care processes.

Rudin, Jones, Shekelle, Hillestad, & Keeler (2014) observed that stakeholders in healthcare organizations were well aware of the benefits they could derive by being part of a health IT platform that would facilitate an exchange of health information among them. However, they lacked clarity in terms of how to organize this platform to create a compelling business case for its sustainability.

As recently as 2015, Bergmo (2015) highlighted the lack of a viable business model to deliver and sustain e-health. The author lamented the fact that in spite of e-health having been around for many years, “basic issues” with regard to its sustainability stand unresolved.

With e-health gaining momentum around the world, there are bound to be changes to the scope of traditional roles and processes in the e-health ecosystem, which may have a significant impact on e-health business models. However, it is evident from the above literature review which spans the period between 2000 and 2015, that little research is available on the potential critical success factors for a patient-centric e-health business model that considers all at once the key players, and the values created and captured by each of them, while suggesting alongside a win-win arrangement among them for a fair, efficient and sustainable e-health ecosystem. It is hoped that the present thesis will fill some of the gaps in the e-health literature and make a worthy contribution to this body of knowledge.

1.4 Research Questions and Scope

Following from the research gaps identified, this thesis set out to investigate two fundamental research questions:

Research Question 1 (RQ1): *Who are the key players in a patient-centric e-health ecosystem and what are the potential values they can create and capture through digital data flows?*

The objective of RQ1 is to adequately model a patient-centric e-health ecosystem in terms of the key players, their roles, and the potentially major digital flows among them. Such modelling, it is hoped, would be a prerequisite to the identification of values created and captured in the e-health ecosystem for any subsequent analysis. RQ1 considers in particular the case of healthcare

providers who are fraught with dilemmas of participation and cooperation in e-health. This is addressed in the first phase of this research.

Research Question 2 (RQ2): *What are the critical success factors for developing a sustainable patient-centric e-health ecosystem?*

RQ2 will help identify some key factors that have the potential to drive healthcare providers' decisions to invest in e-health, and share the benefits of their investments with other players. RQ2 is also intended to contribute to factors that need to be considered from healthcare providers' perspective in the design of a business model; an important consideration in the third phase of the research.

Healthcare providers may be the most important drivers of, and contributors to e-health, but it is wrong to assume that a patient-centric e-health system can be arrived at just by resolving their dilemmas. Therefore, the purpose of RQ2 is also to investigate if there is sufficient incentive for all the key players to participate in a patient-centric e-health ecosystem, by analyzing the values they create and capture. Although the word "sufficient" is subjective, it is not unreasonable to conjecture that the key players will not be motivated to participate in e-health if the values they capture (payoff) do not justify the values they create (contribution) in the network. On the other hand, without the participation of all the key players, e-health may not have the potential to generate sufficient values for its sustainability.

The primary objective of RQ2 is thus to identify the critical success factors for a sustainable e-health business model iteratively, using economic notions of fairness and efficiency for all players in a patient-centric e-health ecosystem. RQ2 is addressed in phases 2 and 3 of this research.

The scope of e-health considered for this research is a total digital health system (TDHS) connecting all the key players electronically via the Internet. In the actual sense though, e-health is a term that encompasses much more than just the Internet and healthcare. It is not just a technical development, but a "state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve healthcare locally, regionally, and worldwide by using information and communication technology" (Eysenbach, 2001, p 20).

1.5 Research Design

Figure 1.1 provides a high-level overview of the research methodology adopted in this thesis.

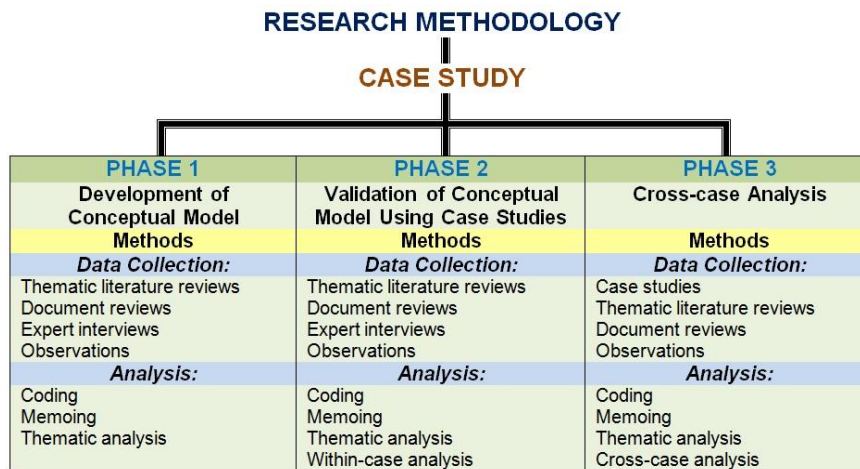


Figure 1.1. Research Design

The appropriateness of a research method derives from the nature of the social phenomenon to be investigated. Given the nature and scope of the Research Questions, the research methodology chosen as most appropriate for the research purposes is the case study. Patton (1987) holds the view that if the phenomenon in question is an area of interest that is complex and calls for in-depth probing, the most appropriate method is the case study. Leedy & Ormrod (2010) concur that case studies are particularly apt for a researcher seeking to explore in depth a little known or understood situation. Given the multifaceted, complex and still-evolving nature of e-health the phenomenon under study, there is a good fit between the study and the chosen methodology. What makes e-health a complex phenomenon is that it involves several interwoven issues and externalities that need to be contended with in order to gain a holistic understanding of the phenomenon. Compounding this challenge is the fact that the literature concerning the evolution of the phenomenon is narrowly-focused as already discussed in the **section 1.3**, ‘Prior Research and Gaps’. The forenamed characteristics of this study make it an ideal candidate for the case study methodology which is believed to bring to the fore meaningful emergent concepts to help unravel conceptual relevance and ultimately lead to answers to the research questions.

Correspondingly, the research conducted in this thesis adheres to the following three phases:

1.5.1 Phase 1 – Development of a Conceptual Model of Patient-Centric E-Health Ecosystem

This phase of the study began with a systematic review of extant literature on health information technology (HIT) and observations of developments in the field to generate sensitizing concepts which would lead to the identification of the areas of enquiry for this research, commonly referred to as ‘substantive areas’ - major streams of research to inform the topic. The substantive areas in this research were defined as ‘e-health’, ‘game theory’ and ‘business model’. A focused and extensive review of literature and other information sources related to e-health then followed with the purpose of gathering data which would help identify the key players in the e-health ecosystem and understand their roles and business model arrangements in order to adequately model the ecosystem as well as the major digital flows among the key players in the ecosystem. The six primary or key players identified were - Patients (Consumers), Providers, Payers, Vendors, Infomediaries and Regulators.

In addition, key business model design parameters for each of the six identified key e-health players were analyzed using the ADVISOR business model framework, to make an assessment of the values they can possibly create in the network as well as to understand how and why they may collaborate for value rather than compete for revenues. A qualitative analysis of the e-health network supported by literature was then undertaken to identify the significant values created in e-health by each of the key players, and the corresponding values captured by them. These values have been presented in Table 3.2 in Chapter Three. A provisional model of the e-health ecosystem was thus developed.

Further, to validate the provisional model, inputs were sought from experts from different walks of the healthcare industry using an interview template developed for the purpose. These expert interviews were conducted through email, phone or personal meetings. Twenty one industry experts were targeted for this exercise and the response rate was 57% with twelve experts completing the interview by the deadline of September 30, 2010. The provisional model was refined by comparing it with the data gathered through expert interviews, and perusal of evolving literature on the subject, with the

result a conceptual model for this research was deduced through triangulation of the data sources.

1.5.2 Phase 2 –Validation of Conceptual Model Using Case Studies

Phase 2 of this research involved a descriptive case study approach to validate the conceptual model where the ‘case’ or ‘unit of analysis’ was a national level e-health ecosystem. This phase commenced with a review of the various healthcare systems around the world which is presented in Chapter Two. The review, aided by literature reviews and tracking of industry trends, led to the identification of potential candidates for the case study. Representatives of these ecosystems were then identified through referrals, internet searches and LinkedIn lookups, and contact was established with them via email to request their participation in the study. The criteria established for selecting cases were progress and performance. The above measures resulted in the selection of specific case studies to be conducted to seek answers for RQ2. The cases eventually selected were the national-level e-health ecosystems that are underway in Singapore (a high-performing healthcare system) and in the US (a low-performing healthcare system). The case study protocol was then developed, and case studies of the National Electronic Health Records (NEHR) system in Singapore and the Health Information Technology for Economic and Clinical Health (HITECH) program in the US, were conducted. The sources of data for the case studies included an environmental scan of the case or ecosystem through literature and documentation reviews, interviews with representatives of key players in the ecosystem and observations of characteristics of the ecosystem. The ecosystems were individually analyzed using the game theoretic notions of fairness and efficiency, and modeled through iterative conceptualization until triangulation of data sources was achieved. Within case reports were prepared for the NEHR and the HITECH program.

Incidentally, the interview respondents are referred to as ‘informants’ in this study as they were selected through the ‘key informant technique’, where “one or a few individuals are solicited to act as guides” (Tongco, 2007) to the community of interest, which in this context was a national-level e-health ecosystem. Prerequisites for such informants were knowledge about the e-

health ecosystem they are a part of, capacity to relate to the researcher's frame of reference and of course, willingness to participate in the study.

1.5.3 Phase 3 –Cross-Case Analysis

This final phase of the research focused on a cross-case analysis of Singapore's NEHR and the US' HITECH Program to uncover any patterns for the purpose of analytical generalization, leading to some modification of the original conceptual model. The modified model was compared with literature until theoretical saturation was reached, and a cross-case report prepared. Finally, a theoretical framework for conceptualizing the issues surrounding e-health adoption by key players, and for identifying the critical success factors for a patient-centric, sustainable e-health ecosystem, was developed.

1.6 Significance of the Research

E-health has the potential to transform the healthcare industry that is currently fraught with problems of accessibility, quality and affordability. There is reason to believe that EHR is a key component of e-health. Notwithstanding the promises it brings, e-health, like any other high-technology environment, is faced with formidable legal, economic and operational barriers to its adoption. These typical barriers apart, a significant deterrent to patient-centric e-health is the adoption and use of EHRs by healthcare providers who tend to shirk from the investment because of the participation and cooperation dilemmas detailed in **section 1.2**, 'Nature of the Research Problem'. For the feasibility of patient-centric e-health, it is critical that these dilemmas be resolved to the satisfaction of the healthcare providers. As for its sustainability, it is critical that payoffs correspond to contributions for all key players, especially, the healthcare providers.

The findings of this thesis would hence make a meaningful contribution to the body of knowledge on e-health in terms of facilitating a better understanding of the e-health ecosystem, its key players and their roles and business model arrangements. Besides, the findings would also throw light on the values they can create (contribute to) and capture from (payoff) the ecosystem, and whether the apportionment of such values is equitable for all players. However, the most significant contribution of this study would be to generate a set of critical success factors for a sustainable patient-centric e-health

business model that may eventually pave the way for ‘collaboration for value’ rather than ‘competition for dollars’.

1.7 Organization of the Thesis

This thesis comprises eight chapters followed by references and appendices. Following this Introduction in Chapter One, the remainder of this thesis is organized into the following chapters:

1.7.1 Chapter Two Literature Review

Chapter Two reviews relevant literature for the purposes of developing sensitivity to the phenomenon of e-health, acquiring a vocabulary of research concepts, identifying substantive areas as well as scoping this research. Yet another focus area of this chapter is selection of appropriate cases for phase 2 of this study. This is achieved through a search of literature and industry reports for gaining familiarity with significant e-health initiatives being undertaken around the world.

1.7.2 Chapter Three Research Methodology

This chapter details the steps followed in executing the three phases of this study namely 1) development of a conceptual model of the e-health ecosystem, 2) Validation of the conceptual model using case studies and 3) cross-case analysis.

1.7.3 Chapter Four A Conceptual Model of the E-Health Ecosystem

In this chapter, a conceptual model of the e-health ecosystem is developed in response to RQ1, using data sources such as literature and document reviews, expert interviews and observations.

1.7.4 Chapter Five Validation of Conceptual Model: Within-Case Analysis of Singapore’s NEHR

Chapter Five covers the first of the two case studies undertaken for the purpose of validating the conceptual model. The case in question is the NEHR, an e-health initiative led by the Singapore government. A within-case analysis of the NEHR is presented as part of this chapter.

1.7.5 Chapter Six Validation of Conceptual Model: Within-Case Analysis of The US' HITECH Program

Chapter Six presents the within-case analysis of the HITECH Program, an e-health initiative spearheaded by the US government. This forms the second case study conducted to validate the conceptual model.

1.7.6 Chapter Seven Cross-Case Analysis

This chapter addresses Phase 3 of this study. A comparison is made between the two case studies - the NEHR and the HITECH program, to produce cumulative knowledge and seek a common explanation that can characterize the issues surrounding e-health implementations.

1.7.7 Chapter Eight: Conclusions

Chapter Eight discusses the major conclusions from this research - the critical success factors for e-health implementations. It furthermore highlights the contributions of this study to the existing body of knowledge and describes as well, the study's limitations. The chapter concludes with suggestions for further research.

The next chapter provides a systematic review of relevant literature which helped develop sensitivity to the phenomenon under study namely, e-health. The review also helped acquire a set of vocabulary to be used in this study as well as identify the substantive areas thus setting the direction for subsequent phases. Furthermore, the review facilitated an awareness of the e-health initiatives being undertaken around the world. Significantly, the review also helped select the cases for Phase 2 of this study.

CHAPTER TWO LITERATURE REVIEW

Guided by the research problem and the research questions formulated in Chapter One, this chapter starts with a systematic review of research literature on health information technology (HIT) that has emerged during 2000-2016. The year 2000 was deemed a significant starting point for the literature search because it marked the introduction of the term e-health. The main objective of such a review was to track the evolution of e-health and the conspicuous developments in the field - crucial steps to get a grasp of the key issues (sensitizing concepts) involving e-health. The chapter includes a general discussion of these various sensitizing concepts. The preliminary understanding thus gained threw light on the areas of enquiry, which are central to identifying the direction in which the industry is headed, and, consequently, scoping this research. These areas of enquiry often referred to as 'substantive areas' in qualitative research terminology, were identified as 'health cloud', 'game theory' and 'business model'. The chapter also presents an overview of significant e-health initiatives happening around the world, and furthermore, details the rationale adopted in selecting cases for in-depth study in phase 2 of this research. The chapter ends with a summary of key inferences and conclusions drawn from the discussion.

2.1 Literature Review: Purpose and Approach

This review serves four purposes: i) to help develop sensitivity to the phenomenon under study, ii) to help acquire an inventory of essential vocabulary that characterizes such studies iii) to help scope this research and iv) to select appropriate cases for an intensive study in phase 2, that would help validate the conceptual model developed in phase 1.

An expected outcome of an effort of this kind is the acquisition of 'sensitizing concepts' which are terms and expressions that "suggest direction along which to look" (Blumer, 1954 as cited in Cabitza, Simone & Cornetta, 2015) or simply 'background ideas that inform the overall research problem' (Charmaz 2003, p. 259). For a researcher, these concepts are an indispensable starting point without which the search cannot begin, and therefore cannot progress or conclude. As Gilgun puts it, "Research usually begins with such concepts, whether researchers state this or not, and whether they are aware of

them or not” (as cited in Bowen, 2006, p. 14). These sensitizing concepts mark the starting point of the analysis.

Familiarity with the growth and development of one’s chosen field of study would indeed be a great resource for the researcher. Thus, scholars (e.g. Suddaby, 2006; Urquhart & Fernandez, 2013; Yarwood-Ross & Jack, 2014) have warned against the risk of overlooking prior research. Such an approach would prove detrimental as it would invariably lead to a waste of precious research time and there is always the danger of the researcher being bogged down by irrelevant concepts. Prior knowledge of what has happened over a period of time would on the contrary sensitize the researcher to the phenomenon being studied, and help establish sensitizing concepts or ideational constructs which would go a long way in identifying and selecting areas of enquiry referred to as ‘substantive areas’ (Urquhart, Lehmann, & Myer, 2010). This rings true especially in the context of e-health where it is hard to grasp the complexity beyond the surface of the phenomenon without a thorough and systematic literature review.

The remainder of this chapter includes an overview of e-health, several key concepts related to e-health, and a snapshot of significant e-health initiatives around the world.

2.2 E-Health as Defined in Literature

The term e-health came to be used first in the year 2000 (Pagliari et al., 2005) and it still remains a grey area in view of the many varied definitions of its scope and focus (Pagliari et al., 2005; Mettler, Rohner, & Baacke, 2008; Kivits, 2013; Treskes, Van Der Velde, Atsma & Schalijs, 2016). According to Eysenbach (2001), for instance, e-health is the point of intersection where medical informatics, public health and business come together for a common purpose. In the view of Eysenbach (2001) it signifies health services and information delivered or enhanced through the Internet and related technologies. Pagliari et al. (2005) draw attention to the fact that most e-health definitions place an emphasis on its communicative functions which are facilitated by networked digital technologies, especially the Internet. They therefore conclude that “e-health is the use of emerging information and communications technology, especially the Internet, to improve or enable health

and healthcare” (p.14). As different from these scholars, de Brantes, Emery, Overhage, Glaser & Marchibroda (2007) view e-health in terms of its potential to reduce or eliminate information asymmetries in the healthcare market place and transform it into a more transparent and efficient market. Busch (2008) points out that e-health involves digital and electronic tools and network exchanges conceived and developed to facilitate designated market players to generate, transfer and utilize healthcare data in electronic form. On the other hand, the World Health Organization (WHO) simply defines e-health as “the transfer of health resources and healthcare by electronic means” (WHO as cited in Treskes et al., 2016, p.443).

Despite such varied definitions, the common factor underlying e-health is that it comes with the promise of improved healthcare, reduced costs, reduced medical errors, increased efficiency of information flow and, most importantly, empowerment of healthcare consumers to take decisions on their own. This is the fundamental premise and promise of an e-health ecosystem.

2.3 Electronic Health Records (EHR)

EHR is a term that has received increasing scholarly attention in recent health informatics literature. EHR is a longitudinal electronic record of health information generated by one or more encounters in a healthcare delivery setting. It is created, managed, and consulted by authorized clinicians and medical staff (Raghupathi & Kesh, 2009). EHRs conform to nationally recognized **interoperability** standards and contain information drawn from multiple sources.

The term ‘interoperability’ refers to the provision for two or more systems to share and use information. As one would expect, it implies considerable cooperation and coordination among the stakeholders concerned. In the opinion of Brailer (2005), interoperability is a prerequisite for binding together a huge network of critical and real-time health data so as to derive in full the benefits of the application of e-health technologies.

EHRs may be termed the building blocks of e-health, and they are different from electronic medical records (EMR). While both EHRs and EMRs are electronic records of individuals’ health-related information, they are different in that the former conforms to nationally recognized interoperability

requirements while the latter does not. Unlike EHRs which are exchangeable across disparate organizations, access to EMRs is limited to authorized clinicians and staff within a single healthcare organization. Moreover, Garets and Davis (2005) point out that EMRs are computerized clinical records of individuals created disparately by healthcare providers such as hospitals, while EHRs follow individuals through different modalities of care and facilitate sharing of health information among authorized stakeholders. A significant advantage of EHRs is that it facilitates quick and accurate access to an individual’s health history (Charette, 2006). Table 2.1 summarizes the key differences between EMR and EHR.

Table 2.1.

EMR vs. EHR

EMR	EHR
• Provider-centric	• Patient-centric
• Intra-organizational	• Inter-organizational
• Episodic	• Longitudinal

EHRs are not the product of a simple computer application, but of a carefully built set of highly integrated systems that require significant investments of time and financial capital as well as process change and human factor reengineering (Amatayakul, 2009). According to the United States based Center for Studying Health System Change, although EMRs help coordinate care within a healthcare practice, they are not very helpful when it comes to, for example, exchanging data across care settings. This is due to the fact that their design lacks in standardization of data elements without which there cannot be any interoperability (O’Malley, Grossman, Cohen, Kemper, & Hoangmai, 2009). While interoperability has long been recognized as the key to maximizing returns on technology investment, there is little motivation for healthcare providers to transition to EHR by making necessary workflow changes to their EMR, largely because of the costs involved and the lack of incentives to do so (Dolan, 2010).

Figure 2.1 illustrates the components envisioned for an EHR by the Certification Commission for Healthcare Information Technology (CCHIT).

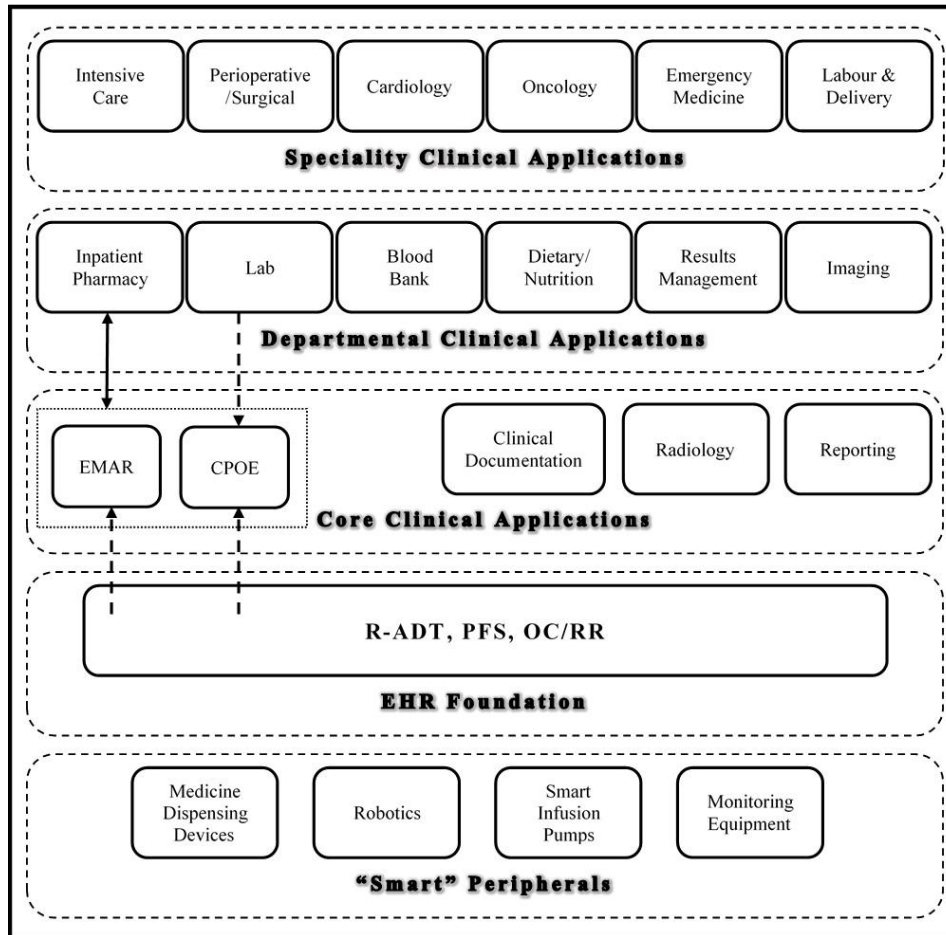


Figure 2.1. EHR Construct Adapted from CCHIT

R-ADT: Reservation/Registration – Admission, Discharge, Transfer systems

PFS: Physician Fee Schedule

OC/RR: Order Communication/Results Retrieval

EMAR: Electronic Medication Administration Records

CPOE: Centralized Physician Order Entry

2.4 Personal Health Records (PHR)

Distinct from EHR, PHR is an electronic record containing health-related information managed, shared, and controlled by an individual (Amatayakul, 2009). However like EHR, PHR also conforms to nationally recognized interoperability standards and contains information drawn from multiple sources. PHRs are increasingly being recognized as a means to support consumer empowerment and value-driven healthcare. Unlike EHRs that are **provider-centric** and primarily intended to support clinical decisions, PHRs are **patient-centric**.

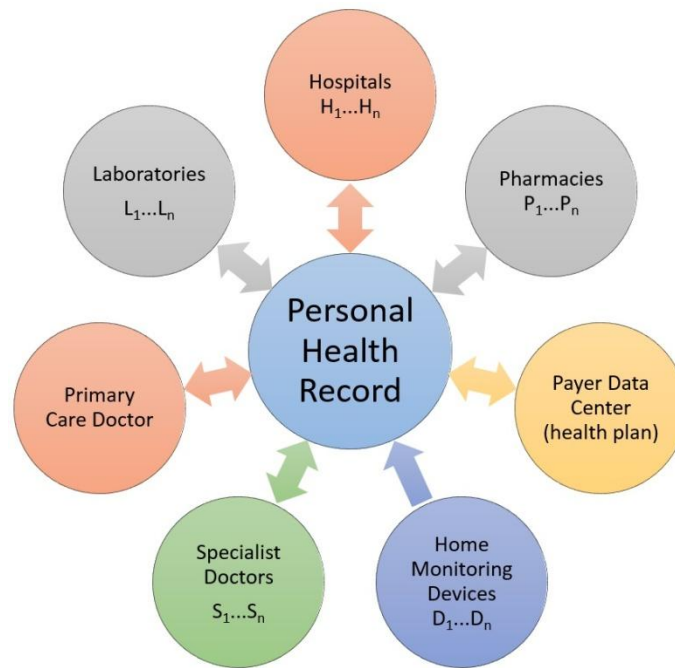


Figure 2.2. Conceptual Model of an Interoperable PHR

As shown in Figure 2.2, they are electronic applications through which individuals can maintain and manage their own health information or that of others whom they represent. These records contain the breadth and depth of an individual's personal health information and have privacy, consent and authorization features built into them (Leslie, 2005). In an emergency situation, the healthcare provider can access these online records which provide basic life-saving information about a patient, via the emergency access or override feature.

PHRs may be implemented as **stand-alone** solutions that do not consolidate information directly or indirectly from physicians, or they may be **tethered** to electronically integrate information across multiple data inputs including ancillary streams like exercise and diet data. Tethered PHRs may be sponsored by a healthcare provider, payer, employer, affinity group or commercial vendor (Amatayakul, 2009). Understandably, tethered PHRs are tied to the sponsoring organization's information systems, and do not allow sharing of health information with 'outside' organizations.

Kaelber and Pan (2008) discuss a third model of PHRs namely an **interoperable** PHR, which they claim to be of great value. Anoshiravani, Gaskin, Kopetsky & Longhurst (2011) describe interoperable PHRs as systems

that can automatically import data from external sources with the added facility to electronically exchange healthcare data with ‘outside’ organizations. Such systems accord ownership and control of health information to patients, rather than to providers or payers. The benefits of an integrated and interoperable e-health system can be best harnessed if PHRs and EHRs can seamlessly exchange data with one another. Figure 2.3 illustrates the three types of PHRs.

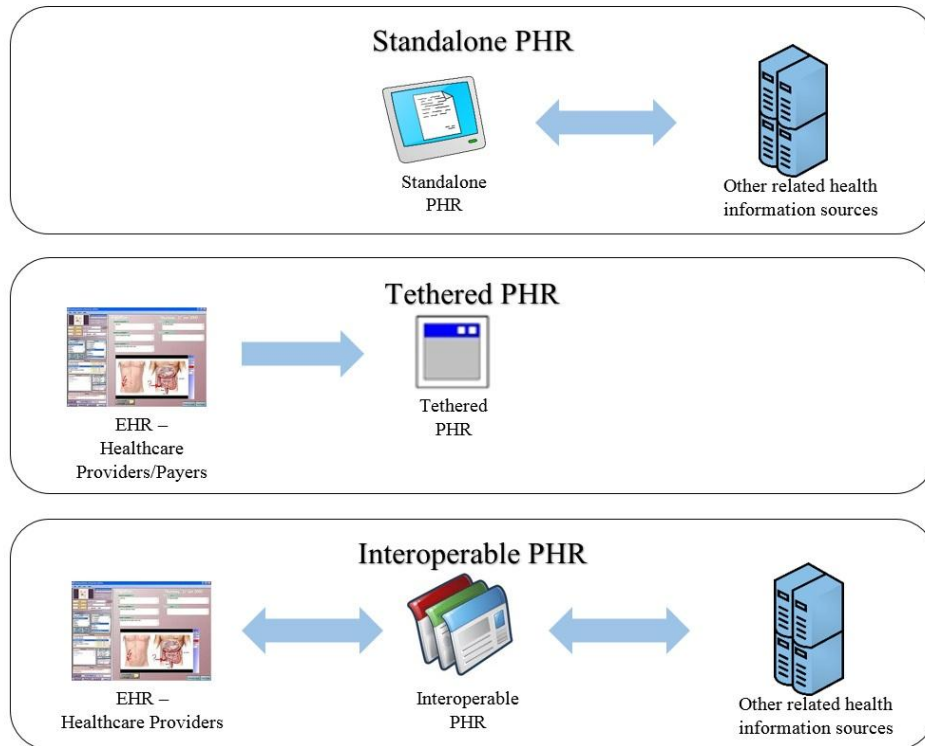


Figure 2.3. PHR Models

2.5 Cloud Computing in Healthcare

Etymologically, the term “cloud computing” comes from ‘The Cloud’ (internet-based computers) which can provide a variety of services (Shimrat, 2009). Cloud computing is a range of IT services delivered over the Internet – Software as a service (SaaS), Platform as a service (PaaS) and Infrastructure as a service (IaaS) (Kuo, 2011; Webb, 2012). It is reasonable to conjecture that the application of cloud computing to e-health has great potential to contribute to and enrich e-health. With e-health becoming a national level agenda in several countries, digitized clinical data is expected to grow exponentially. It has been suggested that cloud computing could be the technology needed to cope with such an overload (Catalino, 2010; Abukhousa et al, 2012). More specifically, cloud computing has the potential to reduce IT infrastructure costs of healthcare

organizations considerably, and, what is more, it can also eliminate IT maintenance costs that are major roadblocks to EHR adoption (Catalino, 2010; Abukhousa et al, 2012). Also, cloud computing offers an infinite and elastic structure which can drive profitability for healthcare providers by improving resources utilization and increasing their scalability (Sujith, 2008).

When a ‘cloud’ is made available to the general public on a free or pay-as-you-go basis it becomes a utility computing service, and is labelled a ‘public cloud’. Some examples of public clouds are Gmail, Microsoft Office 365 and Dropbox. As different from this, ‘private clouds’ are cases where data centers of a business or organization are not available to the general public (Armbrust et al., 2009). A private cloud is a data center architecture intended for the sole use of a single organization and possibly its partners. It not only requires flexibility and scalability, but also greater control, security and privacy. There is also a third type of cloud referred to as a ‘hybrid cloud’ which allows an organization to maintain control of its internally managed private cloud as well as utilize the public cloud as and when needed.

As the healthcare industry looks beyond EHRs to maximize the use of health data, the cloud computing model is expected to play a significant role in health information exchanges (Lassetter, 2010; Lai & Wang, 2016), which refer to the electronic movement of health-related information among organizations according to nationally recognized standards. According to estimates by MarketsandMarkets (2015), the global healthcare cloud computing market is expected to reach \$9.48 Billion by 2020 from \$3.73 Billion in 2015 at a CAGR of 20.5%.

In the present context, cloud service providers have the opportunity to function as **infomediaries** who can create new values in the e-health ecosystem beyond exchange efficiencies, by reducing information asymmetries among the market players, which would eventually augment market transparency and efficiency (de Brantes et al, 2007; Yip & Hsiao, 2009, Sunyaev & Schneider, 2013). ‘Infomediary’ is a portmanteau word coined by Hagel III and Rayport (1997) by fusing the sounds as well as meanings of the words ‘information’ and ‘intermediary’. An infomediary is described as a neutral, unbiased, third party entity that functions as an information conduit and as a business matchmaker (Song and Zahedi, 2007), creating in the process, a novel kind of information

supply chain (Hagel III & Rayport, 1997). However, this is not to say that technological advancements like cloud technology will remove or even minimize the barriers confronting the healthcare providers. What follows is a game theoretic view of some of these major barriers to e-health.

2.6 Major Barriers to E-Health: A Game Theoretic View

The formal study of decision-making in strategic situations where several players must make choices that potentially impact the interests of the other players is called game theory (Turocy & von Stengel, 2001). The term “game” in game theory is used to formally describe a strategic situation. Game theory is a set of analytical tools that helps comprehend the dynamics that unfold when decision-makers interact (Osborne & Rubinstein, 1994). It provides a systematic way to understand the behaviour of players in situations of interdependent fortunes (Brandenburger & Nalebuff, 1995) like in the e-health ecosystem. It is the study of conflict and cooperation among intelligent, rational entities often referred to as ‘players’, in their decision-making processes (Myerson, 1991). Since e-health calls for cooperation among the players amidst conflicts, it is believed that game theory principles may be useful for an analysis of their behaviour. In fact game theoretic frameworks have been utilized by scholars like Bandyopadhyay, Ozdemir & Barron (2012) and Martinez, Feijoo, Zayas-Castro, Levin & Das (2016) to investigate issues in e-health in other contexts. While the former group used game theory principles to investigate if PHRs had the potential to spur EHR adoption among the healthcare providers, the latter group developed a game theoretic model to predict the willingness of healthcare providers to exchange patient information with other unaffiliated healthcare organizations including competitors.

A basic aspect of a game is the interdependence of the players’ decisions (Dixit & Nalebuff, 2008), which, in the context of e-health, may mean a key player’s freedom of choice whether or not to participate and create values in the ecosystem. If the healthcare providers for example are not motivated to participate in e-health and create values in the form of EHRs, significant values may be lost for the ecosystem rendering it thereby unsustainable. For every key player to participate and create value in the e-health ecosystem what is basically

needed is fairness in terms of the values that can be captured from the ecosystem.

2.6.1 Fairness

The notion of fairness has to do with ensuring that all players in a game get a fair deal in their interactions, agreements or situations. According to Grandori (1999), fairness denotes rules or criteria used to divide valuable resources for apportionment among different players. Of the four rules the concept of fairness suggests, the input-output rule is obviously the most relevant for the e-health ecosystem. The input-output rule states that fairness is the correspondence between the pay-off received by a player and their contribution to the achievement of the total output. In the context of e-health, this rule would mean that every player should be able to capture values in proportion to the value they create in the network. Such fairness is essential to keep the players engaged to the ecosystem, without which the benefits of e-health cannot be harnessed in full.

2.6.2 Efficiency

It may be noted that the notion of efficiency may conflict with the notion of fairness in the digital industry which is characterized by intense competition resulting from reduced information asymmetries. In healthcare, resource misallocations are massive owing to the lack of uniform and transparent information in the marketplace (Shmanske, 1996; Yip & Hsiao, 2009). Some key players have remarkable incentives to hoard information and leverage the asymmetry to maximize their profits. A case in point is the healthcare providers who have more incentive to institutionalize patient data than to share the data with other players. The consequence is a serious lack of coordinated care, the brunt of which has to be borne by healthcare consumers (de Brantes et al., 2007). No doubt, the e-health ecosystem can significantly reduce such asymmetries and improve market transparency and efficiency, but it may not provide the financial stimulus for such players to participate in the ecosystem. The ecosystem would be sustainable only if the right tradeoff between efficiency and fairness is achieved. Another possibility worth investigating is whether the ecosystem may still be sustainable if at the least, no player is worse off than status quo because of their participation in the ecosystem, and at least

one player (healthcare consumers) is better off. Such an outcome is referred to as 'Pareto-efficient'.

2.6.3 Pareto Efficiency

A possible outcome of a game is Pareto-efficiency which implies that there is no other outcome that makes every player at least as well off and at least one player strictly better off. That is, a Pareto-efficient outcome cannot be improved upon without hurting at least one player (Grandy, 2006). However, whether this notion would hold good as a basic criterion for the sustainability of e-health, remains to be investigated.

A game theoretic view of the major barriers to e-health particularly from the healthcare providers' perspective makes it evident that these are manifestations of the prisoner's dilemma, a classic example to demonstrate game theory. Prisoner's dilemma is a game theoretical model of cooperation and conflict, originally developed by Merrill Flood and Melvin Dresher in 1950 and formalized and nicknamed by Albert W. Tucker a little later (Surhone, Timpledon & Marseken, 2010). Luce and Raiffa (1957) in their book, *Games and Decisions*, describe Prisoner's Dilemma as follows:

Two suspects are taken into custody and separated. The district attorney is certain they are guilty of a specific crime, but he does not have adequate evidence to convict them at trial. He points out to each prisoner that each has two alternatives: to confess to the crime the police are sure they have done, or not to confess. If they both do not confess, then the district attorney states he will book them on some very minor trumped-up charge such as petty larceny and illegal possession of a weapon, and they will both receive a minor punishment; if they both confess they will be prosecuted, but he will recommend less than the most severe sentence; however, if one confesses and the other does not, then the confessor will receive lenient treatment for turning state's evidence whereas the latter will get "the book" slapped at him. (p. 95)

Prisoner's dilemma, in other words, is the conflict between self-interest and group interest. Rapoport and Chammah (1965) define prisoner's dilemma as a mixture of interpersonal and intrapersonal conflict, which eventually leads to individual defections culminating in an overall scenario of less desirable

outcomes (Turocy & von Stengel, 2001). In the context of e-health, these are some typical dilemmas faced by healthcare providers during the various stages of the evolution of e-health and may be considered to fall into two categories namely (i) participation dilemmas and (ii) cooperation dilemmas. These dilemmas, if unresolved, may render e-health infeasible and unsustainable. A brief account of each of the dilemmas is given below.

2.6.4 Participation Dilemmas

These are barriers that deter healthcare providers from taking the essential first steps towards e-health, which involves making substantial investments in building EHRs. What follows is a short discussion of the participation dilemmas:

2.6.4.1 Productivity Paradox.

The famous quip by Robert Solow, Nobel Laureate in Economics, that, "we see computers everywhere except in the productivity statistics" (Solow, 1987), still rings true after decades, especially in the context of investments in e-health. Some healthcare organizations, for instance, still challenge the much advocated link between investments in technology and improved organizational performance, keeping alive the debate on IT payoff, referred to in literature as the "productivity paradox" (Brynjolfsson & Hitt, 1998; Devaraj & Kohli, 2000).

In the absence of demonstrable evidence of positive payoffs from e-health investments (Wiedemann, 2012; Bergmo, 2015), the strategy most prevalent among individual healthcare providers is defection to e-health rather than joint cooperation. This would mean that if healthcare providers are not motivated to invest in EHRs due to the productivity paradox, e-health may continue to remain a distant dream.

2.6.4.2 Tragedy of the Digital Commons.

EHRs are the building blocks of e-health that need to be heavily invested in and created by the healthcare providers. These digital health records also need to be enabled for exchange and reuse of health data by other players in the network such as patients, payers, vendors, and other healthcare providers (Adler-Milstein & Bates, 2010), so that the benefits of e-health are harnessed in toto. In other words, in a patient-centric e-health ecosystem, health data is viewed and

treated as a public good or “commons” which every stakeholder including patients and those authorized by patients can consume without necessarily contributing to it. Albanese and Fleet (1985) describe this as ‘free-riding’ where a member of a group benefits from its access to a common resource more than they actually contribute to the cost of this common resource. This ‘free-riding’ is reminiscent of the misaligned incentives discussed in the context of e-health and often deters healthcare providers from investing in e-health (Bandyopadhyay et al., 2012) which in turn might prove detrimental to other players. If healthcare providers shirk from investing in e-health, it will only lead to a deficient or less desirable outcome for everyone, resulting in a situation referred to by Adar and Huberman (2000) as the ‘tragedy of the digital commons’.

2.6.5 Cooperation Dilemmas

These dilemmas, as different from participation dilemmas, relate to such healthcare providers as have already invested in EHRs for productivity gains, but are reluctant to share the EHRs with other players in the network. Two such dilemmas are:

2.6.5.1 Information Asymmetry.

It is well-acknowledged that the physician-patient relationship is characterized by asymmetric information (Arrow, 1963; Blomqvist, 1991). This is because a physician who examines a patient acquires information about the patient which the latter cannot access on his/her own (Blomqvist, 1991). Such information asymmetry results in provider-centrism where the providers are very much in control of their patients’ healthcare decisions and choices, which may not always be in the patients’ interest.

However, given the potential of e-health to foster a sharing and exchange of health data, it has been suggested from time to time that information asymmetries of this kind may be reduced to facilitate greater patient empowerment.

Though the health data of individual patients is maintained by healthcare providers in heavily invested systems, it is by all means a common property resource owned by both healthcare providers and patients and it should therefore be made accessible to both groups. However, the reality is that such

health data is underutilized, if not totally unutilized, especially by patients for reasons beyond their control (Martinez et al., 2016). One basic reason is that healthcare providers who have invested in EHRs are unwilling to progress to the next level by sharing the data with their patients and other players in the network. If such information sharing is made possible as in an efficient market system, patients would really be empowered to shop around and choose a healthcare provider on their own, based on criteria such as cost-effectiveness, reliability and quality (Hill & Powell, 2009). This would go a long way in reducing provider-centrism, as well as, providers' return on EHR investments.

2.6.5.2 Information Blocking.

Some healthcare providers may be willing to invest in EHRs if they perceive certain significant productivity gains from the investment. Furthermore, they may even take e-health to the next level by sharing their patients' health data with parties outside their institutional walls. However, they may limit such sharing to a select group of partners within the system or network 'to maintain a captive market share and reinforce market dominance' (Martinez et al., 2016, p.2). This may endanger the interoperability, and hence, the exchangeability and reusability of health data beyond the network. This results in patients' choices getting restricted to a few partners or players carefully selected by the healthcare provider in extreme self-interest. Such an outcome defeats the very purpose of e-health namely patient-centrism which means unlimited and ubiquitous access for patients to their health data.

It is against such a backdrop that this study aims to investigate the sustainability of a patient-centric e-health ecosystem with particular focus on the dilemmas of the healthcare providers without whose participation and cooperation patient-centric e-health may not be realized. In other words, this study aims to unlock the latent value of e-health technologies by discovering a logic that can align the technical potential of e-health with realization of benefits for all its stakeholders. This logic or 'heuristic logic' is what is referred to as a **business model** (Chesbrough & Rosenbloom, 2002).

2.6.6 Business Models in E-Health

This section begins with a short discussion on the concepts of business model and value notions, and then proceeds to present a synthesis of the various e-

health business models that were observed through thematic reviews of related literature and industry trends. The reviews concerned were conducted with a view to comprehending the workings of the various types of e-health business models that are in existence.

A business model, simply defined, is the representation of a firm's core logic for creating and capturing value in a value network (Shafer, Smith, & Linder, 2005; Spil & Kijl, 2009), and is geared towards creating value for all the parties involved (Zott & Amit, 2010). It is the blueprint for how a business can be organized for the benefit of all the stakeholders. Value is 'created' when a firm (player) develops its core competencies, capabilities and advantages to perform work activities that differentiate it from competitors. Value is said to be 'captured' when the firm derives economic returns in relation to the value it creates (Shafer et al., 2005). A comparison of the values created and captured in the e-health network will help evolve a business model to promote 'collaboration for value' which will lead to a fair, efficient and sustainable e-health ecosystem.

Zott & Amit (2010) visualize a firm's business model as transcending the boundaries of the firm on account of the interdependent activities it engages in with its partners. As such, e-health business models may take on several forms, each with a different purpose and having its own revenue and cost structure (Parente, 2000). From the standpoint of e-commerce relationships among the various players, the most popular forms identified are portals, connectivity, business-to-business (B2B), and business-to-consumer (B2C) (Parente, 2000; Payton, 2003). It may be noted that the emergence of other forms such as consumer-to-consumer (C2C) (Eysenbach, 2001; Broderick & Smaltz, 2003) was predicted more than 10 years ago, and some of them have already been in existence for some time now (e.g. www.ivillage.com).

Another perspective of e-health business models is their orientation or "centrism". Although all models operate with the common goal of improving patient care, some models are provider-centric, primarily focusing on designing and creating interoperable EHRs integrated with medical imaging, therapy, laboratory diagnostics etc. Others are patient-centric and focus on personal health records (PHRs) thereby putting patients in control of their health information. The onset of the latter trend was documented as early as 1999

(Kilgore, 1999), with the past decade seeing a gradual shift in focus from provider-centric applications to consumer-centric models that empower healthcare consumers by allowing them to access, manipulate and understand data about their personal health (Burkhard, 2009; Zieth et al., 2014). Such a shift is necessitated by a growing awareness of patients and others, of the need to take control of their health (Purcarea, 2009, Truog, 2012). In support of this trend, findings from several studies claim that a large majority of the healthcare consumers consider PHRs useful and evince an interest in building their own PHRs (Peters, Niebling, Slimmer, Green, Webb & Schumacher, 2009; Ford, Hesse & Huerta, 2016). Regardless of centrism, some business models are proprietary (e.g. Kaiser Permanente's My Health Manager), while others are open-source (e.g. Microsoft Health Vault).

A look at the e-health market trends may also reveal the existence of other interesting infomediary business models which are rather specialized. Verisk Health^v recently rebranded to Verscend Technologies (Business Wire, 2016), for instance, has gone through sweeping changes in its business model over the last few years. From a company specializing in providing medical record retrieval services to providers, insurers, patients and law firms on a pay-per-record basis, it has now moved towards data-driven healthcare solutions. Keas^{vi} is another infomediary, that targets major self-insured employers to market its employee wellness program, a health management platform, aimed at reducing these companies' healthcare costs. A further example is IBM^{vii} which focuses on health analytics solutions to cater to the growing demand for leveraging patient data to extract business insights.

Although a variety of models are used by e-health infomediaries to organize their business, their economic survival has often been questioned because the payoffs they can extract from the network are closely tied to the benefits their co-players can extract from the network (Ford et al., 2004; Konrad & Peter, 2007). A case in point is Google Health which decommissioned its PHR product in early 2012 after dabbling with it for five years (Spil & Klein, 2014). Based on a scan of the current e-health market trends, it is found that revenues for an e-health infomediary may be generated through various sources ranging from licensing fee (e.g. Microsoft Health Vault), to sale of wellness programs (e.g. Keas), to sale of analytics solutions

(e.g. IBM) and transaction fees generated by B2C, B2B and / or C2C ecommerce activities on its network (e.g. VeriskHealth, Keas, iVillage). The scenarios for each of the possible revenue sources for an e-health infomediary are summarized in Table 2.2.

Table 2.2.

Revenue Sources for E-Health Infomediaries

Revenue Source	A Typical Scenario
Advertisements	The e-health firm may sell web inventory to e-health vendors who wish to promote their products or services to the e-health network members through advertisements e.g. it may charge the vendors on a Cost Per Mille (CPM) basis.
Subscription Fees	The e-health firm may offer premium services to special interest groups on a subscription basis e.g. it may provide updates on new medical technologies to surgeons for a yearly subscription fee.
Transaction Fees	The e-health firm may exact transaction fees when it moves data over the Internet from one network member to another e.g. it may move a patient's medical history from a physician to a pharmacy for a transaction fee.
Business-to-Consumer Ecommerce	The e-health firm may facilitate sale of healthcare products or services by a business on its network to consumers on its network for a commission e.g. it may earn a commission when a patient (consumer) purchases medicines from a pharmacy (business). Additionally, it may also charge the business a listing fee for inclusion in its network.
Business-to-Business Ecommerce	The e-health firm may facilitate sale of healthcare products or services by a business on its network to another business on its network for a commission e.g. it may earn a commission when a hospital (business) purchases refurbished medical equipment from another hospital (business) through online auctions. Additionally, it may also charge the businesses a listing fee for inclusion in its network.
Consumer-to-Consumer Ecommerce	The e-health firm may facilitate sale of healthcare products by a consumer on its network to another consumer on its network for a commission e.g. it may earn a commission when a healthcare consumer purchases a used treadmill from another healthcare consumer through online auctions.

2.7 Vocabulary of Research Concepts

It is hoped that the literature review included in this chapter brings together the vocabulary that needs to be assimilated in order to be able to develop a sound understanding of the phenomenon under study namely, e-health, and its impact on the healthcare industry. Table 2.3 below provides a subset of the vocabulary and their meanings:

Table 2.3.

Vocabulary of Research Concepts

Concept	Definition
E-Health	The use of emerging information and communications technology, especially the Internet, to improve or enable health and healthcare.
Interoperability	The ability of two or more IT systems to exchange and use information. Interoperability is a prerequisite for binding together a huge network of critical and real-time health data so as to benefit from e-health technologies.
Electronic Medical Record (EMR)	Computerized clinical records of an individual created disparately by healthcare providers such as hospitals and physician offices. They do not enable sharing of health information because they do not conform to nationally recognized interoperability standards.
Electronic Health Record (EHR)	A longitudinal electronic record of an individual's health information that conforms to nationally recognized interoperability standards and therefore, has the ability to follow the individual through different modalities of care from various healthcare providers. It also enables sharing of health information among authorized stakeholders.
Personal Health Records (PHR)	An electronic record containing health-related information that is managed, shared, and controlled by an individual, and conforms to nationally recognized interoperability.
Provider-centric	Refers to healthcare IT systems that are focused on benefits for healthcare providers. For example, the EHR is a provider-centric system that is primarily intended to support healthcare providers' clinical decisions.
Patient-centric	Refers to healthcare IT systems that are focused on benefits for patients or healthcare consumers. For example, the PHR is a patient-centric system that is primarily intended to support patient or consumer empowerment.
Cloud computing	The technology of delivering computing as a utility. It refers to a range of IT services delivered over the Internet - Software as a service (SaaS) Platform as a service (PaaS) and Infrastructure as a service.
Infomediary	A neutral, unbiased, third-party entity that functions as a digital information conduit and business matchmaker.
Game theory	The study of conflict and cooperation among intelligent, rational individuals or entities in their decision-making processes.
Fairness	The correspondence between the pay-off received by a player and their contribution to the achievement of the total output.
Pareto-efficiency	An outcome of a 'game' that makes every player at least as well off and at least one player strictly better off.
Prisoner's dilemma	Refers to the conflict between self-interest and group interest.

Concept	Definition
Free-riding	Refers to a situation where a member of a group benefits more from its access to a common resource, than it actually contributes to the cost of this common resource.
Tragedy of the commons	Denotes a situation where the rational behavior of an intelligent individual or entity will be to exploit a freely available common resource for self-gain rather than consider the best interest of the whole group. In the digital world such behavior leads to a deterioration of the system making everyone worse off and resulting in what is known as the tragedy of the digital commons.
Information asymmetry	Refers to a situation where information is not uniformly and transparently available to the various parties involved in a transaction.
Information blocking	Denotes a situation when persons or entities knowingly and unreasonably interfere with the exchange and use of electronic health information.
Value creation	Occurs when a firm (player) develops its core competencies, capabilities and advantages to perform work activities that differentiate it from competitors
Value capture	Occurs when the firm derives economic returns in relation to the value it creates
Business model	A description of the logic using which a firm will create and capture value in a business ecosystem

2.8 Sensitizing Concepts and Substantive Areas

The literature review has provided the sensitizing concepts or sources of ideas needed for establishing the substantive areas for this study. Sensitizing concepts can be thought of as narrow concepts that guide the selection of the substantive areas, leading to the theory building process (Urquhart et al., 2010). Some of the sensitizing concepts derived from the review included in this chapter are listed in Table 2.4.

Table 2.4.

Sensitizing Concepts

S.No.	Sensitizing Concept
1.	Arrival of communication and information technology in the healthcare industry to reduce inefficiencies
2.	Investment in electronic medical records (EMR) by healthcare providers to digitize patients' health records
3.	Diffusion of several proprietary EMR systems that are not interoperable and therefore restrict portability of health information
4.	Emergence of e-health with the promise of patient-centric health care
5	Recognition of interoperability as a key factor in making e-health feasible

S.No.	Sensitizing Concept
6.	Arrival of EHRs and PHRs that foster interoperability
7.	EHRs and PHRs entail significant investments for healthcare providers
8.	Interoperability reduces the information asymmetry healthcare providers traditionally enjoyed, and benefited from.
9.	Healthcare providers not only concerned about the significant investment e-health calls for but also about the resulting misalignment of incentives – other stakeholders benefit more from their investments than they themselves do.
10.	Cloud technology arrives with the promise of significant reduction in IT investment costs for healthcare providers. Another promising aspect of the technology is its potential to act as an infomediary that connects the key stakeholders in e-health and infuses new opportunities into the ecosystem.
11.	Healthcare providers continue to be concerned about the misaligned incentives as also about the security and privacy of their data centers on a cloud if they were to embrace that technology.
12.	Search for a business model framework that can maximize use of the vast amounts of data on the e-health network and at the same time, foster creation and capture of value for all key stakeholders

The sensitizing concepts listed above led to some logical deductions regarding a sustainable e-health ecosystem.

It is critical that the benefits of e-health be rendered achievable with fairness to all the stakeholders involved, particularly, the healthcare providers. Hence it is crucial to derive the characteristics of a viable e-health business model that will at once deliver the aforementioned benefits and yet remain fair to its stakeholders. It is believed that the game theory can help investigate and address issues relating to the stakeholders' interdependence, mutual gain, vulnerability and coordination; provide insights into how the e-health ecosystem can be structured to promote cooperation among its stakeholders such that health data is meaningfully utilized; and guide this study towards uncovering a successful e-health business model.

The sensitizing concepts derived through the literature review have also helped to recognize potential areas of enquiry such as 'e-health', 'game theory' and 'business model'. This selection of multiple areas of enquiry has been made not only in view of their relevance to this study, but also because a theory building research draws from several substantive areas as reflected in reality rather than adhere closely to a single substantive area. For instance, Robey, Boudreau and Rose (2000) have undertaken research informed by two major

streams of research namely information technology and organizational learning. Webster & Watson (2002) strongly recommend that researchers in the field of Information Studies (IS) look outside the field as IS is an interdisciplinary field that often straddles other disciplines.

With the substantive areas for this research established, the next step involved defining the scope of e-health for the purpose of this research. In keeping with this objective, a thematic review of literature was undertaken to help clarify what constituted a patient-centric e-health system and define as well as the scope of e-health for the purpose of this research.

2.9 Patient-Centric E-Health Ecosystem

As seen above, e-health is an umbrella term used to denote a variety of activities involving technology and the Internet for the purpose of delivering healthcare (Wickramasinghe et al., 2005). An obvious implication of such a definition is that an e-health ecosystem should facilitate easy access to information for all stakeholders involved in the e-healthcare processes (Wen & Tan, 2003; Charette, 2006; Regan, Pusatli, Lutton & Athauda, 2009; Ebel et al, 2012). The potential of an e-health market system is enhanced by evidence-based medicine which is defined as “the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients” (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996, p. 71). In such a context, health data assumes great significance inasmuch as it can foster evidence-based patient-centric medicine that is efficient, and offers high quality and value (Neupert, 2009; Jacob, 2013).

As mentioned above, EHRs form the building blocks (Hill, Langvardt & Massey, 2007; Sittig & Singh, 2012) of such a network but their diffusion has been rather slow largely on account of resistance from healthcare providers who are expected to implement these expensive systems in the face of uncertain Return on Investment (ROI) (Goldman, 2009; Thomas, 2013). It is small wonder therefore that, until recently, the digitization of health care has primarily focused on creating EHRs (electronic health records) for patients, rather than TDHS (total digital health systems) which simultaneously offer intra- and inter-enterprise benefits because of their scalability, interoperability and distributable capabilities (Yellowlees, Marks, Hogarth, & Turner, 2008;

Raghupathi & Kesh, 2009; Saleem, Flanagan, Wilck, Demetriades, & Doebbeling, 2013). Yet another key element of patient-centricity which a TDHS should incorporate is the PHR which gives an individual access to their “lifelong health story” (Baur, 2008) and thus augments the value of e-health resources. It is widely believed that cloud computing in healthcare (health cloud) has the potential to foster such a TDHS.

2.10 E-Health Researcher-Defined

As a result of the review, vocabulary, and sensitizing concepts, a more informed definition of e-health may be proffered. In this thesis, e-health is defined as a patient-centric TDHS that includes EHRs and PHRs, encompasses all the key players and allows interoperability among them by providing a common platform for interfaces and transactions among them. Therefore, all subsequent references to e-health in this thesis would imply a TDHS comprising EHRs and PHRs. This research also intends to investigate the feasibility of a cloud-based e-health ecosystem, which is predicted by researchers and industry analysts alike to have great relevance for health IT in future.

Such scoping of e-health is an essential pre-step for setting the context so as to determine those entities that will constitute key players in such a system, and for guiding identification of these key players, as well as the digital data exchanges among them.

2.11 Key E-Health Initiatives around the World

A review of e-health related literature and industry news would not be complete without a probe into significant e-health developments that are ongoing in several countries around the world. Such a review, it is believed, would contribute to the basis upon which the ‘cases’ for phase 2 of this research would be selected. This section presents a snap shot of such developments in alphabetical order of the countries where they are taking place.

2.11.1 Bahrain

The Kingdom of Bahrain, a chain of around 30 islands, offers free healthcare to its citizens and boasts one of the most advanced healthcare systems in the Gulf region. Its average life expectancy at birth was 77 years as of 2015 and its total expenditure on health was 5% of its GDP in 2014 (“World Health Statistics 2016: Monitoring health for the SDGs”, 2016). The country’s National Health

Information System (I-Seha) is widely credited for its contribution to the development of the public healthcare system and has gone on to win the “Enhanced Public Knowledge Management” award at the United Nations Public Service Awards in 2014 (“Bahrain News Agency | Kingdom of Bahrain wins two major awards in Seoul”, 2014)

2.11.2 Hong Kong

Hong Kong remained the most efficient healthcare system in the world until 2014 when it was ousted from its position by Singapore (Chen & Wong, 2014). The country’s average life expectancy was 84 years as of 2014, and its total health expenditure in 2013 amounted to 5.4% of its GDP (Du & Lu, 2016). The Hong Kong government embarked on an initiative known as E-Health Engagement Initiative (EEI) in 2009 to implement their vision of a territory-wide patient-oriented eHR Sharing System which would connect both the public and private healthcare sectors (Sinha, Sunder, Bendale, Mantri & Dande, 2013). The plan is for this initiative to be executed in two phases and completed by 2020.

2.11.3 India

In spite of India’s positive economic growth over the last couple of decades, the country’s healthcare system has not received much attention from its government until recently. According to statistics from (“World Health Statistics 2016: Monitoring health for the SDGs”, 2016), the country’s total expenditure on health was 4.7% of its GDP in 2014, and the government’s contribution to this was only about one-third (“2015 health care outlook India”, 2015). As for the country’s life expectancy at birth, it was 68 years in 2015, lagging behind the global average of 71 years (“World Health Statistics 2016: Monitoring health for the SDGs”, 2016). Nevertheless, India is one of the top destinations for medical tourism where such tourism is regarded as a form of ‘outsourcing’ akin to the IT industry (Connell, 2013). With the Indian government beginning to accord more priority to the healthcare sector in its recent budget, the sector is expected to undergo a major overhaul (“2015 health care outlook India”, 2015). A key feature of the country’s 12th five-year plan is to establish a composite Health Information System (HIS) that would be

connected both at the state and national levels (Mossialos, Wenzl, Osborn & Sarnak, 2016).

2.11.4 Italy

Italy was ranked the third most efficient healthcare system in the world by Bloomberg in 2014. The country's life expectancy at birth was 83 years in 2015, and its total health expenditure stood at 9.2% of its GDP in 2014 ("World Health Statistics 2016: Monitoring health for the SDGs", 2016). 78% of the Italy's health expenditure is financed publicly. Its healthcare system, organized at three levels - national, regional and local, is universal and mostly free of charge at the point of service (Ferre et al., 2014). A universal electronic health records system referred to as the New Health Information System is underway since 2002 and it aims to connect every level of healthcare. One of the challenges faced in this endeavour is achieving the capability to scale the national healthcare system to a transnational level that would allow flow of health data among the European Union Member States (Comande, Nocco & Peigne, 2015).

2.11.5 Malaysia

Malaysia is not only a top destination for medical tourism, but also the world's largest producer of surgical gloves (Suppiah, 2016). Malaysia's life expectancy at birth was 75 years in 2015 and its total healthcare expenditure in 2014 totaled 4.2% of its GDP ("World Health Statistics 2016: Monitoring health for the SDGs", 2016). As per Bloomberg's ranking of healthcare systems around the world, Malaysia dropped six spots from 16 in 2009 to 22 in 2014. In recognition of the fact that an integrated healthcare IT system is a significant enabler of a healthy nation, Malaysia has already embarked on its journey towards connected health. The country hopes to realize its vision of "1 Person 1 Record" by 2020 (Suppiah, 2016).

2.11.6 Singapore

Singapore scores as one of the world's best healthcare systems on every count besides also being one of the prime destinations for medical tourism. Some of its accolades include being ranked as the world's most efficient healthcare system by Bloomberg in 2014 (Chen & Wong, 2014) and the world's healthiest country by The Lancet Group in 2016 (Lim et al., 2016). Despite these

achievements, its total health expenditure in 2014 was kept at only 4.9% of its GDP, far lower than that of other industrialized nations. The country's life expectancy at birth in 2015 was 83.1 years ("World Health Statistics 2016: Monitoring health for the SDGs", 2016). Singapore initiated a nation-wide electronic health records endeavour in 2010 referred to as the National Electronic Health Records (NEHR) through which it hopes to achieve its strategic vision of 'One Patient One Record' (Muttitt, McKinnon & Rainey, 2012).

2.11.7 Sweden

Sweden shares the top spot for the healthiest country in the world with Iceland and Singapore according to a recent report published by The Lancet Group (Lim et al., 2016). Although the country dropped thirteen places in Bloomberg's ranking of efficiency of healthcare systems from 14 in 2009 to 27 in 2014, it has a target to become the world leader in e-health by 2025 (Sorlin, 2016). The country's life expectancy at birth was 82.4 years in 2015 and its total health expenditure as a % of its GDP was 11.9 in 2014 ("World Health Statistics 2016: Monitoring health for the SDGs", 2016). For the purpose of fortifying its healthcare infrastructure it set up the Swedish eHealth Agency in 2014 (Mossialos et al., 2016). Sweden's e-health initiatives are geared towards empowering its citizens to take a more active role in managing their health. Sweden has already established a national e-health portal for its citizens namely My Healthcare Contacts which includes interactive services that allow them to ask health-related questions anonymously, and which are guaranteed to be answered by healthcare professionals in seven days (Hagglund & Koch, 2015). Moreover, it plans to provide its citizens access to their complete electronic medical records by 2017.

2.11.8 Switzerland

Ranked the 14th most efficient healthcare system in the world in 2014 by Bloomberg after dropping four spots since 2009, Switzerland's healthcare expenditure was the highest in the world at \$9674 per person (Du & Lu, 2016). The country boasted a life expectancy at birth of 83.4 years in 2015 (Mossialos et al., 2016) and its total healthcare expenditure amounted to 11.7% of its GDP in 2014 ("World Health Statistics 2016: Monitoring health for the SDGs",

2016). The Swiss government has implemented eHealth Suisse, a national e-health service to promote integration of its healthcare system through electronic health records. However, having an interoperable patient record is not a priority in view of privacy and data protection considerations.

2.11.9 Turkey

Turkey has made great strides in its healthcare system rising in Bloomberg's ranking from the 35th spot in 2009 to the 25th spot in 2014 (Du & Lu, 2016). The country's life expectancy at birth was 75.8 years in 2015 and its total healthcare spending as a % of its GDP stood at 5.4% ("World Health Statistics 2016: Monitoring health for the SDGs", 2016). Turkey's Health Transformation Program was kicked off in 2003. A significant goal of this program was to achieve e-health supported by the initiative 'Saglik-Net'. One of the key components of Saglik-Net is the National Health Information System (NHIS), a country-wide infrastructure that provides for collecting and sharing electronic health records of patients. The NHIS is designed such that the data it requires is automatically generated by the healthcare providers' information systems and conveyed to the NHIS through web services (Dogac et al., 2014).

2.11.10 The US

The US has one of the most advanced healthcare systems in the world (Vitalari, 2015). However such a distinction does not necessarily translate into positive health outcomes for the country. The US' total health expenditure was 17.1% of its GDP in 2014, the highest rate among industrialized nations, and the country's life expectancy at birth in 2015 was lower than that for other advanced countries, at 79.3 years ("World Health Statistics 2016: Monitoring health for the SDGs", 2016). In spite of its colossal spending on healthcare, the US is the only advanced nation in the world that does not guarantee universal health coverage for its citizens. A common reason that can be attributed to both the high health expenditure and the lack of universal health coverage is the fragmented state of its healthcare system (Vitalari, 2015). Recognizing that integrating its healthcare system is key to a positive transformation of its healthcare system, the US government endorsed the Health Information Technology for Economic and Clinical Health Act (HITECH Act) in 2009 (Rouse, 2014). The Act made provision for \$27 billion in incentives to

stimulate adoption of electronic health records among physicians and hospitals (Blumenthal & Tavenner, 2010).

Table 2.5 presents the most recent statistics on healthcare indicators available for the above countries.

Table 2.5.

Potential Cases for Phase 2: Key Healthcare Indicators

S.No.	Case (Country)	Average life expectancy at birth in years	Total expenditure on health as % of GDP
1	Bahrain	77	5%
2	Hong Kong	84	5.4%
3	India	68	4.7%
4	Italy	83	9.2%
5	Malaysia	75	4.2%
6	Singapore	83.1	4.9%
7	Sweden	82.4	11.9%
8	Switzerland	83.4	11.7%
9	Turkey	75.8	5.4%
10	The US	79.3	17.1%

2.12 Definition of the Case or Unit of Analysis for Phase 2

Based on the knowledge acquired about the various e-health initiatives happening around the world, it became evident that e-health ecosystems are envisioned as national-level initiatives rather than being restricted to a provider, community or jurisdiction. Therefore the unit of analysis for case study in phase 2 of this research was defined as a nation-wide e-health ecosystem.

2.13 Selection of Cases for Phase 2

This section discusses the sampling strategy adopted to select specific cases for study during phase 2 of this research. The approach adopted was ‘purposive sampling’, whereby the cases were selected based on the following sampling strategies:

Maximum variation – According to Patton (1990), this strategy refers to selecting cases that have diverse variations, but at the same time, offer potential to strengthen the results. This is because, any common patterns or explanations that emerge from very different cases, can help capture “core experiences and central, shared aspects” (Patton, 1990, pp.172). Since this research aims to identify the critical success factors for implementing patient-centric e-health, it was believed that this strategy could help improve the analytic generalizability of the findings, which would be based on common patterns that cut across the

variations in the cases. By applying this strategy, the cases that were selected for study were Singapore's NEHR and the US' HITECH Program. While the former is a high performing healthcare system, the latter is a low performing healthcare system. Needless to say, it would be of significant interest if some commonalities can be deduced across these diverse cases that would contribute to identifying the critical success factors for e-health implementations.

Information richness – Miles and Huberman (1994, p.34) contend that it is crucial for the sampled cases to have the potential to provide rich information on the phenomenon of interest. The cases that met this criterion were again Singapore's NEHR and the US' HITECH Program. During the process of reviewing literature and industry reports to identify potential cases for study as well as, while soliciting deeper insights into these cases from identified representatives, it became evident that the only cases which offered scope for an intensive study. This was because, not only was a variety of secondary data sources available for the two cases, but also, access to primary data was possible in the form of interviews that materialized with some identified representatives of these cases. It was firmly believed that the insider knowledge elicited from these representatives would complement the knowledge gained through literature and document reviews, to produce information-rich cases. Moreover, the two e-health initiatives selected for study have made significant progress relative to most others which are still in the concept or early implementation stages. This was yet another characteristic which was believed to further enhance the information-richness of the two cases selected for study.

2.14 Chapter Summary and Recap

The foregoing literature review was intended to help acquire and establish an inventory of vocabulary for use in this research, generate seed concepts relevant to this study, identify potential areas of enquiry referred to as 'substantive areas' and scope this study. The review began with an exploration of the term 'e-health' and related topics such as EHR, PHR and cloud technology. This in turn, led to a discussion of the major barriers confronting e-health. A game theoretic perspective of these barriers resulted in identifying two categories of such barriers termed 'participation dilemmas' and 'cooperation dilemmas' in this research. Furthermore, the review endeavoured to drive home the fact that

for e-health to become a reality, it is imperative to conceive a ‘logic’ to organize the business of e-health in a methodical fashion. It needs to be organized in such a way that it strikes a balance between exploiting the technical potential of e-health and ensuring a fair share of the resultant benefits for all its stakeholders. Incidentally, the ‘logic’ concerned is what is commonly referred to as a business model. The chapter therefore included a discussion of existing e-health business models. Thus, as expected, the literature review given in this chapter resulted in the formulation of a vocabulary of research concepts and sensitizing concepts, which eventually led to the identification of the substantive areas relevant for the research namely ‘e-health’, ‘game theory’ and ‘business model’. The scope of this research was then defined in order to stay focused on the key issues confronting a viable patient-centric e-health ecosystem. Besides, the chapter provided a summary of various e-health initiatives that are in progress in several countries. These initiatives were identified as potential cases for an in-depth study during phase 2 of this research, and two of these cases were selected for the study based on the purposeful sampling strategies of ‘maximum variation’ and ‘information richness’.

The next chapter details the methodology adopted in carrying out the three phases of this study.

CHAPTER THREE METHODOLOGY

Chapter Three describes the case study methodology adopted in this research. It begins with a rationalization of the choice of research methodology, outlines the research road map, and goes on to detail the specific steps followed in executing the three phases of this research. While phase 1 of this research was concerned with conceptualizing a patient-centric e-health ecosystem and the issues surrounding the materialization of such an ecosystem, phase 2 set out to test the conceptual model developed in phase 1 using case studies of unfolding national-level e-health initiatives such as Singapore's NEHR and the US' HITECH Program. Phase 3, on the other hand, had to do with a comparison of the insights drawn from each of the two case studies, for the purpose of deriving a common explanation that could help characterize the issues typically encountered in e-health implementations, and lead this research to identifying the critical success factors for e-health implementations.

3.1 Choice of Research Methodology: Rationale

The case study strategy enables the researcher to obtain a holistic view of a complex phenomenon (Gummesson, 1991) by tapping into multiple sources of evidence. And, it is often the preferred strategy when the focus of the research is on a contemporary phenomenon within real-life context (Yin, 2003, p. 1). Moreover, the nascence and the richness of the field of e-health make it a good candidate for the case study approach which is believed to help understand the dynamics and intricacies involved in the domain. Specifically, the focus of the current study, namely e-health ecosystems, is a topic of interest that is inarguably complex and abstract, and therefore warrants the use of the case study approach to ensure that the topic is well explored.

Eisenhardt (1989) describes case study as an approach that can involve single or multiple cases, and as an efficacious strategy to understand the dynamics within a single setting. There are no fewer than three different types of case study approach depending on the purpose of the study – exploratory, explanatory or descriptive (Yin, 2003). Exploratory case studies are undertaken to investigate a new field of research perhaps with a view to formulating an appropriate research design and hypothesis, explanatory case studies seek to study complex causal links and descriptive case studies attempt to describe

specific characteristics of a phenomenon in its natural setting. It needs to be stated here that the context of the current study lends itself well to a descriptive, multi-case study.

3.2 The Research Approach

The roadmap followed for conducting this research is depicted in Figure 3.1.

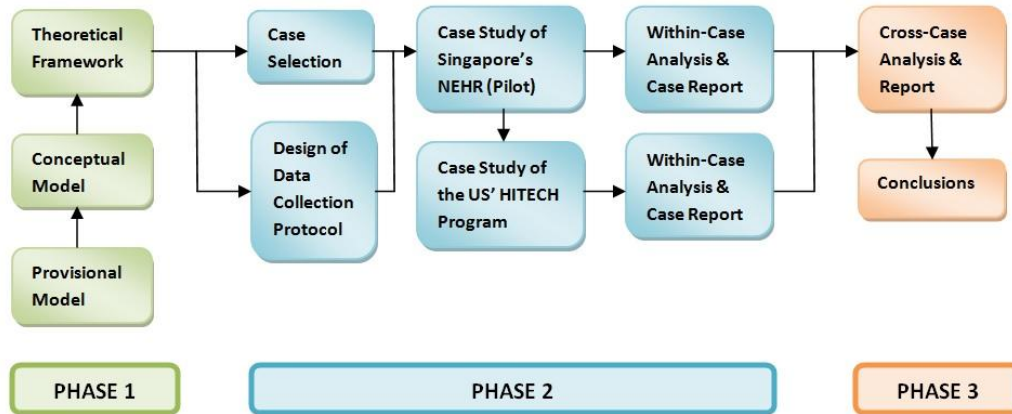


Figure 3.1. Research Roadmap

Phase 1 involved developing an initial theoretical framework backed by literature search. This theoretical framework helped identify key concepts and the relations among them which were believed to account for the phenomenon investigated, namely e-health. It further provided a structure to conceptualize a patient-centric e-health ecosystem – the key players, the potential digital data flows and the values thereby created and captured by the key players. Such conceptualization was deemed necessary in the light of the research objective to educe the critical success factors for a patient-centric e-health ecosystem. The conceptualization was accomplished by employing multiple sources of data such as thematic literature reviews, observations and expert interviews. Phase 1 culminated in the development of a conceptual model of a patient-centric e-health ecosystem which also provided answers to the set of questions raised under RQ1. Phase 1 is covered in Chapter Four.

Phase 2 focused on testing the conceptual model developed in phase 1. The testing was intended to examine the extent to which the conceptual model reflected reality as well as to investigate how the notions of fairness and efficiency should be traded off for achieving a sustainable e-health ecosystem. Towards this end, in-depth case studies of two national-level e-health ecosystems – Singapore’s NEHR and the US’ HITECH program, were

undertaken. The within-case reports for the NEHR and HITECH program are presented in Chapter Five and Chapter Six respectively.

Phase 3 was concerned with extracting insights from the two case studies undertaken in phase 2 for the purpose of characterizing the issues surrounding adoption of e-health at a national level as well as identifying the critical success factors needed for establishing a national level e-health ecosystem. This was achieved through a cross-case analysis where the insights gleaned from the individual case studies were compared so as to derive common patterns and explanations which would in turn provide answers to RQ2.

The following sections are intended to describe the specific steps involved in executing the three phases described above.

3.3 Phase 1: Development of Conceptual Model of a Patient-Centric E-Health Ecosystem

This phase of the research was aimed at developing a conceptual model of a patient-centric e-health ecosystem by utilizing three sources of data, namely thematic literature reviews, industry observations and expert interviews.

The expectation was that the data thus collected would help ascertain the key players in a patient-centric e-health ecosystem, the digital data flows that are made possible in such an ecosystem, and the values that can consequently be contributed to and captured from the ecosystem by the key players. It was imperative to develop a sound understanding of these various aspects of the e-health ecosystem, so that a qualitative game theoretic analysis could subsequently be undertaken to determine if the values created and captured by each player participating in this ecosystem are equitable enough to warrant their participation. This would in turn help determine whether a patient-centric e-health ecosystem, the way it is described in this research, is feasible and sustainable. Besides, it would also help focus on what needs to be done to make such an ecosystem a reality. Given below is a detailed description of the sources of data discussed previously.

3.3.1 Thematic Literature Review

A highly focused review of relevant literature is known as a thematic literature review. Urquhart and Fernandez (2013) observe that the theoretical data

collected through such a review not only enables researchers to exploit extant literature to advantage, but also enriches their study by facilitating comparison with emergent themes from data obtained through the other sources.

In this research, such a literature review was done using the following steps:

1. A search for journal articles relevant to the substantive areas of this research was conducted using Google Scholar. Keywords such as ‘e-health’, ‘electronic health records’, ‘electronic medical records’, ‘personal health records’, ‘game theory’, ‘business model’ etc. were used to identify journal articles relevant to the ‘substantive areas’.
2. Once a journal article was identified to be relevant on the basis of its abstract, its full-length pdf was downloaded from the database for an in-depth review. Examples of such databases used in this research are Academic Search Premier, Business Source Premier, ScienceDirect, MEDLINE Complete, ABI/INFORM and ProQuest.
3. Journals carrying relevant articles were earmarked for the purpose of further exploring these sources for pertinent literature. Health Affairs, Healthcare Financial Management, Health Management Technology, Physician, Communications of the ACM, Harvard Business Review, and British Medical Journal were but a few of the many journals referred to in this research.
4. To supplement the data from the academic journals, iterative searches of internet-based resources such as white papers and conference papers were also performed, and more data sources identified.
5. As and when data was extracted from these searches, it was simultaneously analyzed by comparing it with existing data for convergence or divergence, as this would help guide future data collection efforts.

3.3.2 Industry Observations

In addition to having a thematic literature review, it was also necessary to keep track of emerging trends in the industry. This was considered even more crucial in the context of e-health which keeps evolving astonishingly rapidly. Observing and analyzing such trends and developments alongside the data from the literature review would help construct a more current and, at the same time, a more complete model of e-health. This step was sought to be accomplished

through iterative searches for internet-based sources such as industry reports, online magazines, news websites and organizational websites.

In the manner outlined above, more than two hundred journal articles, online resources and industry reports were perused. The e-health model thus developed based on a thematic literature review and observations of current industry trends would however be considered only provisional; its robustness could be ascertained only with reference to yet another source of data, namely expert interviews.

3.3.3 Expert Interviews

It was also considered necessary to develop a research instrument for in-depth interviews with industry experts in order to ascertain the robustness of the provisional model before embarking on further research. The objective of these expert interviews was two-fold: to validate the provisional model of the e-health ecosystem derived through a thematic literature review and industry observations, in the first instance, and to elicit expert opinion on the game theoretic notions of fairness and efficiency in the e-health ecosystem. This would help determine if different experts concurred with literature on the perceived imbalance in the existing business model arrangements among the key players. **Section 2.6**, ‘Major Barriers to E-health: A Game Theoretic View’ presents the conceptual framework used to investigate the correspondence between the values created and the values captured in the e-health ecosystem. Besides, the section provides as well an overview of these notions.

3.3.4 Research Instrument

The research instrument to interview industry experts was a structured interview template that comprised two sections (Appendix A). The conceptual model of digital flows and the research instrument were first peer-reviewed at the 2nd Symposium on Healthcare Advances in Research and Practice (SHARP 2.0), held during April 28-29, 2011, in Moorhead, Minnesota (USA). Next, as a pilot run, the process was also repeated at the UPMC (University of Pittsburgh Medical Centre) in Pittsburgh, Pennsylvania (USA) on May 2, 2011. The feedback obtained through these pilot tests was used to further refine the questionnaire with a view to establishing its validity and reliability. The final

questionnaire included eleven questions that were distributed over two sections. A brief account of each of the sections is given below:

3.3.4.1 E-health Ecosystem.

This section provided an illustration of the provisional model, with some background on the basis upon which this model was derived. The informants were required to go through this background and give their view whether the model adequately reflected reality. They were also expected to point out omissions or redundancies, if any, in the model, stating valid reasons.

3.3.4.2 Values-Created vs. Values-Captured by Primary E-Health Players.

This section listed the sources of values-created versus values-captured that were identified for each key player in the e-health ecosystem. It provided some theoretical background of game theoretic value notions as well so as to establish an understanding of these concepts in the context of e-health. The informants were asked to discuss whether these values were adequately identified and represented for each of the key players, and to point out discrepancies, if any, stating reasons. Opinions were also sought on: whether the value captured was greater or less than the value created for any player(s); which player(s) contributed (created) the greatest and least values to the ecosystem; which player(s) derived (captured) the greatest and least values from the ecosystem; the notions of fairness and efficiency as necessary conditions for the sustainability of the e-health ecosystem.

3.3.4.3 Target Informants.

Twenty one professionals across India, Malaysia, Singapore and the United States, representing different sectors of healthcare organizations such as Ministries of Health, IT departments of healthcare providers, health IT vendors, healthcare BPOs etc. were identified for expert interviews. A summary of the target informants' profile is presented in Table 3.1. It was ascertained that the potential informants were involved in the phenomenon of e-health in some capacity. While some of these target respondents were from professional circles or referrals through professional networks, the others were identified through LinkedIn, a social media platform. The tool used for selecting the informants was 'purposive sampling' which means deliberate selection of an informant on

the basis of qualities possessed by the informant such as knowledge and experience required to inform this research. Most importantly it was expected that the informants had both practical insider knowledge and willingness to act as surrogates for a wider circle of players in the e-health ecosystem to do so. The informants who contributed to the study are highlighted in bold font. It may be observed that these informants comprised a good mix of senior and middle management professionals.

Table 3.1

Phase 1: List of Target Informants

Informant	Position	Organization
#1	Business Manager, Healthcare Informatics (Global)	Crimsonlogic, Singapore
#2	Senior Manager (Quality)	Surescripts LLC, USA
#3	Program Manager	US Dept. of Veteran Affairs, USA
#4	IT Manager	Tan Tock Seng Hospital, Singapore
#5	Director of Industry Research, Institute for Communication Technology Management	The Marshall School of Business, University of Southern California, USA
#6	Senior Consultant, Health Services Group	Ministry of Health, Singapore
#7	Owner	ManyMedia, USA
#8	Assistant Director (Information Systems Division)	MOH Holdings Pte Ltd, Singapore
#9	Vice President, Technology and Innovation	Western Interstate Commission for Higher Education, USA
#10	Vice President (Client Relations)	E4E Healthcare Business Services, India
#11	Vice President (Sales)	E4E Healthcare Business Services, India
#12	Business Development Director	CMPMedica, Singapore
#13	Project Manager (Healthcare IT Systems)	Friar Tuck, Singapore
#14	Associate Professor, Centre for Computational Intelligence	Nanyang Technological University, Singapore
#15	Senior Healthcare Consultant	Frost & Sullivan, Malaysia
#16	Database Architect, Virtual Clinical Image Management	Accelerad, USA

Informant	Position	Organization
#17	Principal, iPMO	MOH Holdings Pte Ltd, Singapore
#18	Manager (Clinical Governance)	Singapore General Hospital, Singapore
#19	Research Manager (Government Insights & Health Insights, Singapore)	IDC, Singapore
#20	Manager (Healthcare Practice APAC)	Frost & Sullivan, Singapore
#21	Founder and Managing Director	Venture E (Shanghai) Co., Ltd

3.3.4.4 Methodology.

The twenty one target respondents were sent an introductory email along with the interview template in early June 2010, inviting them to participate in the expert interview via email. They were requested to respond within a week, failing which they were sent a reminder. To boost the response rate, they were given the options of phone interviews and face-to-face interviews. A week after the first reminder, a second reminder was sent to those who had not responded by that time.

Some respondents who were available for a face-to-face interview were met personally to get the interviews done. A few others sought clarifications over the phone before completing the interview and emailing it back.

3.3.4.5 Response Rate.

As of 30 September, 2010, the final deadline, the response rate was 57% with twelve out of the twenty one targeted experts responding to the interview.

3.3.4.6 Analysis.

The analysis was primarily aimed at validating the key players in the e-health ecosystem modelled in this research, confirming the values created and captured by these players as identified through thematic literature reviews. It was also intended to solicit opinions on whether there was correspondence between the values created and the values captured in respect of every key player (whether a player created more value than they captured, and vice versa).

To analyze the interview transcripts, coding approaches suggested by Corbin and Strauss (1990), Burnard (1991), Chamaz (2006) and Saldana (2009) were explored and evaluated systematically before a decision was made to go

ahead with the techniques advocated by Saldana (2009). Such a decision was primarily made on account of the fact that Saldana's work presented a 'pragmatist approach' intended to help researchers select "the right tool for the right job" (p.2) depending on the context. Besides, the approach was objective in that it was free from any bias for or against a specific research genre or methodology.

The coding scheme is presented in Appendix B. Expert responses to each interview question were addressed individually and coded in a manner that captured the essence of the response. Depending on the complexity of the response, multiple codes were sometimes identified for a single response. For each of the eleven questions, the codes were analyzed to uncover the presence of any patterns. Characteristics of patterns like frequency (happen often or seldom), similarity (happen the same way), correspondence (happen in relation to other events) and rarely, causation (one causing another), were observed. For the purpose of assessing **coding reliability** two coders including the researcher were involved in the coding process. The codes were finalized once an adequate level of agreement was reached between the coders.

3.3.4.7 Findings.

The findings based on the analysis of the qualitative data received from the twelve experts were compared with the findings from the thematic literature reviews and industry observations, and inferences were drawn. These expert interviews provided invaluable inputs which could help define the provisional models derived through thematic literature reviews and industry observations.

Chapter Four presents the data, analysis and findings from phase 1 of this research.

3.4 Phase 2: Validation of Conceptual Model in the Field

One of the biggest issues confronting e-health is a lack of demonstrable evidence of its benefits for its investors as well as its sustainability over a period of time, which this phase of the research aimed to probe and address using the case study approach. Phase 2 of this research was thus concerned with field testing the conceptual model derived in phase 1 using case studies. The test was intended to determine the extent to which the sampled e-health ecosystems conformed to the conceptual model. It was of particular interest to

investigate the dilemmas confronting the healthcare providers as well as the notions of fairness and efficiency in these ecosystems (discussed in **section 2.6**, ‘Major Barriers to E-health: A Game Theoretic View’) with a view to evolving some critical success factors which would bolster sustainability of the ecosystem. Also on the agenda for this phase of the research was finding an answer to the question whether an e-health ecosystem on a cloud (health cloud) would prove to be one such design characteristic.

3.4.1 Sources of Data for Phase 2

As e-health is a relatively new and evolving field, it was hoped that this study would benefit greatly from research already undertaken in this area. This would then be complemented with primary data gathered through qualitative research interviews. These two slices of data would be utilized for the purpose of conducting case studies of seemingly successful e-health implementations around the world. The conceptual model developed in phase 1 of this research would be tested through in-depth case studies which would in turn utilize the slices of data collected through secondary research and expert interviews. It was hoped that a comprehensive approach such as this would help investigate the perceived imbalance in values-created vs. values-captured for the various players in the e-health network, and lead this research on to the process of deriving the critical success factors of a sustainable ecosystem. A brief discussion on the importance and relevance of the data sources for the case studies follows.

3.4.1.1 Secondary Research.

The qualitative case study approach uses a variety of data sources as evidence, some of which can be accessed through secondary research. An obvious advantage of secondary research may be economy. Additionally, it provides access to information that would normally be inaccessible through primary sources. Secondary research also makes it possible to combine information from different sources to reach conclusions not suggestible by a single source (Stewart & Kamins, 1993, p. 2). Moreover, secondary data is less subject to biases that might occur if the researcher were to gather the information first-hand for a specific purpose (Boyd, Westfall & Stasch, 1994, p. 171).

Specifically, this research was intended to gather secondary data on the outcomes of e-health adoption for the various players across several countries that have made significant progress in e-health. Such data, published in both academic and trade journals, was compared and complemented with the primary data from qualitative research interviews so as to determine the extent to which the issues in e-health adoption as revealed by the conceptual model were prevalent in the cases studied, as well as to analyze and evaluate how these issues were dealt with in the cases. Such an approach, it was hoped, would likely be able to lead to answers to RQ2.

3.4.1.2 Qualitative Research Interviews.

Interview is a mode of inquiry in qualitative research that can serve as one of the multiple sources of data for the case study method. The interview technique is one of the most common qualitative research methods used in healthcare research (Gill, Stewart, Treasure & Chadwick, 2008) and is probably the most suitable approach especially for investigating and understanding abstractions (Seidman, 2013). The e-health ecosystem, being nascent, can be thought of as an abstraction, something nonspecific and not concrete and is therefore, liable to be influenced by perspectives, reflections and insights of healthcare consumers, policy-makers and industry players alike. Such attributes make it a suitable context for the interviewing technique.

Interviews may be of three types: structured, unstructured and semi-structured (Gill et al., 2008; Kvale & Brinkmann, 2009). Structured interviews have predetermined questions allowing for little or no variation during the interview process, and therefore offer limited scope to elicit elaborations. Unstructured interviews on the other hand do not have a fixed set of questions and often proceed from the initial response of the interviewee to a question. They are more like conversations and hence time-consuming. They may be relevant in contexts where very little information is available about the topic of interest while a great deal more is required. Semi-structured interviews, while providing a structure, also offer some flexibility to the researcher in respect of handling different respondents as the context dictates (Noor, 2008). Besides, they also allow divergence from the structure to pursue details (Gill, Stewart, Treasure & Chadwick, 2008). For the purposes of the current study which

aimed to cover a list of topics as well as pursue emergent trajectories relevant to the topics concerned, semi-structured interviews seemed a reasonable choice as they balance structure and flexibility in right proportions.

3.4.2 Steps in Execution of Phase 2

The specific steps followed in executing phase 2 of this research are detailed below.

3.4.2.1 Step 1: Search for Potential Cases.

Phase 2 began with a high level review of notable e-health developments around the world as recognized through literature reviews. A review of ten potential cases, well-known for their advanced healthcare systems, and recognized as pioneers in , ‘the use of technology for healthcare delivery, is presented in **section 2.11**, ‘Key E-Health Initiatives around the World’.

3.4.2.2 Step 2: Defining the Case or Unit of Analysis.

Based on the review in step 1, the unit of analysis for this research was defined as a nation-wide e-health ecosystem as explained in **section 2.12**, ‘Definition of the Case or Unit of Analysis for Phase 2’.

3.2.4.3 Step 3: Design of Data Collection Instrument.

A semi-structured interview was developed based on the game theoretical framework discussed in **section 2.6**, ‘Major Barriers to E-health: A Game Theoretic View’ which contributed to the conceptual model that was evolved in phase 1 of this research. The qualitative research interview was designed to be semi-structured with six interview questions. The interview template is given in Appendix C.

3.2.4.4 Step 4: Selection of Cases for the Study.

During the initial review in step 1, it became increasingly apparent that secondary data was not easily accessible for some of the cases considered, while credible primary data was difficult to obtain for many. The nascence of e-health as well as the fact that several major initiatives are still ongoing could be attributed to the above-mentioned situation. In addition, being restricted to data sources in the English language also proved to be a constraint. By employing the purposive sampling strategies of **maximum variation** and **information richness** explained in **section 2.13**, ‘Selection of Cases for Phase 2’, the cases

that were eventually selected for an in-depth study were Singapore’s NEHR and the US’ HITECH Program, both national-level e-health initiatives. One of the strategies behind such a selection, namely **information richness** was supported by the fact that primary data for the above-mentioned cases was accessible in the form of interviews with representatives of these e-health initiatives in addition to the availability of a variety of secondary data sources. Table 3.2 lists the profiles of the representatives who were contacted, and tracks how they responded to the invitation for their participation in this case study research.

Table 3.2

Phase 2: List of Target Informants

Informant	Position / Profile	Remarks
#1	Managing Editor (and Healthcare Editor), FutureGov Asia, Hong Kong	#1 was kind enough to provide some leads for the case study.
#2	Advisor – IT Management, Pantai Hospitals, Malaysia	An email request to #2 to participate in our case study bounced back. Subsequently came to know that #2 had moved from Pantai Hospitals, Malaysia.
#3	CEO, HealthHiway, India	Sent a general email enquiry requesting for #3’s direct email id, but did not get a response.
#4	Senior Vice-President and Chief Financial Officer – UPMC, USA	No reply.
#5	Technical Leader, TClouds (health cloud), IBM Zurich Research Lab, Switzerland	No reply.
#6	Director, Institute for Health Policy, Massachusetts General Hospital–Partners Healthcare System and Harvard Medical School — both in Boston, USA . He has been named National Coordinator for Health Information Technology.	Sent a general email enquiry requesting for #6’s direct email, and received a reply from #6’s Senior Executive Assistant, offering assistance on his behalf. However when participation in the case study was requested, it was turned down.
#7	Director of Medical Services Ministry of Health, Singapore	No reply.
#8	E-Government Consultant at <u>Prime Ministry</u> , E-Health Coordinator at Ministry of Health, Turkey	No reply.
#9	Senior Researcher and Consultant at CEFRIEL, Milan Area, Italy .	No reply.

Informant	Position / Profile	Remarks
#10	Director of Information Technology, California Healthcare Foundation, USA	No reply.
#11	Principal, Clinical Transformation Services, Information Systems Division, Ministry of Health Holdings, Singapore	No reply.
#12	IT Executive Director, UPMC, Pittsburgh, USA	#12's initial response was positive but subsequently the interest waned due to increased work commitments.
#13	Mayo Clinic, Rochester, USA Co-chair, SHARP 2.0	#13 responded to the email request but could not commit to an interview.
#14	Deputy Director, Health Care Division Ministry of Health and Social Affairs, Sweden	No reply.
#15	Professor of Health Informatics & Paediatrics, International Medical University, Malaysia Vice-President, Malaysian Health Informatics Association	No reply.
#16	Head of E-Government Group, Ministry of Health, Bahrain	No reply.
#17	General Manager (Sales), Asia Pacific & Japan Napier Healthcare, Singapore	Conducted a face-to-face interview on 20/04/2015. Verified transcription of the interview on 26/06/2015
#18	ST Electronics (Info Software) Systems Pte. Ltd., Singapore	Conducted a face-to-face interview on 15/05/2015. Verified transcription of the interview on 05/06/2015
#19	Quintessence Business Solutions & Services, USA	Conducted an email interview. Response received on 23/08/2015
#20	Sutter Health, Sacramento, California, USA	Conducted a telephonic interview on 02/09/2015 and verified transcription on 03/09/2015

As revealed by this audit trail, the final response rate stood at a meagre 20% with only four of the twenty representatives eventually participating in the study. Two of these informants were professionally engaged with Singapore's NEHR (National Electronic Health Records) while the other two were engaged with the United States' HITECH (Health Information Technology for Economic and Clinical Health) program. Although the cases of these two

countries are diverse in many respects, they share a strong history of early technology adoption (Stephanie, Tan, Morales-Arroyo, & Sharma, 2011). It was therefore hoped that probing into the emerging e-health ecosystems of these countries would offer useful insights into the broad range of issues typically encountered in e-health initiatives.

It has to be recorded at this point that in spite of the researcher's efforts over a substantial period of time to involve as many representatives from as many different cases as possible, the outcome was much less than what was desired. This may be partly due to the fact that e-health is an evolving field that involves interactions among several organizations from varying walks of the healthcare industry, and that the experts from one walk of the healthcare industry are only familiar with the changes taking place in their domain areas, and may not necessarily be conversant with developments in the other walks of the healthcare industry. Another likely reason is the intense nature of the interview envisaged which required, among other things, that the respondents assimilate the context and background information before responding to the questions posed. Thus, the initial, tentative, design had to be adapted to the emerging dynamics of the study with the result that only two case studies could eventually be done.

3.2.4.5 Step 5: Case Studies, Within-Case Analyses and Reports.

The case studies utilized multiple sources of data such as literature reviews, documentation reviews, online searches and qualitative research interviews. Between the two cases selected in step 4, the study of Singapore's NEHR was designated the pilot case study in view of the ease and convenience of access it afforded to the informants.

The interview protocol that was followed to collect primary data is detailed below:

- A face-to-face meeting was scheduled with the Singapore-based informants for conducting the interview, and an email or a telephonic interview was conducted with the overseas informants based on their personal preference in terms of the mode (email vs telephonic) as well as the timing of the interview (for telephonic interviews). Follow-ups were made through

emails or phone calls or a combination of both, for the purpose of clarification and elaboration.

- Interviewees were informed in advance that they might need to commit a little over an hour for the interview at their preferred timings and locations.
- The purpose of the study was explained to the interviewees in detail, and they were assured of the opportunity to review and suggest changes to the transcript of the interview, if they so desired. Only after their vetting was the interview included in the data, and analyzed.
- During face-to-face or phone interviews, research memos were written to flesh out concepts and patterns as they emerged.
- The face-to-face and phone interviews were transcribed and emailed to those informants who preferred to take a look at them before they confirmed the proceedings of the interview.
- If some informants wished to clarify or change their responses, a meeting or a phone conversation was set up with them for the purpose, and their interview was updated. Alternatively, where necessary, clarifications via email were sought as well as provided.
- The updated interview was again emailed to the informants for their verification and confirmation.
- Upon final confirmation from the informant, the interview was included in the data for the case study.
- The data thus collected was thematically coded. The coding scheme is presented in Appendix D.

The data collected from the various secondary research sources and the interviews, was thematically analyzed using the conceptual framework established in phase 1 of this research. The secondary research tapped into a wide range of documents – literature, news websites, industry journals, industry reports, blogs and parliamentary proceedings - to serve as sources of evidence. The data thus obtained was also compared with the data from the semi-structured qualitative research interviews for corroboration and triangulation. The within case analyses and reports for Singapore’s NEHR and the US’ HITECH program are presented in Chapters Five and Six respectively.

3.5 Phase 3: Cross-Case Analysis

The third and final phase of this research comprised a cross-case analysis of the two cases studied in phase 2, namely Singapore's NEHR and the US' HITECH Program. The primary focus of this analysis was to develop findings that were consistent across the two cases. Such an analysis involved a comparison of key themes that emerged from the two cases studied, thus allowing patterns to be perceived across the cases. These patterns enhanced the robustness of the findings and in turn, led to analytic generalizations with regard to the critical success factors for e-health implementations in view of the potential issues confronting e-health adoption. The cross-case analysis is presented in Chapter Seven, and the conclusions, in Chapter Eight.

3.6 Chapter Summary and Recap

This chapter provided a justification of the methodological approach adopted by this research and presented as well the roadmap followed by this research. The three phases in which this research was carried out were described above in detail. Phase 1 involved conceptualization of an e-health ecosystem that would be patient-centric, as well as, recognition of the issues that might jeopardize actualization of such an ecosystem. The sources of data for Phase 1 were thematic literature reviews, industry observations and expert interviews. Phase 2 focused on testing the conceptual model evolved in phase 1, using case studies of Singapore's NEHR and the US' HITECH program. The two cases were selected through purposive sampling based on the strategies of *maximum variation* and *information richness*. Phase 2 relied on a variety of secondary data sources and qualitative research interviews for evidence. The data accumulated was thematically analyzed and within-case reports were prepared individually for the two cases. Phase 3 was concerned with a comparison of the key themes that emerged from the two cases studied in phase 2. A cross-case comparison such as this, illuminated common patterns and facilitated analytical generalization which, in turn, led this research to answers for RQ2 - the critical success factors for patient-centric e-health.

The next chapter marks the beginning of phase 1 of this research, the focus of which is to evolve a conceptual model of a patient-centric e-health ecosystem in response to RQ1.

CHAPTER FOUR A CONCEPTUAL MODEL OF THE E-HEALTH ECOSYSTEM

This chapter addresses RQ1 by constructing a conceptual model that embodies a patient-centric e-health ecosystem. This is proposed to be accomplished by identifying the potential key players in the ecosystem and comprehending their roles as well as the values they can create and capture in a patient-centric e-health ecosystem. This chapter is also intended to ascertain if this research is progressing with validity.

With these aims in view, various sources of data were collected through thematic literature reviews, industry observations and expert interviews. It is hoped that these sources of data would be adequate not only to arrive at a comprehensive set of potential key players who significantly contribute to the e-health ecosystem, but also to reaffirm the objectives of this research for their relevance and significance. These are a few essential first steps based on which further insights can be gained in terms of the ways in which the key players can drive e-health, the potential digital data flows among them and the values they can create and capture in the ecosystem in the process. The chapter ends with a synopsis of the key findings.

4.1 Data, Analysis and Discussion

4.1.1 *Sources of Data for Modelling*

For the purpose of finding insights to address RQ1, data from various sources such as thematic literature reviews, industry observations and expert interviews, were gathered. These data sources have been described in **section 3.3**, 'Phase 1: Development of conceptual model of a patient-centric e-health ecosystem'.

4.1.2 *Key Players in E-Health*

As regards RQ1, to ascertain the key players in e-health related literature that has emerged over the past decade or two was reviewed, and current market trends noted.

It needs to be noted that several authors (Parente, 2000; Joslyn, 2001; Aggrawal & Travers, 2001; Wen & Tan, 2003; Broderick & Smaltz, 2003; Walker et al., 2005; Konrad & Peter, 2007; Busch, 2008) have identified Patients, Providers, Payers and Vendors as the key stakeholders (players) in an e-health ecosystem. However, since their work preceded significant

developments that took place in e-health later and fell short of a futuristic view, some potential key players were either unaccounted for or relegated to the background. Given below is a brief account of the aforementioned scholars' works and the gaps therein which helped guide further purposive sampling.

Parente's (2000) work focused on healthcare ecommerce and different business models including 'connectivity' models which function akin to the modern day HIE (Health Information Exchange), albeit for profit. Joslyn (2001) underscored the significance of patient-centric healthcare ecommerce, predicting a trend of 'personal medical records', which has now evolved into Personal Health Records (PHRs). Aggrawal & Travers (2001) made a case for the potential of web-based ecommerce in laying the foundation for effective and efficient transactions among the key healthcare market players, thereby improving information flows and reducing costs. The focus of their work was limited to business-to-business (B2B) and business-to-consumer (B2C) healthcare ecommerce. Wen & Tan (2003) examined possible opportunities and challenges facing key players in e-health so as to meet the needs of increasingly sophisticated consumers. They particularly drew attention to the dearth of investment in interactive technologies and ecommerce ventures from healthcare providers which can facilitate active and meaningful engagement of healthcare consumers. Although these studies primarily focused on ecommerce in healthcare, they incidentally provided significant inputs that helped to identify some key players in the e-health ecosystem. As Broderick & Smaltz (2003) had pointed out, e-health is not another name for healthcare e-commerce.

Besides the four players— Patients, Providers, Payers and Vendors, a potential fifth player, namely the infomediary, is also discernible in the systems these scholars describe, although no explicit mention of such a player is found in their works. Konrad and Peter (2007) discussion of the potential role of an 'Intermediary' in enabling business processes integration in healthcare comes very close to the concept of infomediary, though the two concepts are not the same. Konrad and Haas described the 'Intermediary' as a 'broker between the cooperating parties' (p.5) and suggested the possibility of several intermediaries of the kind existing within an e-health ecosystem. In other words, the scope they envisioned for the role of the intermediary was rather narrow in the sense that it was not conceptualized as a single entity functioning as a conduit

connecting all the key players in the e-health ecosystem. While examples of such infomediaries abound in other industries, they are relatively new in e-health, and they are predicted to rise to prominence when they come to be abetted by cloud technology. Zahedi and Song (2008) described a health infomediary as a neutral online entity that could offer a range of services – illness and wellness related information, advice, guidance, assessment and referrals. However what is evident is that the role of a health infomediary has been steadily evolving in tandem with the advancements in technology and developments in e-health.

Of particular interest in this context are established technology companies that made their foray into e-health as cloud-based infomediaries. Some of these prominent players that pioneered into the health cloud space are Microsoft and Google. With their already heavy investments in cloud technology, they had the vantage position to extend their offerings to medical records services (Shimrat, 2009). Both Microsoft HealthVault (www.healthvault.com) and Google Health (www.google.com/health) shared the common goal of creating integrated online environments where one can create and store one's personal records, get information, find doctors, make medical appointments, communicate online, manage medications, share information with providers, perform tailored searches and do a lot more. Both players offered free web-based services that were consumer-centric in the sense that they put users in control of what went into their records, and who had access to those records. However Google retired Google Health with effect from January 1, 2012, the reason being the inability of the product to create the sort of broad impact it was expected to make. Microsoft on the other hand, entered into a joint venture with GE Healthcare in the same year to launch a new company called Caradigm with a view to delivering an open, interoperable technology platform for healthcare organizations which, in turn, would augment the vision of a patient-centric healthcare system.

In their roles as infomediaries, players like Microsoft have the potential to function beyond traditional HIEs that merely enable the movement of health-related data among their multiple stakeholders. Microsoft may be ahead of the curve in this mission powered by open platform products that are vendor-neutral, interoperable and cloud-based.

Figure 4.1 shows a screenshot of the consumer interface for Microsoft Health Vault.

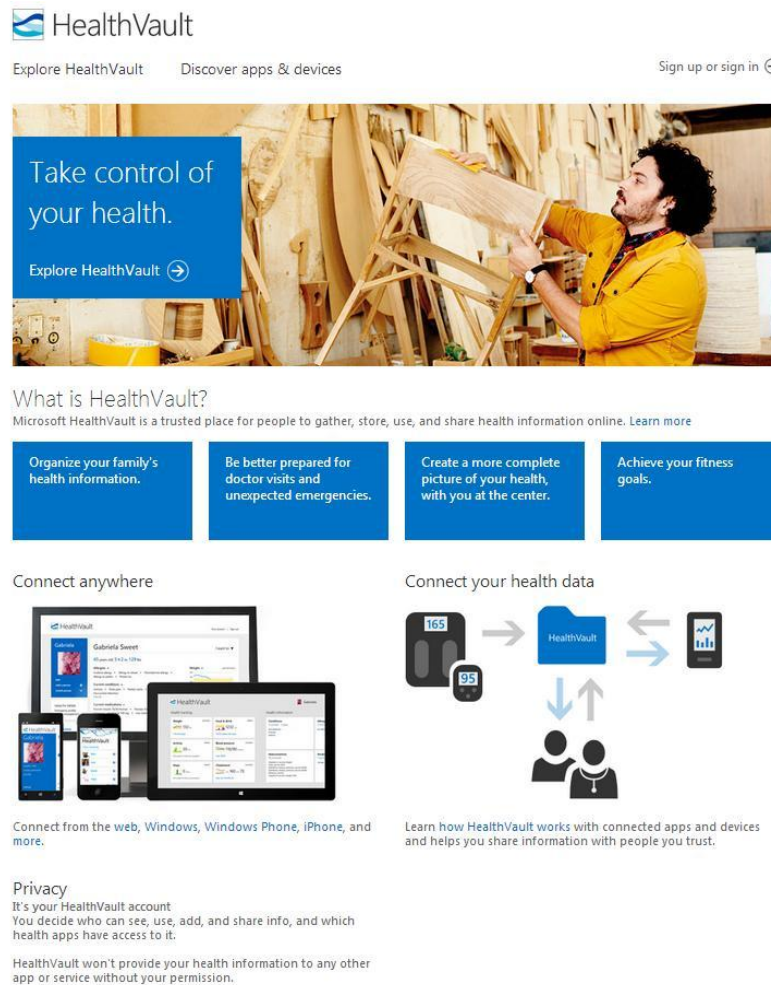


Figure 4.1. Consumer Interface for Microsoft HealthVault

Source: <https://www.healthvault.com/sg/en>

It is thus both evident and logical that an infomediary is an essential player in the e-health ecosystem who can foster effective connectivity among the other players.

With the five key players already identified, an in-depth review of literature was undertaken to spot any other potential key players not observed in the e-health ecosystem earlier.

Such probing revealed that it was not until 2003 that Regulators began to be acknowledged as part of the e-health ecosystem, when Broderick & Smaltz (2003) and later Walker et al. (2005) recognized the role of the government as not just one of the payer sources, but as a regulator of the e-health network. Broderick & Smaltz (2003) paid due attention to the

significance of business to government (B2G) relationship in e-health in compliance with governmental regulations. Walker et al. (2005) discussed the role of the government in promoting interoperability standards to achieve a fully-standardized HIE that could not only reform healthcare but also potentially yield billions of dollars in financial returns.

Another scholar, Busch (2008), suggested that the healthcare market has players at two levels – primary and secondary. At the primary level of the healthcare continuum are market players who use health information to provide patient care directly or indirectly (by supporting direct providers of patient care). These primary market players include Patients, Providers, Vendors and Payers. Secondary market players, on the other hand, use health information in roles other than direct and indirect patient care activities like public health, patient autonomy, quality assurance, safety, public policy, certification and standards, privacy, security, confidentiality, integrity etc. (Busch, 2008). Although the above definitions served as useful criteria for this research to distinguish the primary from the secondary level e-health market players, it was observed that the primary e-healthcare continuum could not be complete without the role of an Infomediary who renders movement of health data across disparate organizations possible, and thus creates tremendous values in the e-health ecosystem. Another area this study did not subscribe to was Busch's classification of activities such as patient autonomy (empowerment), privacy, security, confidentiality, integrity, certification and standards as secondary, when in fact, these activities contribute to major regulations and standards that underpin the information exchanges among the primary e-health market players.

It is imperative for an e-health system to comply with these standards and policy regulations inasmuch as it is evident that the role of the Regulator as a primary level e-health market player cannot be overlooked. A case in point is the US healthcare industry where the federal government has tackled privacy and security concerns over electronic health information by extending the privacy and security regulations of the Health Insurance Portability and Accountability Act (HIPAA) to e-health Vendors as well as Infomediaries such as Microsoft, to curb their commercial exploitation of health information (Blumenthal, 2009). The government has also enlisted the help of other private

organizations to enforce standards for health information exchange. The Certification Commission for Healthcare Information Technology ([CCHIT](#)) for example, is a non-profit organization that establishes standards for an exchange of health information among the e-health players (Goldstein, 2009). Another non-profit organization collaborating with the US government in achieving widespread adoption of interoperable EHRs is Health Level Seven (HL7), which is involved in the development of international standards for the exchange, integration, sharing and retrieval of electronic health information.

Some other standards and vocabularies are SNOMED (The Systematized Nomenclature of Medicine), LOINC (Logical Observation Identifiers Names and Codes), and NCPDP (National Council for Prescription Drug Programs) (Soti & Pandey, 2007).

All in all, this study identifies six key players at the primary level: Patients (Healthcare Consumers), Providers, Payers, Vendors, Infomediaries and Regulators. At the secondary level are several public and private organizations focusing on activities such as research, surveillance, litigation etc. Table 4.1 presents a concept matrix of the key players in e-health as identified through literature reviews and industry observations.

Table 4.1

Key Players in E-Health: Concept Matrix based on Literature Review and Industry Observations

Data source	Key Players in E-Health					
	Patients	Providers	Payers	Vendors	Infomediaries	Regulators
1.Articles						
Parente (2000)	✓	✓	✓	✓		
Joslyn (2001)	✓	✓	✓	✓		
Aggrawal & Travers (2001)	✓	✓	✓	✓		
Wen & Tan (2003)	✓	✓	✓	✓		
Broderick & Smaltz	✓	✓	✓	✓		✓

Data source	Key Players in E-Health					
	Patients	Providers	Payers	Vendors	Infomediaries	Regulators
(2003)						
Walker et al. (2005)	✓	✓	✓	✓		✓
Konrad & Peter (2007)	✓	✓	✓	✓	✓	
Busch (2008)	✓	✓	✓	✓		
Zahedi & Song (2008)	✓	✓			✓	✓
Blumenthal (2009)	✓	✓		✓		✓
Goldstein (2009)	✓	✓				✓
2.Industry observations						
GoogleHealt h (retired in 2011)	✓	✓	✓	✓	✓	
Microsoft Health Vault	✓	✓		✓	✓	

When this provisional model was presented to the experts for their feedback, generally there was consensus among them that the model adequately reflected reality. The experts were in agreement with the six key players identified, and were predominantly of the view that the model reflected reality or was close to reality at the least. However there were other significant inputs from these experts that this research carefully considered for incorporating into the final model. Some of them are:

- Renaming the player “Patients” to “Consumers” or “Recipients” as the term “Patients” is rather narrow semantically. Not all recipients of healthcare services are patients as healthcare services cater not only to those who are ill but also to those who want to perpetuate their wellness. Besides, it is not

only patients who use or contribute health data, but their next-of-kin may also do so on their behalf.

“Patient would be just one of the categories in another broader category of Recipients. So I think it would be appropriate if you can name the category differently for e.g. Recipients or Customers/Consumers”.

“You may want to include Next-of-Kin (NOK) who accompanied their parents or friends to seek treatment. Especially, for those who are elderly, information (treatment plan) usually flows to NOK rather than the patients. Most of the time, it is the NOK who make the decision on behalf of the patients”.

““Patients” is a narrow definition”.

This input, having been found valid and well-corroborated by literature (Wickramasinghe et al., 2005; Porter, 2009), led to the amendment of the label “Patients” in the provisional model to “Patients / Consumers” in order to be more inclusive.

- Research institutions and universities need special mention as they affect patient care directly with their treatment options.

“Also need to consider research institutions, medical education systems, universities, scientists – they seem to affect patient care directly with their treatment options”.

“Research institutes and universities need a special mention”.

Since the above-mentioned players only use health information in roles other than direct and indirect patient care activities (Walker et al., 2005; Busch, 2008), it was decided that they could not be considered primary e-health players.

Other Observations:

In the course of the researcher’s interactions with experts, some observations emerged and were recorded in memos. Some of them are mentioned below for what they are worth.

- It was noted that use of healthcare-related terminologies was not standard across different cross-sections of the healthcare industry. For instance, while the term ‘Providers’ is commonly used in healthcare literature to refer more or less exclusively to healthcare providers, it was suggested that the

meaning of the term could be extended to include patients’ families and sometimes their domestic helpers as well, as they also play an active role in a patient’s healthcare.

- The suggestion that ‘traditional’ or alternative healthcare practitioners such as Traditional Chinese Medicine, Ayurvedic practitioners and acupuncturists may also be considered for inclusion into the group of ‘Providers’, sounded a little controversial. This necessitated a revisiting of literature in order to clarify and refine the role of a ‘provider’ in the e-health ecosystem.

The confirmatory e-health ecosystem is depicted in Figure 4.2.



Figure 4.2. The Validated E-Health Ecosystem

4.1.3 Key Player Roles

Table 4.2 lists the key players in the e-health ecosystem, whose roles have been synthesized using data from literature review, industry observations and expert interviews.

Table 4.2.

Key Players in the E-Health Ecosystem and their Roles

Players	Roles
Patients / Healthcare Consumers	Recipients of wellness- or illness-related health services for personal or next-of-kin’s consumption – (Parente, 2000; Joslyn, 2001; Aggrawal & Travers, 2001; Wen & Tan, 2003; Broderick & Smaltz, 2003; Busch, 2008).
Providers	State-authorized providers of health services - clinical settings and

	professional staff that design, implement, and/or execute healthcare initiatives as part of wellness or illness programs (Parente, 2000; Joslyn, 2001; Aggrawal & Travers, 2001; Wen & Tan, 2003; Broderick & Smaltz, 2003; Busch, 2008).
Third-Party Vendors	Diverse market players who play a supporting role to the Providers in their provision of healthcare. These players include health IT vendors, medical equipment vendors, pharmaceutical vendors, transportation services, laboratories, legal systems, billing agents etc. (Aggrawal & Travers, 2001; Wen & Tan, 2003; Broderick & Smaltz, 2003; Busch, 2008).
Payers	Any entity that processes the claims payment transactions of healthcare episodes on behalf of plan sponsors. A plan sponsor is an entity that funds a health program – private insurance plans, government-sponsored plans, employer-sponsored plans etc. (Wen & Tan, 2003; Broderick & Smaltz, 2003; Busch, 2008).
Infomediaries	Organizations that act as mediators or brokers to facilitate information exchange among its network participants, gather pertinent health information from various sources, and syndicate, aggregate and distribute it to foster patient-centric health care (Morales-Arroyo & Sharma, 2009; Mettler & Eurich, 2012).
Regulators	Public and private organizations that develop capabilities for standards-based, secure and confidential exchange of health information to improve the coordination of care among the e-health market players (Broderick & Smaltz, 2003; Walker et al., 2005; Blumenthal, 2009).

Now that the key players in e-health have been identified and their roles understood through the various sources of data, the next step involves gathering field insights into factors that are believed to make e-health successful.

4.1.4 Critical Success Factors for E-Health

It was considered important to obtain a preliminary understanding of what the experts deemed to be critical success factors for e-health. In other words, this research sought to identify those elements which characterize or go into a successful e-health business model. To this end, the experts were consulted for their views on whether outcomes such as cost-efficiency and improved services are among factors that would make e-health successful. A summary of the experts' views which were divergent is provided below:

- While there was significant agreement that cost-efficiency and improved services are among factors that would make e-health successful, there was also some disagreement on this point which could not be ignored.
- Some experts expressed concern over the investment burden imposed on healthcare providers for the purpose of facilitating e-health. They seemed to have apprehensions that such a burden might prevent them from achieving cost efficiency. This sounded reasonable as ensuring adequate returns on provider investment is essential for the success of an e-health business model. One way this can be achieved is by incentivizing providers through government subsidies.

“The question now is whether the healthcare system can recover the IT investments that need to be made, through highly efficient and improved services”.

“some industry players (insurance companies, for example) are pushing doctors’ offices to comply with requirements that are tremendously burdensome on the doctors’ offices”.

“Provider loses out even in “steady-state” (not just in the initial stage). Govt. should subsidise EHR investment costs”.

These views generally corroborated the findings from the literature reviews given in Chapter Two.

- Other views that were relatively less common but of interest nevertheless were that e-health is a politically driven decision, and that it would work only so long as the aggregate benefit to the society is optimal; it need not result in cost efficiency for every key player; on the same note, cost efficiency does not necessarily translate to lower costs for patients as they may be willing to pay a premium if they perceive value in a proposition.
- As a rule, the experts were of the view that e-health should be capable of bringing about adequate benefits including cost-efficiency and improved services failing which it cannot be said to serve any purpose. Undoubtedly, e-health promises significant benefits for most of the players as well as for the society at large, but the fact remains that it places a burden on the healthcare providers who are tasked with investing in EHRs though there is

no guarantee of returns on their investment. The experts were thus cognizant of the possibility of misaligned incentives from e-health and emphasized the importance of addressing the likely uncertainties and imbalances to ensure that every player gets their fair deal. These findings, significant as they are, underscore the relevance and significance of the present study.

4.1.5 Value Analysis of the E-Health Ecosystem

This section focuses on the potential values that the six key e-health players identified previously can create and capture in a patient-centric e-health ecosystem. This part of the research activity involved three sequential steps. The first step aimed at developing a simplified model of the significant digital data flows in the e-health ecosystem. Based on the insights that emerged from the first step, the second step consisted in assessing and articulating the potential values generated in the e-health ecosystem using the ADVISOR business modelling framework. The third step was intended to identify and corroborate the values generated in the e-health ecosystem, using data sources such as thematic literature reviews and expert interviews.

4.1.5.1 E-Health Digital Data Flows: A Simplified Model.

A simplified model of the digital flows or exchanges in e-health is derived based on an understanding of the e-health ecosystem, its key players, their roles and business model arrangements. In this model, the players on the e-health network primarily assume two roles: one of ‘producers’ of health data which could be supplied to the network, and the other of ‘consumers’ of health data from the network. These two roles are not mutually exclusive and may often co-occur. For instance, the information produced and supplied by a physician in the form of EHRs may be consumed by another healthcare provider in the network, say, a specialist or a hospital, who then makes diagnoses with the health data, in turn producing more data, which could be supplied to other players such as insurers. Likewise, the information produced and supplied by a patient or a healthcare consumer in the form of PHRs may be consumed and edited by others in the network authorized to do so. Such exchanges are facilitated by an ‘infomediary’, yet another role that enables movement of health data among the various players in the network through syndication,

aggregation, and distribution of health information in their central repository, thus providing added value to the ecosystem.

In essence, an e-health infomediary brings together or bridges various players who would otherwise belong to a highly fragmented market, and facilitates seamless digital data flows among them. Figure 4.1 shows some of the significant digital data flows that are enabled by the infomediary in the e-health network.

E-health digital data flows fall into two categories: information-based and transaction-based flows. ‘Information flows’ denotes the information supplied to and consumed by the key players in the e-health network. ‘Transaction flows’, on the other hand, means business transactions among the key players. For instance, information flows may include exchange of EHRs between providers, or between a provider and a payer or vendor. Similarly, PHRs can also be exchanged by a patient or consumer with providers, payers and vendors. Transaction flows involve e-commerce and may include instances like a provider purchasing medical supplies from a vendor, or a patient or consumer purchasing products from a vendor or services from a provider.

In addition to mapping the digital flows, the added values that accrue to every player on account of these digital exchanges (enabled by the e-health platform), have also been identified from the thematic literature. Figure 4.3 sums up these values:

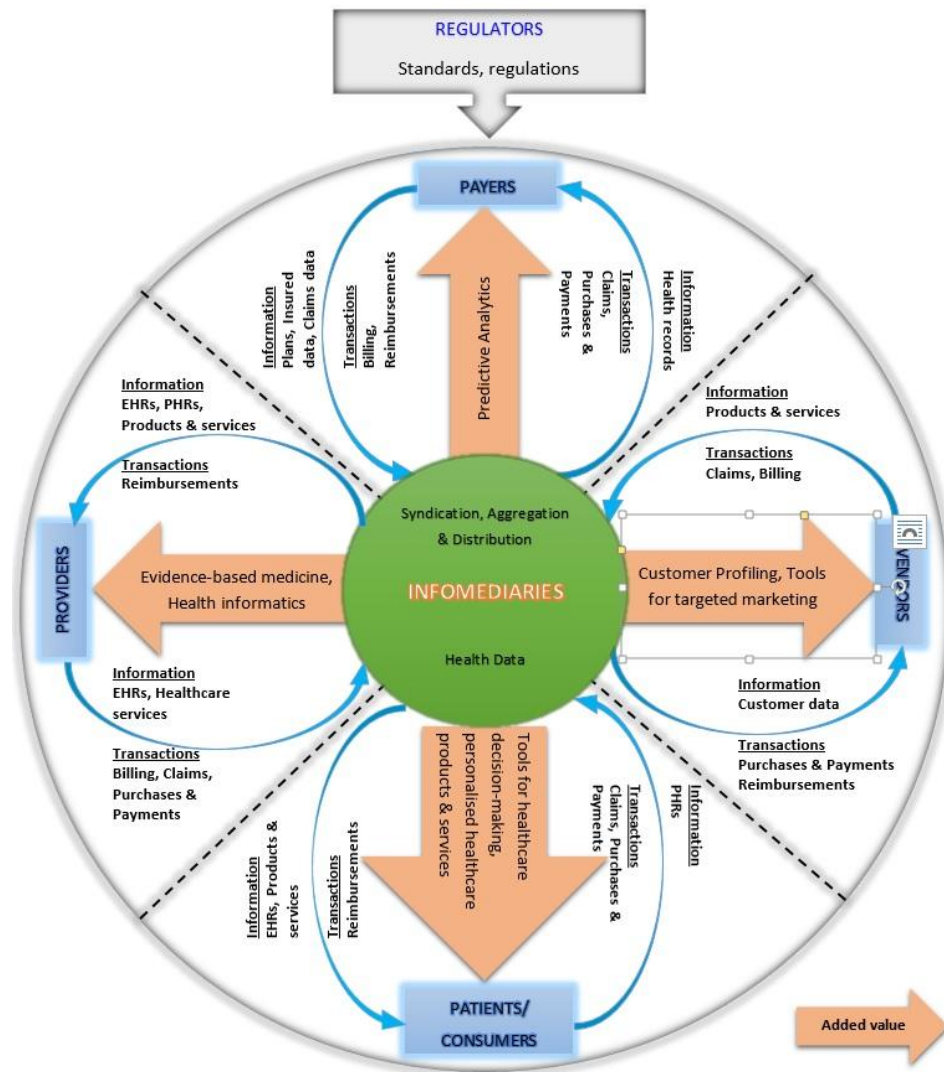


Figure 4.3. E-health Digital Flows: a Simplified Model

The modelling of digital data flows in the e-health ecosystem is based on an understanding of the key player roles and business model arrangements with the resultant model reflecting the significant data flows that are possible. Determining these digital data flows is crucial inasmuch as it sets the stage for identifying the values that can potentially be generated in the e-health ecosystem.

4.1.5.2 Value Analysis using ADVISOR Business Model.

The conceptual framework exploited to analyze the e-health ecosystem for the values created and captured is the ADVISOR Business Model. This model is an extension of the VISOR Business Model proposed by the Centre for Technology & Management of the Marshall School of Business at the University of Southern California (El Sawy, Pereira & Fife, 2008). The

extended ADVISOR framework was developed by the Special Interest Group on Interactive Digital Enterprise (SIGIDE), Nanyang Technological University (Sharma, Pereira, Ramasubbu, Tan, & Tschang, 2010). The VISOR framework helps comprehend how players in the digital business industry may evaluate and capitalize on the emergence of a new technology or service offering. It comprises five variables that need to be considered by players: **Value Proposition**, **Interface**, **Service Platform**, **Organizing Model** and **Revenue/Cost Sharing**. The ADVISOR framework adds two variables to VISOR namely **Adoption by Consumers** and **Disruptive Innovation**, and suggests that the value created and captured by a player in the digital marketplace is a function of the following seven key design parameters:

Value Proposition for the Customer	Compelling value of the digital product or service provided by a player.
Interface or the “Wow” Interface Experience	Easy to use, simple and convenient user interface for the successful delivery of the product or service.
Service Platforms to Enable Delivery	Platform(s) that support the business processes and relationships needed to deliver the product or service.
Organizing Model for Processes and Relationships	Value chains, business processes and partner relationships to ensure the effective and efficient delivery of the product or service.
Revenue / Cost Sharing for Partners	Business justification for the investments in providing the product or service and a fair return of revenues for all players involved.
<i>Adoption by Customers</i>	<i>How customers in effect co-create additional value by using or consuming the product or service</i>
<i>Disruptive Innovation</i>	<i>Impact of new technologies and business arrangements on the market.</i>

It is posited that the total value of an e-health ecosystem is a function of the above components.

It may be helpful to explain why the ADVISOR business modelling framework is chosen from among the many that are available such as the PARTS framework, Porter’s 5-Forces, the BCG Box, and the Diamond Model. A business model design is a significant decision not only for new firms, but also for existing firms that need to rethink their current models to make themselves relevant for the future (Zott & Amit, 2010). This is true especially of the digital business industry characterized by transformational forces that lead to turbulences and vulnerabilities in the market (Sharma et al., 2010), very

often resulting in what Christensen (1997) termed ‘disruptive innovation’. Disruptive innovation is a process that has positively transformed the status quo for customers in several industries by effectuating convenience and affordability. However one of the industries that remain largely untouched by disruptive innovation is the healthcare industry (Hwang & Christensen, 2008). In spite of the numerous technologies being introduced into the industry on a regular basis, healthcare is still no more accessible or affordable than in the past. As rightly observed by Hwang and Christensen (2008), it is time to ask how we can make healthcare more affordable rather than how we can afford healthcare (p. 1329). They further note that only a business model that is designed to offer increased convenience and affordability by taking advantage of disruptive innovations can create tremendous value in healthcare.

A business modelling tool that explicitly embeds in its design the notion of ‘disruptive innovation’ as a key parameter is the aforementioned ADVISOR. No wonder it is considered an apt tool to analyze and articulate how the various players in the e-health industry may deliver value to their co-players through both cooperative and competitive means (co-opetition).

Table 4.3 presents an analysis of the e-health ecosystem using the ADVISOR business model framework. The analysis is from the perspective of each of the key players identified in the e-health ecosystem with the exception of the Regulators, who are not-for-profit entities and who therefore cannot be subject to a business model framework. The conceptual framework is used to comprehend how the key players in the e-health ecosystem may respond to e-health, evaluate the potential of e-health in terms of the new business opportunities it presents, and strategize to capitalize on these opportunities. This analysis is backed by a comprehensive review and understanding of the various existing e-health business models presented in **section 2.6.6**, ‘Business Models in E-Health’ and the roles of the key players that have been identified and presented in **section 4.1.3**, ‘Key Player Roles’. The framework necessitates critical thinking along the seven design parameters to identify the key issues involving e-health from every player’s perspective and determining how best the player would address these issues. It is hoped that such an assessment of the ecosystem for its value potential can lead to evolving an efficient and fair (win-win) arrangement among the players so that each of them derives returns (value

captured) that are consistent with their added values (value created). After all, creating and capturing values are fundamental functions a player must perform to remain in the game (Shafer et al., 2005).

Table 4.3.

Analysis of the E-Health Ecosystem Using ADVISOR

Key Players					
	Patients (Consumers)	Providers	Payers	Vendors	Infomediaries
Value Proposition	Patient-centric, affordable healthcare facilitated by a longitudinal health record and other healthcare decision-making tools	Evidence-based medicine facilitated by EHRs	Efficient claims handling and reimbursements and better risk modelling	Direct, targeted marketing of products and services to healthcare customers	A “computing as a utility” platform facilitating exchange and reuse of health information which reduces costs and improves efficiencies for all
Interface	Web interface that allows for interoperability and exchange of data residing with disparate organizations				
Service Platform	Cloud computing technologies with high security features like encryption, authentication and access levels, etc. to protect health data				
Organizing Model	Standards and certifications for interoperability of health information systems and seamless exchange of health data subject to appropriate access levels (e.g. HL7, Dicom etc.) Regulations to protect privacy and security of health data and curb its commercial exploitation (e.g. HIPAA)				
Revenues / Cost	Cost: Free or small subscription fee Revenues: Usually none, with some possibility for C2C commerce	Cost: Investment in EHR systems, training costs, maintenance/ upgrading costs Revenues: B2B and B2C	Cost: Investment in payer information system, training costs, maintenance & upgrading costs	Cost: Investment in information systems, training costs, maintenance & upgrading costs Revenues: B2B, B2C ecommerce,	Cost: Investment in cloud infrastructure for standards-based, secure exchange of health data. Revenues: Subscription fees,

Key Players					
	Patients (Consumers)	Providers	Payers	Vendors	Infomediaries
		ecommerce, reimbursements	Revenues: B2B, and B2C ecommerce	reimbursements	advertisement revenues, ecommerce transactions
Adoption by Users	Co-creation of value through PHRs, a source of empowerment in healthcare decision-making	Co-creation of value through EHRs which improve efficiencies and reduce medical errors and resulting litigation costs	Co-creation of value through aggregation of insured and claims data which facilitates superior risk modelling	Co-creation of value through targeted marketing which significantly reduces direct marketing costs	Co-creation of value through syndication , aggregation and distribution of health data which creates new markets and business opportunities
Disruptions	Single electronic interface for the entire continuum of healthcare management in lieu of multiple resource-consuming face-to-face interfaces	Electronic interface - with patients in lieu of resource-consuming face-to-face interface - with payers and vendors for efficient and transparent transactions	Electronic interface for insurance claims and purchase of plans in lieu of resource-intensive paper-based transactions	Single electronic interface to access and target the gamut of healthcare customers - healthcare providers, patients, insurers etc.	A well-networked electronic healthcare marketplace on cloud in lieu of the conventional, fragmented marketplace

From the foregoing analysis of the e-health ecosystem using the ADVISOR framework (Table 4.3), it is apparent that, if organized by the right business model, e-health holds immense potential for the future. The businesses of the key players are interdependent insofar as every player potentially creates an ‘added value’ that benefits the other players, thereby giving rise to a compelling proposition in the health ecosystem to collaborate to create and capture ‘value’ rather than compete for ‘dollars’.

4.1.5.3 A Qualitative Analysis of Values in the E-Health Ecosystem.

Supported by such insights from ADVISOR modelling, data collection was directed towards identifying the significant values that could be created and captured by players in the e-health ecosystem conceived in this research. This was accomplished through extensive literature reviews the findings from which are compared and corroborated with inputs from expert interviews.

Data Source 1: Thematic Literature Reviews

Patients (Consumers)

E-health holds great promise for empowerment of patients who are “the largest and most important stakeholder group” (Hill & Powell, 2009). It serves to open doors to competitive markets, which is bound to increase healthcare choices and lower healthcare costs. Equipped with ubiquitous access to PHRs, EHRs and tools for informed healthcare decision-making and guided health promotion behaviors (Burkhard, 2009), healthcare consumers will have complete freedom to choose and switch among multiple care providers while seeking to satisfy their unique needs for quality, service, and price (Joslyn, 2001).

A 2007 survey of US consumers by Accenture found that healthcare consumers regard the presence of EHRs as an important factor in their choice of a physician (“Provider-Led Health Insurers - Healthcare Consumer Satisfaction - Summary - Accenture”, 2007). Another study by User Centric (Peters et al., 2009) on the comparative usability of two cloud-based PHR applications (Google Health versus Microsoft Health Vault) reported that the majority of its study participants found PHRs useful and expressed an interest in creating and maintaining their own PHRs. A more recent study by Zieth et al. (2014) found that patients expressing dissatisfaction with their current healthcare providers were more likely to prefer an EHR-integrated PHR that would not only give

them access to their health information, but also empower them to take control of their healthcare related decisions. Such trends reflect the rise of consumerism which, when coupled with policy imperatives by governments, forces healthcare providers to focus on the needs and demands of consumers, and consequently make hefty investments in EHR systems.

Providers

EHR investments may seem a burden on the healthcare providers in the short term, but the value the providers as well as the other players can leverage from this investment over the long term appears compelling. It has already been discussed how cloud technologies may be explored by healthcare providers to ease their EHR investment burden. When e-health fosters evidence-based medicine (Busch, 2008) with the support of medical informatics, it enhances the quality of care, improves operational efficiencies; reduces medical errors (Miller, West, Brown, Sim, & Ganchoff, 2005; Chaudhry et al., 2006; Hill & Powell, 2009); facilitates training and education of physicians and cost-effective e-procurement of medical supplies (Wickramasinghe et al., 2005); increases reimbursements (Berthold, 2008) and provides access to a larger pool of healthcare consumers by opening up new business opportunities (e.g. authoring personalized healthcare plans).

Payers

The e-health benefits that accrue to Payers are also significant - improved efficiency in claims processing resulting in cost savings (Wen & Tan, 2003; Walker et al., 2005; Menachemi & Collum, 2011), easier implementation of regulations such as HIPAA (Wen & Tan, 2003), reduced wasteful reimbursements on account of redundant tests (Goldstein, 2009), online sale of health insurance bypassing agents (Whitten, Steinfield & Hellmich, 2001) and research and analytics enabled by the very large stores of data aggregated in the e-health network (Wen & Tan, 2003).

Vendors

The diverse range of healthcare Vendors also adds to the list of benefits from e-health in terms of the enormous potential for B2B and B2C e-commerce opportunities it offers (Payton, 2003). They enjoy better visibility of their offerings, and gain direct access to their customers which in turn decrease their marketing costs (Wen & Tan, 2003). Additionally, they are also equipped with tools to do targeted marketing of their products and services to prospective customers.

Infomediaries

For the infomediary, the value in e-health, is the opportunity to syndicate, aggregate and distribute the massive amounts of health data in the network referred to as 'big data' (Kayyali, Knott & Van Kuiken, 2013; DeNardis, 2014), in order to cater to the varying needs of the other players, thereby creating new business opportunities and markets (Morales-Arroyo & Sharma, 2009; Mettler & Eurich, 2012). By facilitating such exchange and reuse of health data (Brailer, 2005), it improves efficiencies and reduces costs for every player in the network while at the same time generating revenues for itself through such value creation. Infomediaries already in the cloud (e.g. Microsoft Health Vault) may well emerge the most dominant infomediaries in the e-health ecosystem, with the take-off of cloud computing technologies in the healthcare sector.

Regulators

The regulators, although non-profit entities, can also create and capture value in the e-health ecosystem even if it may not be in the form of direct economic returns. They view e-health as a means to improve the quality of healthcare (Blumenthal, 2009). To achieve this objective, they drive the standards required to facilitate interoperability among health systems so that health data can be exchanged and reused (Goldstein, 2009), as well as, the regulations to protect the privacy and security of health data, and prevent any unauthorized exploitation of such data by other players in the network (Blumenthal, 2009). Thus, the regulators are in a position to improve the health of populations, augment the efficiency of healthcare systems, and lower healthcare expenditure (Blumenthal, 2009). In addition, regulators may also offer financial incentives to healthcare providers to encourage adoption of EHR systems by reducing their financial burden in such investments (Jones, 2012; Jacob, 2013).

Data Source 2: Expert Interviews

There was a broad consensus among the experts when they were asked to confirm whether the sources of values in the e-health ecosystem had been adequately identified and defined. Some additional values suggested by a few experts for consideration in this research, were:

- Time effectiveness
- Capability to prioritize attention to patients
- Provider education

These suggestions led to further data collection for corroboration, and were eventually included into the list of significant values in the e-health ecosystem presented in Table 4.4 below.

Yet another insightful suggestion was to explicitly map out the contributors (creators) of the values and the corresponding beneficiaries (capturers) of those values. After considerable thought, it was decided that such a mapping might be too complex to prove useful. This is due to the possibility that some of the values may be co-created by multiple players and some of the values may have multiple beneficiaries.

Based on the assessment of the key players' potential for value creation and value capture in the e-health ecosystem using the ADVISOR framework; the literature-backed identification of the values generated in the ecosystem; and the inputs elicited through the expert interviews, the significant values created and captured by every key player in the ecosystem are juxtaposed in Table 4.4. It is to be noted that these values may be tangible or intangible, and are not exhaustive.

Table 4.4.

Validated Values Created Vs. Values Captured

Key Players	Values created	Values captured
1. Patients / Consumers	<ul style="list-style-type: none"> <input type="checkbox"/> Health data (Neupert, 2009) <input type="checkbox"/> Personal health records (Peters et al., 2009) <input type="checkbox"/> Healthcare ecommerce (B2C, C2C) (Parente, 2000; Eysenbach, 2001) <input type="checkbox"/> Health experience sharing in peer-to-peer communication (Wickramasinghe et al., 2005; Calvillo et al., 2013) 	<ul style="list-style-type: none"> <input type="checkbox"/> Ubiquitous access to health records (Burkhard, 2009) <input type="checkbox"/> Patient-centric healthcare (Burkhard, 2009) <input type="checkbox"/> Increased healthcare choices (Joslyn, 2001; Powell & Laufer, 2010) <input type="checkbox"/> Lower healthcare costs (Wen & Tan, 2003; Tang et al., 2006) <input type="checkbox"/> Timely intervention (Archer

Key Players	Values created	Values captured
		et al., 2011) <input type="checkbox"/> Empowerment to make informed choices (Purcarea, 2009; Calvillo et al., 2013)
2. Providers	<input type="checkbox"/> Electronic medical / health records (Hill et al., 2007) <input type="checkbox"/> Improved quality of care (Walker et al., 2005) <input type="checkbox"/> Tele-healthcare delivery (Hill & Powell, 2009) <input type="checkbox"/> Evidence-based medicine (Busch, 2008) <input type="checkbox"/> Preventive healthcare (Chang et al., 2009) <input type="checkbox"/> Medical informatics (Raghupathi & Kesh, 2009) <input type="checkbox"/> Reduced medical errors (Vishwanath & Scamurra, 2007)	<input type="checkbox"/> Improved operational efficiencies (Wen & Tan, 2003; Ahern, 2007) <input type="checkbox"/> Enhanced cost-effectiveness (Vishwanath & Scamurra, 2007) <input type="checkbox"/> Time-effectiveness enabled by automatic capture of patient data (McKesson Corporation, 2007), 2007) <input type="checkbox"/> Capability to prioritize patients based on the severity of their condition e.g. triage services (Konrad & Peter, 2007) <input type="checkbox"/> Training and education of physicians (Wickramasinghe et al., 2005) <input type="checkbox"/> Cost-effective e-procurement of medical supplies (Wen & Tan, 2003) <input type="checkbox"/> New business opportunities created by the eHealth network (B2B, B2C) (Parente, 2000) <input type="checkbox"/> Reduced risk of litigation (Couch, 2013)
3. Third-Party Vendors	<input type="checkbox"/> Direct access to products / services for customers (Wen & Tan, 2003; Atkinson et al., 2009) <input type="checkbox"/> Personalized products and services facilitated by data aggregation (Parente, 2000) <input type="checkbox"/> R&D data (Kayyali et al., 2013)	<input type="checkbox"/> Electronic interface to access and target the gamut of healthcare customers - healthcare providers, patients, insurers etc. (Wen & Tan, 2003) <input type="checkbox"/> Decreased marketing costs (Wen & Tan, 2003) <input type="checkbox"/> Reduced R & D costs (Wen & Tan, 2003) <input type="checkbox"/> Increased business opportunities (B2B, B2C etc.) due to direct access to a large pool of healthcare customers (Payton, 2003; Wickramasinghe et al., 2005)
4. Payers	<input type="checkbox"/> Electronic interface for claims management (Walker et al., 2005) <input type="checkbox"/> Electronic interface for direct purchase of plans by customers bypassing agents (Whitten et al., 2001) <input type="checkbox"/> Research and analytics	<input type="checkbox"/> Improved efficiency in claims handling (Wen & Tan, 2003; Walker et al., 2005; Menachemi & Collum, 2011) <input type="checkbox"/> Cost savings (Walker et al., 2005) <input type="checkbox"/> Easier implementation of

Key Players	Values created	Values captured
	facilitated by data aggregation (Wen & Tan, 2003) <input type="checkbox"/> Targeted information delivery to customers facilitated by data aggregation (Parente, 2000)	healthcare regulations (Wen & Tan, 2003) <input type="checkbox"/> Increased business opportunities (B2B, B2C etc.) due to direct access to a large pool of healthcare customers (Parente, 2000)
5. Info-mediaries	<input type="checkbox"/> Total digital health systems (Raghupathi & Kesh, 2009) <input type="checkbox"/> A digital platform to facilitate exchange and reuse of health data among players in the healthcare market (Morales-Arroyo & Sharma, 2009; Mettler & Eurich, 2012) <input type="checkbox"/> Improved efficiencies for players in the healthcare market (Wen & Tan, 2003) <input type="checkbox"/> Reduced costs for players in the healthcare market (Wen & Tan, 2003) <input type="checkbox"/> Big data (Kayyali et al., 2013; DeNardis, 2014)	<input type="checkbox"/> New markets brought about by syndication, aggregation and distribution of health data (Morales-Arroyo & Sharma, 2009) <input type="checkbox"/> New business opportunities and revenues to be tapped in the form of subscription fees, advertisement revenues, ecommerce transactions (Parente, 2000)
6. Regulators	<input type="checkbox"/> Incentives to facilitate EHR adoption and health information exchange (Jones, 2012; Jacob, 2013) <input type="checkbox"/> Regulations to protect privacy / security of health data (Blumenthal, 2009) <input type="checkbox"/> Standards for interoperable healthcare systems to facilitate exchange and reuse of health data (Goldstein, 2009)	<input type="checkbox"/> Improved health of populations (Blumenthal, 2009) <input type="checkbox"/> Improved efficiency of healthcare systems (Blumenthal, 2009) <input type="checkbox"/> Lower healthcare expenditure (Hill & Powell, 2009)

Analysis and Discussion

Apparently, there are significant values to be captured for every key player in the e-health ecosystem thus encouraging their participation in the ecosystem. The ecosystem seems to present opportunities for every key player to create values that benefit the other players, and correspondingly to capture sufficient values to justify their participation and value creation in the ecosystem. As noted by Michel (2014), it does not suffice if a business keeps innovating itself to create new values for its customer; it should also revisit how it captures values so as to be adequately incentivized for its value creation. Thus, it is not unreasonable to surmise that a fair, efficient, stable and sustainable e-health ecosystem would be one that justifies the participation of every player by

ensuring that there are compelling values they can capture from the network in exchange for the “added values” they create. However the actual outcomes of such a proposition may vary from player to player, thus posing the question of whether the values captured (values added) justify the values created (added values) for all the players involved. After all, value depends on which stakeholder’s perspective it is viewed from (Rudin et al., 2014). In recognition of this fact, experts’ views were sought to determine if there is any perceived imbalance in values-created versus values-captured for any player(s) in the e-health ecosystem, and to understand whether fairness and efficiency were considered to be key design parameters for a sustainable ecosystem. Any new issues brought up by the experts were compared with literature for conformity or contrast.

While some experts were of the opinion that the values created and captured by the key players are congruous, the others held divergent views as shown below:

Players perceived to create more value than they capture:

- Providers were widely considered to be creating more value than they capture from the ecosystem because the onus of the heavy financial burden in terms of EHR investments is directly on them. E-health, in the view of the experts, has yet to evolve, firstly to the point of preserving the productivity of the Providers, and then to the point where the Providers can actually start reaping the benefits from their heavy investments.

“Providers – from adopting an e-health mode of treatment delivery they are yet to reap the full benefits of the high investments. E-health at this point in time is yet to evolve to preserve the productivity of providers”.

“The value created for the patients will be bigger than value captured as they will then be able to access different providers of health care”.

“Providers create more value than they capture because of EHR investments”.

These opinions resonate very well with the findings from the literature reviews given in Chapter Two.

- Regulators were considered by some experts to be the player that creates the maximum value in the e-health ecosystem. Such significant contribution of

the Regulators is expected to continue until the ecosystem stabilizes and healthcare related indices reflect better measures as a direct result of adoption of e-health.

“Regulators/Government create maximum value until indices begin to show better health values because of the adoption of e-health”.

“The government will create the greatest value as it will lower the overall cost of the public health care”.

That the regulators play a significant role in creating values in e-health is indeed true as they are the entities tasked with improving outcomes in healthcare, a public good, through appropriate regulations, standards and other actions (Accenture, 2012).

Incidentally, some experts were of the view that the Regulators might capture the least value which however may not be true. By creating values in healthcare enabled by e-health, regulators are not only able to achieve population health goals (Diamond, Mostashari & Shirky, 2009), but are also able to retain their legitimacy as regulators since the value they create is a yardstick for the public to assess their performance (Kelly & Muers, 2002).

- Some dissenting viewpoints on the role of an infomediary may also be mentioned here. Some experts held the view that Health IT Vendors create the greatest value because they act as the conduit through which products and services reach Patients in the most effective and efficient manner.

“We (third-party vendors) are the conduit through which the services reach the patients in the most effective and efficient manner”.

It is inferred that the ‘IT vendors’ referred to in this context are, as a matter of fact, the ‘infomediaries’ as described in this research. One of the key propositions of such an infomediary is to meet the market demand for value-added services that would enable its customers ‘to find what they are looking for’, especially in the face of the increasingly ubiquitous Internet (Konrad & Peter, 2007, p.105).

In contrast, some experts were of the opinion that the infomediary creates the least value.

The contrasting scenarios indicate that the role of an infomediary is not clearly understood. It is likely that the role of the infomediary may have been construed as similar to that of a typical IT vendor whose role is limited to the

institutional boundaries of its customers (e.g. Providers). As a matter of fact, the role of the infomediary spans multiple organizational and even industrial boundaries in its bid to forge meaningful connections among the various stakeholders in its network. Consequent on this ambiguity regarding the role of the Infomediary, the term was redefined so as to improve clarity (Table 4.2).

Players perceived to capture more value than they create

- By and large, patients (consumers) were considered to be the player capturing the greatest value from e-health. In fact, they were viewed as capturing more value than they create, and quite rightly so, because they are the intended beneficiaries of any health system (Hill & Powell, 2009).
- Another player that was thought to capture more value than they create is the EHR vendor. This is because the EHR vendors are often known to capitalize on the system integration opportunities arising from the lack of interoperability across hospitals' IT systems.

The above-mentioned observation is alluded to by Kellermann and Jones (2013) who suggest that the lack of progress on interoperability may be a result of the resistance from not only the providers but also the Health IT vendors. This is because, enforcement of interoperability will lead to standardized health IT systems which will not require the intervention of an IT vendor to be able to exchange information among them. This, in turn, will result in loss of business opportunities for EHR vendors who are known to charge hefty 'interface fees' to facilitate interoperability across silo systems (Tahir, 2014).

- A rather unique but noteworthy perception, though not commonly encountered, is that Payers create the least value since the adoption of e-health and other technologies has not resulted in reduced plan premiums and improved benefits for consumers.

It is true that there is no strong demonstrable evidence of the benefits of e-health to date. This may have to do with the fact that the value of Health IT accrues over time (Rudin et al., 2014) and for any transformation to be achieved in healthcare, continuity and consistency are key (Britnell, 2015).

Perceptions of fairness and efficiency

The predominant view among the experts seemed to be that e-health will come to fruition only if there is fairness and efficiency in the ecosystem, and that an imbalance between values created and captured for any player will render e-health unsustainable in the long run.

A different view though rarely encountered is that e-health may still be sustainable if the outcome is Pareto-efficient, i.e., no player is worse off than status quo. This view is in conformity with the line this research has taken and is worth exploring in further research as well.

Figure 4.4 shows a concept map of the key findings related to the e-health ecosystem and the issues therein, some of which require further investigation. These key findings represent the key concepts that have so far emerged in this research.

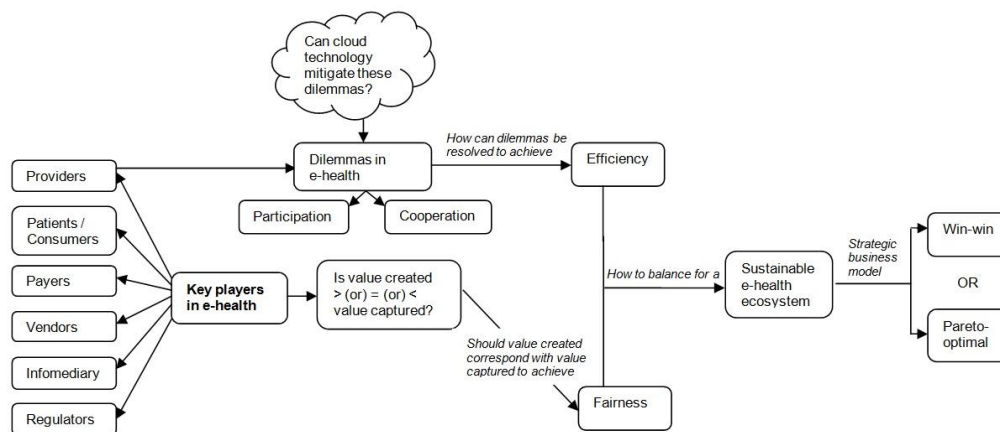


Figure 4.4. A Concept Map of Findings about the E-Health Ecosystem

4.2 Caveats

The modelling of the e-health ecosystem was primarily based on literature reviews, observations of market developments, and expert interviews. The key players identified are by no means exhaustive, but can be classified into six broad categories as discussed in this chapter. Such a classification is not merely for the purposes of ease or simplicity, but rather to keep this research focused on the need to investigate the critical issues facing the e-health ecosystem. Likewise, the data flows identified among the key players are non-exhaustive but reflect those that are significant.

4.3 Chapter Summary and Recap

The purpose of this chapter was to address RQ1 through the identification of the key players in a patient-centric e-health ecosystem, their roles and the potential values they can create and capture in a patient-centric e-health ecosystem through digital data flows. Also embedded within the scope of this chapter was the objective to validate the relevance and significance of this research. To help reach these targets, multiple sources of data such as thematic literature reviews, industry observations and expert interviews were deployed. It may not be an exaggeration to say that the findings based on these data sources supplemented by ADVISOR business modelling have been insightful. Supplemented by updated research, these findings have been instrumental in augmenting the provisional models developed early on in this research.

The findings so far have helped establish the fact that there are six key players in an e-health ecosystem without whom, the ecosystem may not be able to generate sufficient values for its balance and sustenance. Also, evident through the findings is the fact that the e-health ecosystem offers the potential for every player to capture values which may otherwise be inaccessible to them; however, it may only be sustainable if it is fair and efficient from every player's perspective. At the least, no player should be worse off than status quo because of their participation in e-health. In other words, the minimum requirement for an e-health system may be to be Pareto-efficient. Currently, there is a perceived imbalance in the ecosystem because of the financial strain it saddles the Providers with. The Providers are seen as having to contribute more value to the ecosystem than they can capture. This clearly tilts the balance in the ecosystem to the disadvantage of the Providers, and will lead to a less than Pareto-efficient ecosystem which may not be sustainable. Our research sets out to further investigate how a balanced and sustainable ecosystem may be achieved, and if the cloud technology has the potential to render it possible. With these steps accomplished, RQ1 may be said to have been addressed, and phase 1 of this research, completed. Moreover, the relevance and importance of this research also stand validated through the triangulation of the various slices of data which imply that misaligned incentives among the key stakeholders of e-health may pose a challenge for its successful implementation. Besides, the discussion

embodied in this chapter helped outline the first ever key steps needed to set the study into focus and look for guidelines for seeking answers to RQ2.

The next chapter marks the beginning of phase 2 of this research. It presents the case study of Singapore's NEHR, an ongoing e-health initiative. This case study forms the pilot study undertaken to test the conceptual model of the e-health ecosystem developed in phase 1 of this research.

CHAPTER FIVE VALIDATION OF CONCEPTUAL MODEL: WITHIN-CASE ANALYSIS OF SINGAPORE'S NEHR

This chapter marks the beginning of phase 2 of this research which was concerned with validating the conceptual model of a patient-centric e-health ecosystem developed in phase 1. Such validation was intended to be accomplished through two descriptive case studies namely Singapore's NEHR and the US' HITECH program. The rationale behind the choice of these cases for study has been elaborated on in **section 2.13**, 'Selection of Cases for Phase 2'. Of the two cases chosen, Singapore's NEHR was designated the pilot study owing to the relatively easier accessibility it afforded to the informants. It was hoped that this pilot study would cast light on improvement opportunities in the case study design. This chapter presents the within-case analysis and report of Singapore's NEHR, the pilot case study, and ends with a brief account of the lessons learnt in the course of this case study and key conclusions from the study.

5.1 Introduction

Singapore's healthcare system is a two-tier system which involves participation of both public and private sectors in the provisioning as well as the financing of healthcare services (Lim, 2005). The distribution of Singapore's healthcare services across the various sectors is depicted in Figure 5.1. The focal point of Singapore's healthcare financing system is the 3M scheme – Medisave, Medishield and Medifund. This is based on the philosophy of shared responsibility. This means the government would subsidize healthcare costs, but the people will still have to share the costs of the healthcare services they use so as to keep the healthcare system viable and sustainable. Ranked the world's 'healthiest country' in 2015 alongside Iceland and Sweden ("World Health Statistics 2016: Monitoring health for the SDGs", 2016) and having a healthcare system which was the world's 'most efficient' in 2014 (Chen, 2014), Singapore, facilitated by its current position at the forefront of technology, is well-poised to successfully face the challenge of transforming its healthcare further. It is one of the few countries that ranked high on e-health preparedness and hence was predicted to successfully implement e-health (Wickramasinghe, Fadlalla, Geisler, & Schaffer, 2005). This is despite Singapore's total health

expenditure as a percentage of its Gross Domestic Product (GDP) being 4.9 in 2014 ("World Health Statistics 2016: Monitoring health for the SDGs", 2016), relatively far lower than that of other advanced countries.

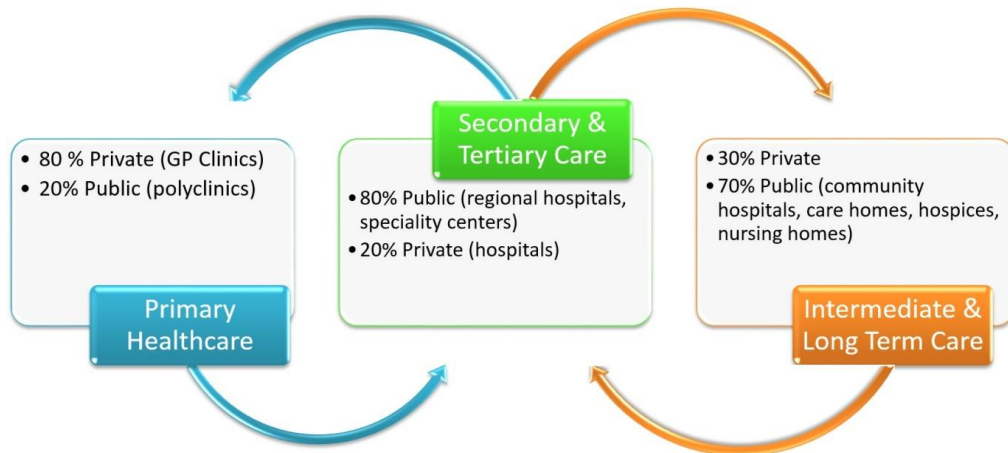


Figure 5.1. Singapore's Distribution of Healthcare Services

5.2 Singapore's Healthcare Transformation Journey

Singapore has reached its current position as a world leader in healthcare only after a long and hard journey. A revisit to the history of healthcare in Singapore since 2000 may be in order in this context. In order to make the healthcare environment competitive, Singapore's public healthcare system was restructured into two major clusters, namely Singapore Health Services (SingHealth) and National Healthcare Group (NHG) in 2000 (Chang, 2010). However, this inter-cluster competition did not prove very helpful as it was perceived to be artificial, and existing only in form but not in substance (Lim, 2005). Such an arrangement also proved to be short-sighted and counterproductive with the two clusters developing their Electronic Medical Records (EMR) systems independently. This prohibited a seamless exchange of health data when patients moved over from one cluster to another (Sinha et al., 2013). To resolve this problem, an interim solution known as the Electronic Medical Record Exchange (EMRX) was implemented in 2004 (Muttitt, 2011). Although this facilitated an exchange of health data between the two clusters, such exchange was limited to a document-level exchange due to the lack of structured data (Sinha et al., 2013). This meant that the 'smartness' to facilitate clinical decisions, research and surveillance was technically infeasible. Another issue with the EMRX was that the data exchange was not governed by any

regulations to protect the privacy of patients. These drawbacks posed new challenges which had not been anticipated earlier.

To compound the challenges mentioned above, yet another threat that made the healthcare transformation complicated stemmed from the realization that the movement of patients, especially of the chronically ill and the elderly, was not just going to be restricted to the two public healthcare clusters, but might actually span across the entire spectrum of primary, secondary, tertiary, intermediate and long-term healthcare, in the public, private as well as voluntary welfare healthcare sectors.

The technical and structural challenges apart, another critical issue said to confront Singapore is what is known as the ‘silver tsunami’. The expression ‘silver tsunami’ refers to a rapidly ageing population, one of the key indicators of which is a population’s median age. By 2030, 1 in 5 Singaporeans is estimated to be over the age of 65, and by 2050, Singapore is predicted to be one of the demographically oldest countries with a median age of 55 years (Institute of Policy Studies, 2012). About 85% of those aged 65 and above are forecast to develop one or more chronic illnesses that would necessitate life-long treatment (Singapore Department of Statistics, 2010 as cited in Ng, Sy & Li, 2011). These projections, in addition to the already existing challenges in Singapore’s healthcare system, led to the stark realization that a transformation of the existing system is what is needed. The rapid growth of the number of the elderly would also mean that the time that Singapore has at its disposal to transform its healthcare system is rather limited as the silver tsunami is likely to impact Singapore’s healthcare landscape sooner rather than later. The situation would result in severe bed / resource crunches in hospitals, stretching the waiting time for a hospital bed to about 12 hours, thereby affecting productivity (Pang, R., personal interview, April 20, 2015; Chowdary, K.P.H., personal interview, May 15, 2015). The demands of such a rapidly ageing population could possibly render the currently hospital-centric healthcare model unsustainable (Gunapal et al., 2016).

The turn of events discussed above eventually led to an integration of the existing healthcare systems not only to better meet the demands of an ageing population, but also to acquire the capability of a seamless exchange of health information that would bring to fruition Singapore’s strategic vision of

'One Patient One Record'. Such a capability is considered critical to ensure that coordinated care is delivered in the most appropriate settings as well as to prevent any undue strain on the country's healthcare infrastructure (Ng et al., 2011).

Thus, over time, through steps and missteps, insights were gleaned and lessons were learnt that helped modify the Singapore healthcare system. The need for integrating healthcare provision beyond the public sector to include the private and voluntary welfare sectors was strongly felt at the political level. This led to a reorganization of Singapore's healthcare system. As a consequence, the healthcare system was split into six major clusters or RHS (Regional Health Systems) in 2010 (Gunapal et al., 2016) for better care coordination and integration to offer holistic, patient-centric healthcare. An independent agency called AIC (Agency for Integrated Care) which was formed in 2009 to develop the Long Term Care sector, was tasked with integrating these six clusters at the national level and help patients navigate the RHSs (Koh & Cheah, 2015). Figure 5.2 depicts Singapore's six health clusters.



Figure 5.2. Singapore's Regional Health Systems Network

This reorganization is believed to facilitate a shift from an episodic level care to a patient level or patient-centric care (Shum & Lee, 2014). Each RHS is made responsible for the health of the population in its region, and this entails collaborations and partnerships beyond the public healthcare sector. RHSs have to collaborate with general practitioners (private, primary care sector) as well as voluntary welfare organizations to offer holistic and integrated care. Each RHS is anchored by an acute care hospital that partners with other healthcare

providers in the region such as community hospitals, nursing homes and general practitioners^{viii}.

The aforementioned challenges and changes culminated in the Ministry of Health (MOH) initiating in 2010 the nation-wide electronic health record systems referred to as the National Electronic Health Records (NEHR) (Chowdary, K.P.H, personal interview, May 15, 2015). To realize its vision of '*One Patient, One Record*', the Singapore government made the NEHR system a key component of the Intelligent Nation 2015 (iN2015), a 10-year plan (Sinha et al., 2013). The NEHR program is estimated to break even within 7 to 8 year of its implementation, and generate a net present value of approximately S\$581 million (Muttitt et al., 2012). MOH Holdings Pte Ltd, the holding company of Singapore's six RHSs, is tasked with the implementation of the NEHR. The NEHR is being developed based on international standards and its deployment is supported by an enterprise architecture (Accenture, 2012).

Considering that 80% of healthcare costs are generally incurred in the last few years of an individual's life time (Pang, R., personal interview, April 20, 2015), the focus of Singapore's healthcare industry is also geared towards providing better intermediate and long term care for the elderly. It is also considered equally important to step up 'preventive healthcare' initiatives in preparation for an ageing population. This might mean ushering in 'Smart Homes' equipped with monitoring systems to enable management of chronic health conditions. Such 'Smart Homes' may be supported by Cloud, SaaS, and mobile technologies. Initiatives such as Smart Home and Smart Mat that are already under trial have the potential to ease this resource crunch faced by hospitals (Pang, R., personal interview, April 20, 2015; Chowdary, K.P.H., personal interview, May 15, 2015). The SmartMat, which is being experimented with in the Changi Prison Medical Center, is a non-intrusive device that can capture breathing and heart rates, which are important parameters in clinical monitoring. In addition, it could also determine the quality of sleep, and send timely alerts e.g. fall alerts. Its flexible design allows it to be mounted on mattresses or cushions in home or clinical settings. All these 'Smart' initiatives would be linked to the NEHR to capture the data flows for monitoring purposes and for determining the appropriate level of care for a patient or consumer (Chowdary, K.P.H., personal interview, May 15, 2015).

5.3 NEHR Implementation

The NEHR was planned to be implemented in two phases (Muttitt et al., 2012).

The targets set for phase 1 were to accomplish by second quarter of 2012:

- one-way sharing of health data with limited integration partners,
- viewing of health information through the NEHR portal

And for phase 2, the targets were to accomplish by 2015:

- increased integration, bi-directional health data flows
- more information and data sources
- reconciliation services
- increased portal access

Singapore is regarded by informants and scholars alike to be making good progress on e-health with the NEHR currently in its second phase of implementation. The bigger plan is for the NEHR to be eventually migrated to H-Cloud, the consolidated healthcare cloud that would host mission critical systems for all public hospitals, specialty centres and polyclinics. The H-Cloud is facilitated by ST Electronics (Info Software) Systems and owned by Integrated Health Information Systems (IHIS), which is a 100% subsidiary of MOH Holdings Pte. Ltd. IHIS serves as MOH Holdings' project management wing for healthcare projects. The target for ST Electronics (Info Software) Systems is to make the mission critical systems in the various healthcare institutions interoperable by year 2017, and have these migrated to H-Cloud subsequently. As of May 2015, over 500 servers and over 200 applications of various healthcare institutions had already been migrated to H-Cloud. Although these various initiatives were primarily focused on the public healthcare sector, it is hoped that the private and voluntary welfare organizations would also be consolidated under H-Cloud in due course (Chowdary, K.P.H., personal interview, May 15, 2015).

It is widely believed that embracing cloud technology will bode well for Singapore's healthcare transformation although it is an arduous path ahead. The various healthcare institutions in Singapore had been functioning like silos, having their own infrastructures, and running their own applications. With the advent of the NEHR, these silos needed to be made interoperable, consolidated, and migrated to H-Cloud (Chowdary, K.P.H., personal interview, May 15,

2015), which is a private cloud (Ng, 2013). Such a step understandably involved heavy initial investments. Although the Government subsidized these costs to some extent, the healthcare institutions also had to deploy their own funds for the purpose. There was some initial resistance to this initiative which was however overcome gradually when these healthcare institutions started seeing the bigger picture and were convinced of the long-term benefits of such a direction (Chowdary, K.P.H., personal interview, May 15, 2015). The present research speculated whether this initial resistance may have been due to the fact that interoperability increases transparency and reduces the information asymmetry that healthcare providers have been profiting from. Significantly, it has been acknowledged by no less a person than Mr. Khaw Boon Wan, the former Minister for Health (August 2004 to May 2011), that information asymmetry could be a valid reason for healthcare market failure not just in Singapore but around the world in general. Equally importantly, the disclosure by Mr. Khaw that competition in healthcare occurs more at the micro level between doctors or departments, than at the higher level of the clusters was revealing (Chang, 2010). A somewhat similar view was encountered during an expert interview when it was shared that the potential loss of business to other institutions due to reduced information asymmetry resulting from interoperability was not a major concern among the public sector healthcare institutions which were anyway facing a resource crunch and struggling to meet the healthcare needs of the public (Chowdary, K.P.H., personal interview, May 15, 2015). This raises the question of whether the reorganization of Singapore's public healthcare system into the six RHS clusters would suffice to infuse fairness and efficiency into the healthcare market leading to 'better service and lower cost for patients' as was hoped for when the two giant clusters of SingHealth and National Healthcare Group were first formed in 2000 (Chang, 2010), but proved to be unsuccessful later.

Despite the various steps taken to improve Singapore's healthcare system, there is still scope for the system to improve further. The insights extracted from the multiple slices of data used in this case study in general, and the expert interviews in particular, bring into focus some of these improvement possibilities. These are possibilities that emerge from the immense potential values that can be created and captured in a well-connected e-health ecosystem

- knowledge that has come to light over the course of this study. What this would mean in the Singapore context is that there is further scope for more values to be created and captured if only the health data is exploited so as to make the healthcare system in Singapore patient-centric or even population-centric, as advocated by Gunapal et al. (2016) and Nurjono, Valentijn, Bautista, Lim, & Vrijhoef (2016). The remainder of this section is a discussion of these improvement possibilities:

- E-health in Singapore is thought to be primarily aimed at improving patient experience, increasing productivity in healthcare institutions, and promoting interoperability among disparate health information systems. It is however still lagging behind countries like the US and Japan in terms of providing Continuum of Care (Pang, R., personal interview, April 20, 2015). Healthcare Information Management Systems & Society (HIMSS), a global thought leader of healthcare transformation through technology, defines ‘continuum of care’ as a system’s capability to track patients over time across an array of healthcare services at all levels and intensity of care (Young, Clark, Kansky & Pupo, 2014). One of the mechanisms that is believed to enable continuum of care is an integrated health system. The current model of healthcare in Singapore does not support care transition and the resulting continuum of care as there is no system in place for a transparent exchange of information that will enable tracking of GP clinics’ patient referrals to hospitals. In a survey conducted by Accenture on healthcare IT adoption and health information exchange in the primary care sector, Singapore was found to be lagging behind several other countries (Accenture, 2012) in this respect. This shortcoming is also acknowledged by Nurjono et al., (2016) who claim that where the Singapore healthcare system is concerned there is some ‘weakness’ at the primary care level, the level at which the integration of the healthcare system begins. This shortcoming may be attributed to the fact that the NEHR is currently more focused on the public sector healthcare ecosystem financed and regulated by the Singapore government. As for the private sector healthcare institutions, the only group that is impacted, in the sense that they are encouraged to acquire access to the NEHR for a monthly subscription fee, is the General Practitioner (or GP or ‘family doctor’) clinics. As part of the GP IT

enablement program launched in 2009, Project Clinic Electronic Medical Record and Operation System (CLEO) was created to facilitate access to the NEHR for the GP clinics as well as to enable an exchange of health information among them (Accenture, 2012). These clinics are generally said to be disgruntled with the monthly subscription model that they are currently subject to, for gaining access to the NEHR (Pang, R., personal interview, April 20, 2015). It is to be noted that as of early 2015, only 40% of the GP clinics have had access to the NEHR and that the government has been soliciting support from the remaining GP clinics (Singapore Parliamentary Report, February 12, 2015, Question No. 494). Apparently there still exists a perceived lack of correspondence between values created and values captured among the GP clinics. It may be pointed out that this is an instance of the participation dilemmas discussed in Chapter Two. It is not clear how these dilemmas will be resolved to the satisfaction of the GP clinics so as to make Singapore's dream of '*One Patient One Record*' come true. As pointed out by Chin (2000), the dream may not come true until the doctors perceive the need to embrace technology for clinical or financial benefits.

Further, if the other groups in the private sector such as the secondary, tertiary, intermediate and long term care providers are also linked to the NEHR, it may augment the efficiency and competitiveness of the healthcare system by enabling a comparison of performance between the two sectors. This is known as 'network effects' (Benkler, 2006) where nonproprietary production in the networked information economy leads to the sharing of efficiency and group sustainability. A case in point is the evidence cited from Denmark and Australia where private sector hospitals function alongside public sector hospitals, creating thereby a competitive environment that pressurizes both the sectors to improve their performance (Dash & Meredith, 2010). Of late, Singapore's public sector hospitals have come under scrutiny for serious lapses in their quality of care. A most recent example is the widely reported slips in Singapore's public hospitals – a wave of hepatitis C infections leading to deaths in Singapore General Hospital (YahooNews, 2015), and the threat of tuberculosis outbreak among paediatric patients in the National University Hospital (Khalik, 2015).

Numerous studies have shown that carefully designing and implementing competition among hospitals belonging to both public and private sectors can drive innovation, quality of care and efficiency in the healthcare system (Lim, 2005; Dash & Meredith, 2010). A well-connected e-health ecosystem which fosters an exchange of information and promotes transparency in the system may be a suitable vehicle to accomplish this.

- The healthcare model in Singapore is ‘fee-for-service’ unlike the model in the US and some other countries which is ‘pay-for-performance’. In a fee-for-service model, care quality may suffer because the providers are focused on providing as many services as possible to maximize their ‘economies of scope’. It is a well-known fact that healthcare providers tend to exhibit entrepreneurial behavior since “every dollar spent on healthcare is a dollar earned by healthcare providers” (Lim, 2005, p.464). In a pay-for-performance model, on the other hand, payments to providers are linked to their provision of quality care to patients. This model offers incentives to providers to focus on the patient instead of just providing unnecessary services. One of the clinical quality indicators that support the latter model is the readmission rate for patients within 30 days after discharge (Lim, 2004). In the US, for instance, the federal government imposes penalties on hospitals with higher than the benchmark readmission rates (Rau, 2014). In Singapore, this rate seems to have been on the rise for the public hospitals, going from 11.7% in 2011 to 12.2% in 2012 and 2013 as per the statistics shared by Minister for Health, Mr. Gan Kim Yang, in a Parliamentary response (Singapore Parliamentary Report October 7, 2014, Question No. 114) - a rate comparable to the benchmark rate in the US. In this context one cannot help raising the question if such a comparison is reasonable considering that Singapore ranks among the most efficient healthcare systems in the world, while the US is ranked at the bottom among advanced economies. In a recent study conducted by Bloomberg, Singapore was ranked the most efficient healthcare system among a total of 51 countries studied, while the US was relegated to the 44th rank (Chen & Wong, 2014). In this context, it is both pertinent and important to consider how e-health could play a role in improving the above-mentioned quality indicator. Gunapal et al. (2016) draw attention to the fact that big data, i.e., health data

residing with the six RHS clusters aggregated at the national level, can help predict as well as mitigate the risks leading to hospital readmissions. Another move that may improve this quality metric is promoting transparency by publishing the readmission rates of the various hospitals so that healthcare consumers can exercise their choice of providers based on the quality of care. It is interesting to note that a suggestion to publish such consumer-friendly information was made in the Parliament in October 2014 (Singapore Parliamentary Report, October 7, 2014, Question No. 114), which clearly signals the rise of healthcare consumerism in Singapore. This is another instance of how a well-connected e-health network has the capacity to reduce information asymmetry, promote transparency and make the healthcare system consumer-centric.

- The current model of the public healthcare system in Singapore, despite its strategic reorganization into the six RHS clusters, is still considered hospital-centric and unsustainable in the face of the ever-rising demands from an aging population (Gunapal et al., 2016). It is suggested that there should be a shift towards population health management and that information technology capabilities such as ‘big data analytics’ could be harnessed to be better able to manage population health. However, such a capability can be reached only if sharing of health information across the independent health systems is enabled so that all the data can subsequently be standardized and aggregated. It stands to reason that such aggregated public health data presents unprecedented opportunities to manage health at the population rather than the individual level. There are however some challenges of creating big data such as standardization of patient data coming from disparate systems, and sufficient anonymization of such data to prevent unauthorized use to discriminate in employment or insurance coverage (DeNardis, 2014). Confidentiality of such patient data is ensured in two ways – through an audit system to identify unauthorized entry and through stiff penalties for any IT security violations (Singapore Parliamentary Report (2012, March 6), News Highlights). A recent, noteworthy development on the ‘big data’ front is the steps taken by IHIS in this direction such as the establishment of systems like Electronic Health

Intelligence System (eHINTS) and Business Information (BI) System to support big data analytics (Kelleher, 2015).

- The health cloud (H-Cloud) may already be underway, but there seems to be some ambiguity on the ground with regard to patient data residency and sovereignty (simply put, ‘who owns what?’). These were said to be outstanding issues yet to be addressed and resolved to the satisfaction of the stakeholders (Pang, R., personal interview, April 20, 2015). A careful search for information to clarify these issues (purposive sampling) revealed that the custodian of patient data across all the six clusters is HSOR (Health Services & Outcomes Research), a department established in 2005 within NHG, one of the six RHS clusters. As for data ownership, the clusters themselves are the owners of their respective patients’ data (Gunapal et al., 2016). In its capacity as the custodian of patient data, the HSOR was tasked in 2014 with developing what is known as the RHS database (big data) with support from IHIS for population management related research activities (Gunapal et al., 2016). In fulfilling this task, HSOR adheres to strict data linking and anonymization protocols as established through the Personal Data Protection Act (PDPA).

5.4 Singapore’s E-health Ecosystem

In this section, the e-health ecosystem in Singapore is compared with the conceptual model developed in phase 1. Such a comparison is made for the purpose of noting similarities and dissimilarities, a knowledge of which would be essential to derive answers to the RQs as well as evolve the critical success factors for a sustainable e-health ecosystem.

5.4.1 Key Players

From the discussions above, it may be evident that the key players in Singapore’s e-health ecosystem at this point of time are the regulators, patients, a subset of healthcare providers who are linked to the NEHR and an emerging infomediary. A concept map of Singapore’s e-health ecosystem is presented in Figure 5.3.

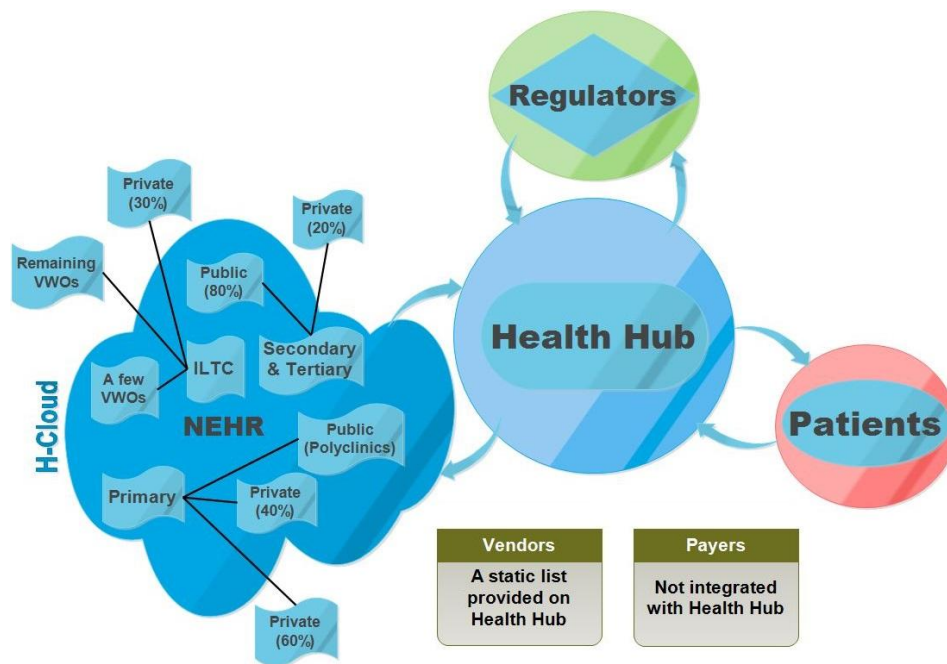


Figure 5.3. A Concept Map of Singapore's E-Health Ecosystem

The case study has also revealed that the health cloud (H-Cloud) is a prerequisite for a sustainable e-health ecosystem as the technology can scale to accommodate exponentially growing health data besides offering other benefits such as reducing providers' IT investment burden, supporting interoperability and decreasing information asymmetry, to name a few.

5.4.2 Values Created and Captured

At present, the ecosystem appears to be more provider-centric than consumer-centric. This means, the ecosystem in its present state offers rather limited potential for values to be created and captured as compared to what was envisaged in the conceptual model (Table 4.4). This is due to the fact that the ecosystem is still unfolding and hence the significant data flows discussed in **section 4.1.5.1**, 'E-Health Digital Data Flows: A Simplified Model' have yet to materialize.

However, considering the fact that initiatives such as www.healthhub.com are underway, it is hoped that, over a period of time, Singapore's ecosystem will evolve to be more inclusive of other key stakeholders and tilt the balance towards consumer-centrism. 'HealthHub' is intended to be a one-stop health information and services portal for citizens, offering them access to their medical records from the public healthcare institutions, as well as giving them access to health-related information and

services (MOH Press Release, 2015). The ultimate goal of this venture is to promote health awareness among Singaporeans so that they are well-equipped to take responsibility for their health and wellness. This move is in alignment with Singapore's philosophy that healthcare is a shared responsibility and that providing healthcare services upon demand is neither a viable nor a sustainable arrangement.

HealthHub has plans to extend the ecosystem through partnerships with organizations in the healthcare, wellness, recreation, fitness and food and beverage businesses, expanding thus the range of vendors in the ecosystem to promote consumer choice. Moreover, HealthHub offers consumers the opportunity to create values in the ecosystem through co-creation of content by sharing or contributing useful health and wellness information that may benefit other consumers in the ecosystem. Patient-entered health data for which the NEHR is mandated to make provision, is yet another opportunity for consumers to co-create data.

It appears that HealthHub has the requisite characteristics to play the role of the infomediary described in the conceptual e-health model, albeit with a narrower scope than envisaged in the conceptual model described in Chapter Four. The ecosystem seems more focused on connecting the public sector healthcare providers. Although HealthHub provides a static listing of the private sector healthcare providers, many of these providers are not linked to the NEHR. The exception to this is the primary care category in which about 40% of the GP clinics are currently linked to the NEHR. Similarly, payers are not well-integrated into the ecosystem, especially payers such as private insurers and employers. As for the vendors, there is a static listing of various types of vendors such as pharmacies, laboratories and screening centres, but transactions with them are not yet enabled. The HealthHub is no doubt a positive step towards boosting consumer awareness of the choices available to them. It, however, limits their empowerment to make informed healthcare related decisions inasmuch as it provides information that is neither complete nor transparent.

5.4.3 The Ecosystem through a Game Theory Lens

It may be worthwhile to examine Singapore's e-health ecosystem using the game theory lens, which provides the conceptual framework for examining the ecosystem. The ecosystem presents instances of the participation as well as cooperation dilemmas discussed in Chapter Two.

5.4.3.1 Participation Dilemmas.

The GP clinics which are private sector healthcare providers evince symptoms of participation dilemmas. This group of stakeholders seems reluctant to participate in the ecosystem because they are required to pay a monthly subscription fee to access the NEHR. Obviously this reluctance stems from the perception that the value they can capture from being part of the ecosystem, may not be worth the financial commitment they have to bear. This is clearly a manifestation of the 'productivity paradox', a participation dilemma. Yet another participation dilemma, namely the 'tragedy of the digital commons' is also observed to be at play in this context. Notwithstanding the fact that the GP clinics have to pay for access to the NEHR, they are also expected to contribute their patients' health data to the NEHR to support continuum of care. Such data as they contribute to the NEHR may be utilized by other providers in the network resulting in 'free riding'. It is the belief of some experts that an interoperable system based on the Continuum of Care Document Architecture (CCDA) devoid of any incentives to stakeholders will not work. The system should provide for some incentives to the key players to cooperate and share information, even though it may not necessarily be in economic terms. The participation dilemmas are thus the result of a perceived lack of fairness in the ecosystem.

5.4.3.2 Cooperation Dilemmas.

The ecosystem also exhibits cooperation dilemmas in the sense that it is not an inclusive ecosystem - it excludes the private sector healthcare providers from categories other than primary care. Yet, it is the private sector that provides numerous value-added services so much so that the Government has co-opted the GP clinics as well as some private hospitals into the public system. For now, these excluded private healthcare providers do not have access to the NEHR. This is reminiscent of the 'narrow network', a cooperation dilemma. A narrow

network limits information sharing and value-capture to a select group of stakeholders, which may threaten optimal utilization of health data in terms of its exchange and reuse beyond the network. The implication is that Singapore's vision of 'one patient one record' and 'continuum of care' may be endangered when patients move across the spectrum of public and private sector healthcare providers with a view to meeting their healthcare needs. Yet another implication is that a narrow network limits information available to the consumers which in turn does not help reduce 'information asymmetry', a barrier to consumer-centrism, and a threat to efficiency in the ecosystem. It is logical that the ecosystem should evolve to include other key players including private sector providers, payers and vendors. Without the participation of these players, sufficient values may not be generated in the ecosystem to keep the stakeholders engaged, and the benefits of e-health may not be harnessed in totality. The ecosystem should also evolve to add more capabilities aimed at reducing information asymmetry - such as enabling healthcare consumers to compare products and services on the basis of quality, price, and other relevant factors so as to be able to make informed decisions. HealthHub, the infomediary, may also benefit from the process since the value it captures will be proportionate to the values captured by the other players in the ecosystem. Correspondingly, the more an infomediary creates values that benefit the other players, the higher are the values it can capture from the ecosystem.

5.4.4 Critical Success Factors for a Sustainable Patient-Centric E-Health Ecosystem

The central posit in this thesis is that the values derived by the key players in the ecosystem should be sufficient to justify their participation in the ecosystem for its balance and sustainability. In other words, the key players should have the opportunity to capture values in proportion to the values they create, without which they will not be incented to participate fully.

Some propositions put forth by the experts for a sustainable ecosystem, were:

- To encourage participation from general practitioners (private sector), a more effective method to get them to leverage the NEHR would be to move from the monthly subscription model to a pay-per-use model. A two-way model may be more optimal where healthcare providers such as GP clinics

who pay for access to health information in the NEHR also get incentivised in some manner for contributing information to the NEHR. There are many revenue sharing models for this ranging from a fixed, one-time offset of subscription fees for each unit of data, to a recurring royalty-credit whenever that unit of data is used by others.

- Healthcare institutions may also consider charging patients nominally (like \$1 per healthcare episode) for creating / maintaining their records.
- To augment participation from the general public and patients in the process of co-creating health data, PHR systems that can link to the NEHR may be sponsored by insurers, for example. Insurers may go a step further and incentivize their policy-holders to use the PHR system which will, in turn, facilitate preventive healthcare versus the less-than-ideal diagnostic healthcare which increases costs for the insurers. It may be noted that an e-health ecosystem actually meets the criteria for what economists term a two-sided market - selling healthcare products and services to patients on one side and market data to other players on the other.
- It will benefit Singapore's citizens if the Government fully sponsors the Next Generation Nationwide Broadband Network (NGNBN) which facilitates Smart Homes and Smart Mat. As a payoff on a national scale, the regulators and policy makers can gain access to more health data captured by these monitoring devices and conveyed to the NEHR. It may be noted that about 80% of the NGNBN infrastructure is already in place, and the network is expected to be fully operational by 2025.
- There is potential for new business opportunities for healthcare providers, in particular, hospitals. They may set up call centers to monitor smart homes so as to be able to direct healthcare resources to where they are most needed.
- Homes may be made 'smart' through NGNBN, smart phones and a base kit (like the one for cable TV) which will enable the public to subscribe to healthcare services they require and pay for these based on their level of consumption of such services ('pay as you use').

5.5 Lessons Learnt

- It was observed during the expert interviews that the informants took care to be politically correct. Due to such a tendency on the part of the informants, uncovering issues in Singapore's e-health ecosystem took considerable probing as well as time. To ease the informants' predicament, they were apprised of the opportunity to review the transcription of their interviews before giving their final approval for its inclusion in the data.
- Literature on Singapore's e-health initiative was found to be far limited compared to similar literature available for other advanced countries like the US. Therefore a variety of other secondary data sources including news websites, industry journals, industry reports, blogs and parliamentary proceedings, had to be relied upon to piece together the case study.
- The Singapore case study also led to the refinement of the semi-structured interview for the US case study. For example, a question on cloud technology was added to ensure that related data is captured. 'Cloud technology' was a naturally emergent topic for the Singapore informants who seemed to be up to date with the H-Cloud initiative. Considering that cloud technology is not a priority in the US within the context of debates centered around the Affordable Health-care Act (Obama Care), care was taken to explicitly incorporate a question to ensure data collection on the topic.

5.6 Conclusions

Based on the insights gathered from the case study, it is reasonable to conclude that Singapore's e-health initiative comprising the three key components of NEHR, H-Cloud and HealthHub is making progress towards sustainability. It is envisaged that the H-Cloud will be accomplished by year 2017, making the mission critical systems in the various public healthcare organizations interoperable. This would be a significant game-changer for Singapore's healthcare industry. For example, the GP and neighbourhood clinics may no longer have the autonomy associated with possessing a patient's medical history. Alliances and chains may emerge to exploit the added values from such open digital flows.

However, it is not to be missed that the current initiative is focused on the public healthcare sector which makes up 80% of secondary and tertiary care, and 20% of primary care. 80% of primary care is provisioned by the 2000-odd GP clinics, and as of early 2015, only about 40% of these GP clinics could have access to the NEHR. Getting the remaining 60% on board the NEHR may be challenging owing to the participation and cooperation dilemmas discussed earlier. Some of these dilemmas were also corroborated by the experts interviewed. Whether the Government will follow the carrot (incentives) and stick (penalties) approach to get them on board is not yet clear. And whether other key players such as the private healthcare providers in sectors other than primary care and payers such as private insurers and employers will be eventually co-opted into the ecosystem is as yet an open question. It has long been suggested that the government should be consistent in its approach towards all the providers. This would mean, among other things, exposing the public sector healthcare providers to market forces and have them compete with the private sector providers for their fair share of patients (Lim, 2005). This goal is achievable through a well-connected ecosystem complete with the entire spectrum of public and private healthcare providers. It is to be noted that the manner in which the public sector hospitals mostly engage their private sector counterparts is through the utilization of the latter's excess bed capacity by leasing their beds (Singapore Parliamentary Report, March 6, 2012, News Highlights). The patients using these leased beds are however only treated by their respective public hospital doctors. Thus, the two sectors hardly have opportunities to cooperate or compete on parameters that might matter to a healthcare consumer. If that happens, it could create a climate of healthy competition between the two sectors.

In conclusion, although the findings from the case study show that Singapore's e-health ecosystem currently falls short of the conceptual model in some respects, the country is still undeniably one of the very few countries that have made giant strides in e-health. This may be evident from the fact that it recently received the prestigious DataCloud Enterprise Cloud Award for H-Cloud squashing competition from hundreds of other global submissions (Lee, 2015). Given Singapore's quest for excellence in providing public services, the country's e-health ecosystem holds out a promise to evolve into a truly

consumer-/citizen-centric system. To quote Porter (2010), “Value should always be defined around the customer, and in a well-functioning health care system, the creation of value for patients should determine the rewards for all other actors in the system” (p. 2477).

5.7 Chapter Summary and Recap

Singapore enjoys the rare distinction of being ranked one of the healthiest countries in the world, as well as, credited with having one of the most efficient healthcare systems in the world. The country’s healthcare transformation was necessitated by the looming ‘silver tsunami’ (a rapidly ageing population), a phenomenon which was predicted to render the country’s predominantly hospital-centric healthcare model unsustainable in the mid to long run. This was one of the major push factors that led to a reorganization of the country’s healthcare system in 2010 into six RHSs which were each made responsible for the population’s health in their respective regions. To complement this, a nation-wide electronic health record systems (NEHR) was also initiated in the same year. The grand plan envisaged was to migrate the NEHR to a cloud platform referred to as the H-Cloud, by 2017. Also underway is HealthHub, a one-stop health information and services portal for citizens, which includes an interface for citizens to access their health records on NEHR. All these various moves are believed to gradually facilitate a shift towards a population-centric healthcare. However at this point in time, the ecosystem falls short of the conceptual model in terms of both the set of key players and the range of values that can be created and captured by these key players. This is due to the fact that the ecosystem is heavily focused on the public healthcare sector and only selectively inclusive of the private healthcare sector. The ecosystem is also found to manifest the participation and cooperation dilemmas discussed in sections 2.6.4 and 2.6.5, which pose a challenge in terms of getting the private sector primary healthcare providers on board. A truly patient-centric e-health ecosystem like the one conceptualized in phase 1 of this research can materialize only if the entire spectrum of public as well as private healthcare providers participate and cooperate in the e-health network. Without this happening, Singapore’s dream of One Patient One Record will be hard to

realize. Nevertheless, as of date, Singapore still remains one of those few countries that have made significant progress in e-health.

The next chapter presents the within-case analysis and report of the second case study, the US' HITECH program.

CHAPTER SIX VALIDATION OF CONCEPTUAL MODEL: WITHIN-CASE ANALYSIS OF THE US' HITECH PROGRAM

This chapter presents the second of the case studies undertaken as part of phase 2 of this research, namely the US' HITECH program. As said earlier, phase 2 of this research is focused on validating the conceptual model of a patient-centric e-health ecosystem that was developed in phase 1. The chapter begins with an introduction to the US healthcare system, goes on to chart the country's healthcare transformation journey and proceeds to contrast the country's e-health ecosystem with the conceptual model developed in phase 1. This is done with a view to evolving a set of critical success factors for patient-centricity and sustainability of the country's e-health ecosystem. The chapter ends with a short account of lessons learnt in the process of conducting the case study.

6.1 Introduction

The US has always been at the forefront of research and innovation in medical technology, often ushering in successful, new-generation interventions (Shi & Singh, 2015). It makes substantial investments in medical research in partnership with the National Institutes of Health, possesses possibly the best trained medical workforce trained in best-of-breed medical schools and hospitals, and has one of the most advanced healthcare systems in the world (Vitalari, 2015). As is often the case, advances made in science and technology tend to create a demand for new products and services. This is especially so in respect of healthcare industry. As a matter of fact, competition among American hospitals is often a matter of how modern and sophisticated the equipment and gadgets in their possession are. Needless to say, such a trend triggers an overuse of technology primarily to ensure that the huge capital investments made on technological equipment are worthwhile and profitable. So, on the one hand, there are medical professionals who are eager to put their latest equipment and gadgets to use and, on the other, there are patients who are led to believe that these latest technologies provide better outcomes (Shi & Singh, 2015). Thus, other than being a world leader in medical technology, the US also happens to have the most expensive as well as the most sophisticated healthcare system in the world.

The US tops the list of industrialized nations in terms of its annual healthcare expenditure with 17.1% of its GDP spent on healthcare in 2014 (Global Health Observatory, 2016). This roughly translates to \$2.87 trillion (Squires & Anderson, 2015). In 2000, the Institute of Medicine issued an impactful report titled 'To Err is Human', which pointed out that between 44,000 and 98,000 deaths occurred in US hospitals as a result of medical errors and that half of these deaths were actually preventable. Prevention would not only have saved precious lives, but also saved money to the tune of \$17-\$29 billion per year. More recently, it has been estimated that the US would have an additional trillion dollars at its disposal, if only it maintained its spending on healthcare at the same percentage of GDP as the next highest spending country in the world (Fuchs, 2014). Furthermore, it is projected that if the current state of affairs continued, the US spending on healthcare will rise to \$5.4 trillion by 2024, which will amount to 20% of the country's GDP (McCarthy, 2015). This is cause for concern as such a rate of government spending on healthcare alone, might compromise spending on other areas including security and well-being, thereby putting at stake the overall welfare of the country (Britnell, 2015).

The US healthcare system also happens to be one of the most complex systems in the world involving an extensive array of interrelationships among providers of care and payers for care (Moses III, Matheson, Dorsey, George, Sadoff, Yoshimura, 2013). Although healthcare facilities such as hospitals, clinics, doctors' offices and other facilities are owned by both private and public entities (Cummings, 2015), in terms of both healthcare provision and financing, the US is more at the private end of the public-private sector mix. A breakdown of the US hospitals by ownership types is shown in Figure 6.1.

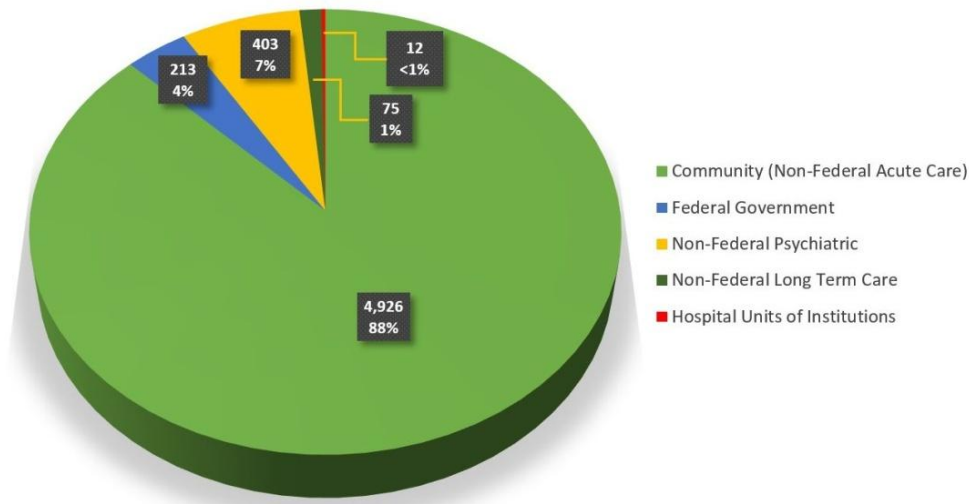


Figure 6.1. Number of US Hospitals by Ownership Type (Total: 5627)

Source: AHA Hospital Statistics, 2016

A further breakdown of the community hospitals by ownership type is shown in Figure 6.2.

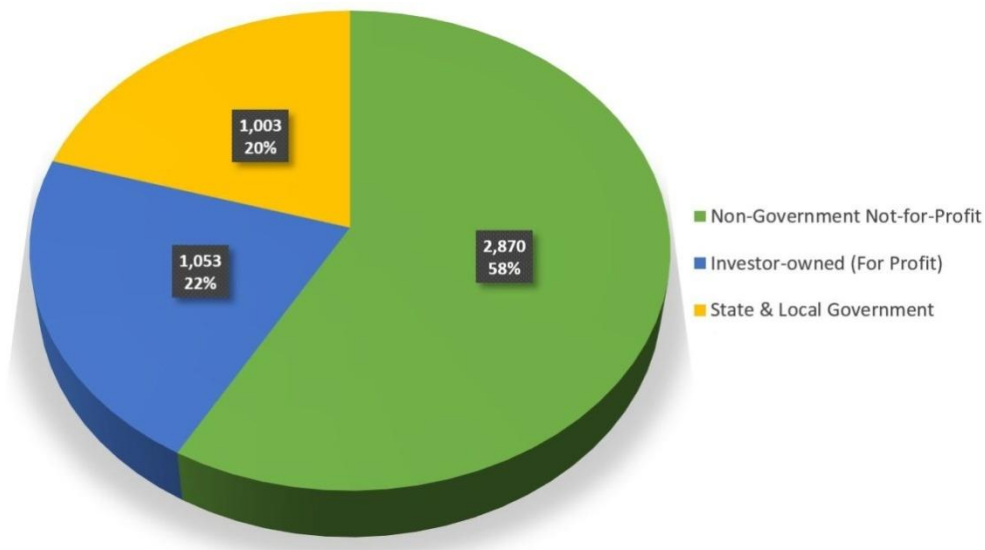


Figure 6.2. Community Hospitals by Ownership Type (Total: 4926)

Source: AHA Hospital Statistics, 2016

Paradoxically, the US also happens to be the only industrialized nation that does not guarantee universal health coverage for its people (Davis, Stremikis, Schoen, & Squires, 2014), despite the heavy spending on healthcare that almost cripples its economy. As many as 33 million people (10.4%) were uninsured in 2014 (Smith & Medalia, 2015), the reasons being not wanting insurance to growing unaffordability of insurance to rejection of insurance by private insurers on account of pre-existing conditions (Cummings, 2015). The burden of healthcare costs on the population has been so heavy that it was

estimated to contribute to about 3 in 5 bankruptcies in 2013 (Lamontagne, 2013). Most of these woes prevalent in the US healthcare industry are often attributed to the country's over-reliance on the private sector for delivering as well as financing healthcare (Goldsmith, 2012).

However, over the last few decades there have been significant changes in the sources of healthcare spending in the US, with general government health expenditure gradually rising to 48.3% of the total health expenditure in 2014 (Global Health Observatory, 2016). This, in a sense, indicates the government's declining reliance on the private sector, and may be attributed to a wide range of government insurance programs made accessible to the Americans including federal programs like Medicare, Medicaid, Children's Health Insurance Program (CHIP), and health plans offered by individual states as well as by the Department of Veteran Affairs. Nevertheless, the 48.3% government spending on healthcare is still considered far lower than the average for most other developed countries which approximately stands at 72% (Britnell, 2015). More than half (55.4%) of the private healthcare spending was contributed by employer based insurance systems in 2014 (Smith & Medalia, 2015). Such a trend is not only a huge financial liability for businesses, but also results in a misallocation of time for corporate leaders, which may lead to decreased productivity and weakened competitiveness. A case in point is the bankruptcy of General Motors in 2009 due in part to its health insurance liabilities which it had to pack into the price of the car, and, in turn, ended up losing its competitiveness in the automobile market (Herzlinger, 2010).

A key barrier to universal health coverage in the US is the fragmented state of its healthcare system (Vitalari, 2015) which is also the prime reason for the country's astronomical healthcare spending. The system comprises a wide range of healthcare delivery, insurance and payment mechanisms that may be financed publicly as well as privately, and lacks the presence of a central governing agency to coordinate and integrate its services (Shi & Singh, 2015). According to the 2011 estimates of the Institute of Medicine, roughly one third of the total healthcare expenditure was wasteful spending on account of various factors such as inefficient and redundant services, fraud, abuse, steep prices and administration costs, and, last but not least, missed opportunities for prevention (Britnell, 2015). It is thus apparent that the US healthcare system is a poor value

proposition relative to its cost (Herzlinger, 2010). The system has reached a tipping point when, undoubtedly, a change is much needed, although how the change can be accomplished is not clear (Sharfstein, Fontanarosa, & Bauchner, 2013).

6.2 The US's Healthcare Transformation Journey

A significant step in the US' long pursuit to transform the healthcare industry was the Health Information Technology for Economic and Clinical Health Act (HITECH Act) which was signed into law by President Obama in early 2009 (Rouse, 2014). The HITECH Act was a component of the American Recovery and Reinvestment Act of 2009 (ARRA) economic stimulus bill created to stimulate the adoption of EHRs and supporting technologies. The Office of the National Coordinator for Health Information Technology (ONC or ONCHIT), a division within the US Department of Health and Human Services, was assigned the responsibility of creating a strategic plan for a country-wide interoperable health information system. The HITECH Act made provision for incentives worth \$27 billion to spur adoption of EHRs among physicians and hospitals (Blumenthal & Tavenner, 2010). The legislation also compelled hospital administrators to enforce policies to protect the confidentiality of patient data in compliance with the Health Insurance Portability and Accountability Act (HIPAA) Privacy Rule of 2003 and Security Rule of 2007 (Ilie, Van Slyke, Parikh, & Courtney, 2009; Clarke III, Flaherty, Hollis, & Tomallo, 2009). A further legislation called the HIPAA Omnibus Rule was enacted in 2013 to direct extensive changes to the HIPAA Privacy and Security Rules and strengthen them so as to conform to the guidelines of HITECH (Rouse, 2015). The HIPAA rules also applied to the IT vendors collaborating with healthcare providers in order to prevent them from commercially exploiting the patient data in their possession (Blumenthal, 2009). According to Accenture (2012), the HITECH Act was a strategic shift in the stance of the government which now wanted to take charge of the out-of-control healthcare industry by driving IT adoption and facilitating greater connectivity across the fragmented system in the process.

In early 2010, the ONC awarded \$548 million worth of grants to the 50 US states, the District of Columbia, and the five federal territories, through the

State Health Information Exchange (HIE) Cooperative Agreement Program. The grants were funded through the HITECH Act for the purpose of developing infrastructure and augmenting capability to exchange patient data among the various healthcare organizations both within and across the states (The Office of the National Coordinator, 2011). A commendable feature of the Act was that the state or the state-designated agency which received the award was to be held responsible for developing the plan and tracking performance for reporting as per the guidelines in the award notice (SearchHealthIT, 2010). Every healthcare provider eligible for the EHR Incentive Program was required to be part of at least one such HIE.

Another major development following the HITECH Act of 2009 was the Patient Protection and Affordable Care Act (also known as ObamaCare or simply ACA) which was voted into law in March 2010 after a long, contentious political battle (Blank, 2012). The ACA was aimed at increasing health insurance coverage for Americans and also at controlling rising healthcare costs (Mangan, 2015). The Act specifically accentuated the significant role that health IT could play in meeting the healthcare related goals of quality and efficiency (Buntin, Burke, Hoaglin, & Blumenthal, 2011). A key component of the ACA was the Health Insurance Exchange Marketplace which opened in October 2013. It is an online marketplace for health insurance that enables shoppers to select the best plan in accordance with their needs by making use of the platform's capability to display a side-by-side comparison of different health plans. Estimates suggest that this marketplace, which operates without a broker, will be able to provide affordable insurance to up to 29 million people by 2019 (ObamaCare Facts, 2016). All these various recent legislations and their provisions are believed to have the ability to improve the performance of the US healthcare system over time on dimensions of access, efficiency and equity.

6.3 HITECH Act Implementation

In recognition of the fact that the widespread adoption of EHRs is inevitable to integrate the fragmented healthcare industry in the US, the federal government made an unprecedented commitment of \$27 billion dollars towards the cause through the 2009 HITECH Act (Blumenthal & Travenner, 2010). This amount

was to be spent over a span of 10 years on incentives to physicians and hospitals to encourage their adoption and meaningful use of EHRs. The incentive scheme was structured as a carrot and stick approach – carrot by way of additional payments if providers demonstrated meaningful use of EHRs, and stick in terms of cut-backs - if meaningful use was not demonstrated (Adler-Milstein & Bates, 2010). The ‘meaningful use criteria’ evolved over three stages from 2011 to 2016. Stage I focused on data capture and sharing, stage II on using advanced clinical processes, and stage 3 on improved outcomes particularly, improved population health (HealthIT.gov, 2013). Key features of meaningful use include electronic prescribing, quality measurement reporting and information exchange (Torda, Han, & Scholle, 2010). While an EHR may have several functionalities, three of these in particular are considered critical to promoting meaningful use, because of their potential to improve quality of care and reduce costs (Menachemi & Collum, 2011). These core functionalities are:

- Clinical Decision Support (CDS) tools that support a physician in making evidence-backed decisions regarding patient care. Widespread use of this system is believed to help reduce medical errors and improve quality of care.
- Computerized Physician Order Entry (CPOE) systems that facilitate computerized orders for medical products and services such as drugs, laboratory tests, radiology, etc. This system is intended to prevent medical errors that are made in the process of making sense of a physician’s handwriting.
- Health Information Exchange (HIE) that enables secure and real time sharing of patient data with other healthcare providers, pharmacies, emergency departments and so on. This has the potential to reduce costs by eliminating redundant tests and improves efficiencies.

Thus, the focal point of this reform was a patient-centred EHR. A 2010 tracking of national trends in technology use by Pew Internet & American Life revealed that as many as 3 in 4 adults used the internet, the top reason for using the internet being, to search for health-related information (Ahern, Woods, Lightowler, Finley & Houston, 2011). The rise of consumerism abetted by technology was becoming evident, and this was what was addressed by the

reform. The message for the healthcare providers through this reform was that they had to adapt to a climate of doing more with less (Orlikoff & Totten, 2010).

In spite of the fact that more than 90% of the US hospitals used computers for some purpose or the other as of 2008, only about 9% of these hospitals had comprehensive health IT systems with a basic EHR. Around the same period, 13% of the primary care offices had fully functional EHR systems (Hammond, Bailey, Boucher, Spohr, & Whitaker, 2010). However, within a span of about eight years, by 2014, about 75% of the non-federal acute care hospitals had adopted at least a basic EHR system with clinician notes, and one-third had adopted a comprehensive EHR (Charles, Gabriel, & Searcy, 2015). As for the physicians, more than 80% had adopted basic EHRs and more than a third, fully functional EHRs by 2014 (Shay, 2016). The latest update on the EHR incentive program is that nearly \$32 billion worth of incentives have been paid out to more than 484,000 healthcare providers as of end January 2016 (Roberta, 2016). This goes to show that the HITECH incentives have played a crucial role in catalyzing EHR adoption and meaningful use among physicians and hospitals alike.

6.3.1 Challenges in Implementing E-Health

Adler-Milstein & Bates (2010) highlight some key challenges encountered by hospitals in their EHR implementations. One of these was the heavy upfront expenses which in the case of some hospitals were higher than their single largest capital expenditure over a five year period. Other challenges included uncertain ROI and the transient negative impact of implementing the technology, such as loss of productivity, staff downtime and possibly loss of revenues too in the process of adapting to the system before it became a way of life. Yet another significant barrier was of course resistance from the physicians hired by these hospitals. The challenges faced by primary care practices in implementing EHR systems were nearly the same (Fleming, Culler, McCorkle, Becker, & Ballard, 2011), albeit on a smaller scale. The experts interviewed attested to the above-mentioned challenges and also brought to attention the fact that resistance to use EHRs was particularly high among the older generation of physicians. In fact the physicians' reluctance to use the EHR platform has been

turned into a new business model by some vendors who started offering scribe services to capture physician notes in the EHR and generate reports for physicians' sign off, all for the purpose of satisfying compliance (Raja, N., personal communication, August 23, 2015). It appears that sometimes the facts on the ground may be different from official rhetoric. Even to date there are some medical practices that are so resistant to technology intrusion into their treatment rooms that they do not mind being left behind in terms of access to tools for effective care-giving (Raja, N., personal communication, August 23, 2015). Moreover, these physicians also do not mind paying penalties for non-adoption as they consider this a cheaper alternative as compared to the long term costs associated with maintaining and upgrading the EHR (Katragadda, M., personal communication, September 2, 2015). Some small, rural groups also refrain from investing in EHR fearing the investment and maintenance costs in spite of the federal incentives (Raja, N., personal communication, August 23, 2015). After all, the government incentives go only as far as to encourage adoption and not beyond. Some physicians and hospitals do not want to invest in the EHR as yet, as the technology itself is still evolving. Stories abound of failed EHR implementations which have made them wary, resulting in their decision to wait to catch the maturity curve much later (Raja, N., personal communication, August 23, 2015).

The patient-centric stance of the reform was instrumental in bringing about a gradual but steady paradigm shift in healthcare which required that healthcare systems move from focusing on episodic care to focusing on integrated care. This meant placing the patients at the centre of care and focusing not only on their illness, but also on their wellness (Serbanati et al., 2011). A healthcare system that only addressed episodic care was considered as falling short of this key requirement. This paradigm shift set the direction for the healthcare systems of the future - it became imperative for healthcare systems to be interoperable so as to facilitate a sharing of patient data both within and outside the provider setting, thus paving the way for all health data pertaining to a patient to be captured in a longitudinal record (Paun et al., 2011). This was what was considered to make for a truly patient-centric experience.

The EHR incentives do not simply hinge on EHR adoption. Rather, for meaningful use of the EHR, the healthcare providers are required to collaborate

with other stakeholders in the region or community to participate in Health Information Exchanges (HIE) which facilitate a sharing of health information according to nationally recognized standards for better care coordination and quality of care (Lassetter, 2010). The grand plan is for these regional HIEs to be connected to their state-level HIEs which, in turn, will be tied in to form a nation-wide health information exchange known as eHealth Exchange (McCann, 2014). The eHealth Exchange actually started off as an ONC federal initiative in 2006 and was transitioned in 2012 to The Sequoia Project, a private sector initiative, for support. The eHealth Exchange currently claims to be the largest HIE network in the US, supporting more than 100 million patients, 4 federal agencies, nearly 50% of US hospitals, 26,000 medical groups, 3400+ dialysis centers and 8300 pharmacies across all the 50 states (The Sequoia Project, 2017). The allure for the participating organizations is the opportunity to do away with expensive customizations to interface with trading partners and to reduce their legal fees by leveraging common standards, legal agreements and governance accessible through the eHealth Exchange. In return, the participating organizations pay two types of fees to the eHealth Exchange, namely the annual eHealth Exchange Network Participation Fees which is a sliding scale based on annual revenues, and Testing Fees, when they first come onboard and / or seek to validate their product. This is how eHealth Exchange, the player whose role resembles that of the infomediary in the conceptual model, has structured the network as a mutually beneficial arrangement. While eHealth Exchange is a national level infomediary, the regional HIEs that it connects through the network are smaller infomediaries or sub-networks which in turn connect a fewer number of healthcare organizations at the level of a region or community.

The federal support for HIEs was for a short term and limited to providing these entities with start-up funding. It was however left to the states to discover a sustainable business model for the long haul either on their own or in partnership with the private sector organizations (Adler-Milstein, Bates, & Jha, 2011). The end objective for the federal government was to consolidate the state level HIEs to a national level network by developing appropriate technical standards. This will facilitate aggregation of patient data leading to creation of 'big data' for population health management activities which can possibly

improve healthcare outcomes both clinically as well as fiscally (Kayyali et al., 2013). At the time of the reform, the states already had entities known as Regional Health Information Organizations (RHIO) which possessed the capability to facilitate clinical data exchange at the local level within defined geographical areas. The RHIOs typically connected healthcare providers, payers, laboratories and public health departments. The financial incentives tied to healthcare providers demonstrating meaningful use through health information exchanges bolstered interest in the RHIOs which already had the structure to achieve HIE. Thus the erstwhile RHIOs became HIEs after the reform. It is to be noted that HIE may have two meanings depending on the context. The term may refer to the process of exchanging health information or to the entity facilitating such an exchange.

Setting up the HIEs and getting the stakeholders to meaningfully exchange data in ways that would result in improved efficiency and quality outcomes was a challenge. For one thing, the manner in which the stakeholders chose to exchange data was determined based on self-interest rather than on the larger public interest of achieving efficiency and quality in healthcare. This resulted in a narrow set of transactions taking place through the exchange in contrast to the vast potential of the HIE for more broad based and meaningful transactions (Adler-Milstein et al., 2011). Some HIE business models were not sustainable because the issue of misaligned incentives among its stakeholders could not be resolved satisfactorily. For instance, providers and patients were unwilling to pay for transactions from which the payers benefited the most financially (Adler-Milstein et al., 2011). Another challenge was that some of the HIEs within a geographical area might be directly competing with each other and therefore least inclined to share their patients' data with the other HIEs (Romeo, 2013). Apart from the challenges discussed above, there were some more in the form of disparate standards being adopted by the HIEs that deterred interoperability and consequently exchange of data, among these HIEs. Thus the very building blocks of the national network, the HIEs, remain siloed and disconnected.

The mixed results yielded by e-health implementations such as EHR and HIE across the US led to the realization that e-health involved more than just technical design (DesRoches et al., 2010). It was observed that in many

instances the technology was implemented just for its own sake without any foresight of the goals to be accomplished through the technology (Mettler & Eurich, 2012). Needless to say, such implementations turned out to be failures. Thus, the need for a carefully planned implementation strategy involving the key stakeholders was recognized. For the success and sustainability of e-health implementations, a business model to collaborate and create value with concerned stakeholders was deemed a necessary component of the strategy (Van Limburg, Gemert-Pijnen, Nijland, Ossebaard, Hendrix & Sevdal, 2011). Mettler and Eurich (2012) suggest aligning comprehensive knowledge about technology's potential with business acumen and sensitivity to customer needs to create a business model that would be both economically and socially sustainable.

6.3.2 Existing Business Models

Thus, seven years into the HITECH reform, the quest for viable business models that will help to achieve a fully integrated, sustainable national health information network continues. In undertaking this search for a sustainable business model, it may be pertinent to examine some business models that are already in use in the much fragmented healthcare industry of the US.

6.3.2.1 Managed Care Organizations (MCO).

Various business models to deliver healthcare have been in use in the US for a few decades now. One such model that started gaining popularity in the 1970s particularly among employers weighed down by the cost of insurance for their employees was the Managed Care Organizations (MCO). Typically financed by the employer or government, the MCO still remains the most dominant healthcare delivery system in the US (Shi & Singh, 2015). It functions in this way: an employer or government negotiates a contract with an MCO to offer a selected health plan for their employees as an alternative to purchasing expensive insurance plans. Three types of managed plans are offered by an MCO, namely i) Health Maintenance Organizations (HMO) ii) Preferred Provider Organizations (PPO) and iii) Point of Service (POS) (Katragadda, M., personal communication, September 2, 2015). In an HMO, the primary care provider acts as a gatekeeper to coordinate care, and the plan only pays for care within the network. A PPO on the other hand offers a wider choice of

healthcare providers and does not have the primary care provider acting as a gatekeeper for enabling access to specialist care. Moreover, it is more flexible when compared to an HMO in that it even allows members to seek care outside of the network. Understandably, a PPO is more expensive and it pays less for care received outside the network as different from care received within the network – a strategy intended to capture value. A POS lets the member choose between an HMO and a PPO at the point of care. An MCO is a capitation contract which functions somewhat like a fixed price contract, where the financial risk is transferred to the providers. The providers receive a fixed annual or monthly payment per member regardless of how much care is provided to the member during the period. If less than expected care is provided, they profit, and, conversely, if more than expected care is given, the difference will have to be absorbed by them. Such an arrangement benefits the payers because of the certainty it offers in terms of budget. However it may be cause for concern if providers compromised on the quality of care to economize (Frakt & Mayes, 2012). The major shortcoming of this model was its flawed design of rewarding physicians for not giving adequate care to their patients (McLean, 2007). In other words, the physicians had no accountability for the health outcomes of their patients, which is a disadvantage.

6.3.2.2 Accountable Care Organizations (ACO).

Around October 2011, a new value-based model of healthcare known as Accountable Care Organizations (ACO) was introduced by the government through the Medicare Shared Savings Program (Fisher, McClellan & Safran, 2011). An ACO comprises doctors, hospitals and other healthcare providers who collaborate to ensure that the chronically ill Medicare patients have timely access to quality care provided in an efficient manner. It is to be noted that Medicare is a national social insurance program that covers Americans aged 65 years and older who have contributed to the program during their employment. In addition, it also covers younger people with certain disabilities and conditions. It is one of the biggest sources of insurance in the US and covered more than 50 million Americans as of 2014 (Smith & Medalia, 2015). As of February 2016, there are a total of 448 ACOs (Centre for Medicare and Medicaid Services, 2016). An ACO differs from an MCO in the sense that it is

designed to address the shortcomings of the latter. In an ACO arrangement the financial risk is split between the providers and payers, and, additionally, bonus payments are tied to providers meeting quality parameters. Moreover, the ACO does not confine members to its network for all the care they require. Such a model is believed to prove efficient as well as sustainable especially with the advent of the EHR the capabilities of which can support this model in terms of keeping track of physician's interventions and associated outcomes (Frakt, 2015). The ACO model has caught on even outside of the Medicare program with the private sector insurers and providers entering into ACO type contracts (Fisher et al., 2011; Frakt, 2015).

6.3.2.3 Pay for Performance (P4P) Systems.

An increasingly acclaimed payment model currently implemented by the federal government in its Medicare program to control healthcare costs without any compromises on the quality of care is the Pay for Performance (P4P) system. P4P systems are devised to measure the performance of the providers along selected dimensions using pre-defined indicators. These measurements are used to assess them on the basis of their efficiency so as to compensate them accordingly (Cromwell, Trisolini, Pope, Mitchell & Greenwald, 2011). P4P is a move away from the traditional fee-for-service model which incentivizes providers for providing as many services as possible without any regard for cost or efficiency. Such a system not only contributes to an increase in healthcare costs but also results in inefficiencies as a result of overutilization of scarce resources. In line with the patient-centric standpoint of the reform, the P4P system also offers scope to embed preventive care within the healthcare system by rewarding providers on the basis of how well they maximize preventive care to improve health outcomes. The fee-for-service system, on the contrary, rewards providers for neglecting preventive care which is cheaper though more efficient than diagnostic care. An anomaly within the system is that providers stand to profit from their patients' adversity - the worse off a patient's condition, the more the provider can profit. For example, a provider will earn more if a diabetic patient suffers kidney failure and less if the patient's condition is kept under control through preventive care such as routine checks (Montgomery, 2016). Although the P4P system shows promise to better align

the interests of the providers and the patients, the question remains whether it will be impactful and to what extent it can improve health outcomes.

6.3.2.4 Provider-Led Healthcare Networks.

A rising trend that has been apparent in the US healthcare industry since the enactment of the ACA is provider-led healthcare networks. Big hospitals vertically integrate by merging with medical practices and solo physicians who cannot afford to invest in EHR and comply with regulatory reporting requirements so as to form large healthcare networks (Zinberg, 2016). Moreover, they also offer health plans in just the way as insurance companies do, to give their patients the added benefits of convenience and care (Accenture Healthcare Consumer Survey, 2012). These provider systems may build their own plan, or acquire an existing plan, or partner with a health plan (Eggbeer, 2015).

One such network is Sutter Health, a not-for-profit healthcare provider with presence in Northern California, Oregon and Hawaii. One of the biggest healthcare systems in the US, it includes clinics and community healthcare providers, and generates \$9 billion in revenues. The clinics and community providers in its network are required to pay a subscription fee to have access to Sutter Health's EHR platform. The federal incentives currently cover the subscription fees. However, when the incentives are phased out, the healthcare providers in Sutter Health's network will have to bear the subscription and support costs on their own. Some of these providers attempt to recover their EHR-related costs by charging their patients for access to the system at their end, and some others just absorb the costs. Sutter Health also has an insurance arm that offers health plans akin to those offered by managed care organizations (MCO) – HMO, PPO and POS. While Sutter Health is a not-for-profit organization, its insurance arm is for-profit (Katragadda, M., personal communication, September 2, 2015).

6.3.2.5 Personal Health Records (PHR).

Another business model that garnered attention around the time of the reform was the Patient Health Records (PHR). The concept of PHR managed to arouse interest by positioning the technology as being patient-oriented as different from the provider-oriented nature of the EHRs (Sunyaev, Chorny, Mauro, &

Krcmar, 2010). Several PHR models emerged in the market, the most notable ones being GoogleHealth and Microsoft HealthVault which to date have only had limited success in spite of riding on big and established names. Inexplicably, GoogleHealth exited from the service in early 2012.

6.3.2.6 Integrated Delivery Systems (IDS).

There are also other healthcare delivery models simply referred to as integrated delivery systems (IDS) which are essentially various forms of strategic partnerships among hospitals, physicians and insurers. An IDS can be described as a network of organizations that either directly provides or arranges to provide a well-coordinated continuum of care to its members, a defined population, and assumes accountability for the health outcomes of the population both in clinical and fiscal terms (Shi & Singh, 2015).

6.4 The US' E-health Ecosystem

This section discusses the US' e-health ecosystem and how it compares with the conceptual model developed in phase 1. The RQs articulated in Chapter One provide the framework for this discussion. Similarities and dissimilarities are highlighted, based on an analysis of which, a set of critical success factors for the ecosystem to be patient-centric and sustainable is identified.

6.4.1 Key Players

A review of the characteristics of the US healthcare industry, the recent (disruptive) reforms, their implications, and the myriad business models that exist, all confirm the highly complex, pluralistic nature of the industry. A concept map of the US e-health ecosystem is shown in Figure 6.3.

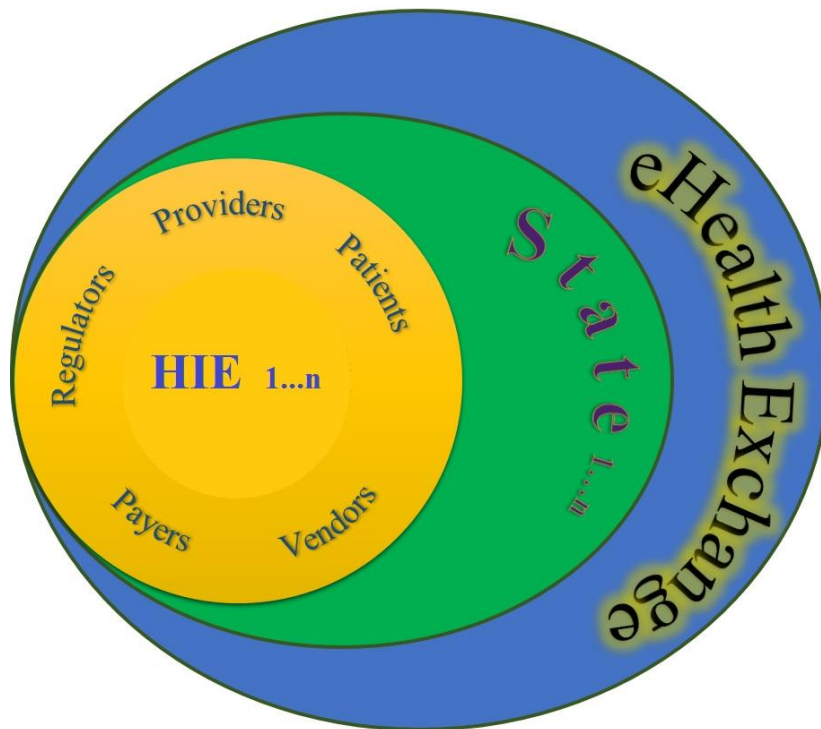


Figure 6.3. A Concept Map of The US E-Health Ecosystem

The ecosystem to be established through eHealth Exchange at the national level is still in a state of flux and is expected to keep evolving for quite some time to come. The US e-health ecosystem has the same players as those identified by the conceptual model the only difference being the players' complex inter-relationships. The players in the US e-health ecosystem are in a highly entangled and layered web of various types of business model arrangements at various levels. It will be apt to state that the national level health information network will be an ecosystem of ecosystems –a high level ecosystem that will connect the smaller ecosystems of HIEs. The HIEs, in turn, connect several entities that include patients, providers (hospitals, medical practices as well as independent physicians), payers, provider-payer arrangements such as MCO, ACO, IDS, provider-led networks, laboratories, vendors and public health departments. The HIE is in itself a complex web, and it will eventually have to be connected to the other HIEs to form the national network. The ecosystem will also include regulators at multiple levels – the federal government, the state government and the state-designated organizations. Needless to say, bringing such a large scale e-health ecosystem to fruition from its current fragmented state is a mammoth task, but it may be a necessary step to transform the industry.

6.4.2 Values Created and Captured

The ecosystem, as it is, allows limited scope for the range of values in the conceptual model to be created and captured in entirety. However, subsets of these values are observed in pockets, at various levels in the ecosystem. For all these values to be available in the aggregate on a single platform, eHealth Exchange should evolve to unify the smaller units of HIEs.

6.4.3 The Ecosystem through a Game Theory Lens

Viewed through the lens of game theory, it is apparent that e-health in the US is a non-cooperative game. One of the conditions that characterizes a non-cooperative game is that the benefits derived from cooperation are not returned to the members in a manner they consider equitable (Ford, Wells & Bailey, 2004). The stability and sustainability of the ecosystem are threatened by the two types of dilemmas discussed in Chapter Two, **sections 2.6.4 and 2.6.5**, namely participation and cooperation dilemmas.

6.4.3.1 Participation Dilemmas.

The US e-health ecosystem does not offer much scope for participation dilemmas that arise on account of a ‘productivity paradox’ largely because of the federal mandate in the form of the HITECH Act of 2009. The Act made provision for the EHR Incentive Program which encouraged EHR adoption and meaningful use among healthcare providers through incentives. Currently 75% of the US hospitals and more than 80% of the medical practices have basic EHR systems, and more than one-third in each group have advanced EHR systems. However, there are pockets of healthcare providers who have not invested in an EHR despite the federal incentives because they find technology intrusive and disruptive, and because they believe that paying penalties for non-adoption will be less costly than investing in EHR and incurring long term costs on its maintenance.

The other participation dilemma, namely the ‘tragedy of the digital commons’ is even more prevalent than the previously mentioned dilemma. One of the criteria for a meaningful use of the EHR is to share patient data with other healthcare providers and entities such as laboratories, public health departments etc. to ensure coordinated care for patients. Many healthcare providers are however unwilling to share their patients’ data with these other

stakeholders. The medico-legal considerations aside, this could be because of their perception that the other stakeholders are free-riders on the assets they painstakingly create. A considerable effort goes into converting a patient's paper records into electronic health records – manual data entry, scanning of documents, and verification of data and documents before filing (Kumar, N., personal communication, August 23, 2015; Katragadda, M., personal communication, September 2, 2015). Understandably, the healthcare providers are disinclined to allow others to benefit from their effort for free.

6.4.3.2 Cooperation Dilemmas.

HIEs at the regional, state and federal levels continue to be developed in a siloed manner owing to two key reasons: lack of interoperability resulting from incompatible technical standards, and competition with the other HIEs in the geographical region (Romeo, 2013). HIEs may not be open to sharing health information with other HIEs that are perceived to be their direct competitors. If only HIEs were willing to exchange data with other HIEs, the patients in their networks would greatly benefit, as this would inevitably lead to the creation of longitudinal health records for patients, regardless of where they receive care. However, from an HIE's perspective, this may adversely cut into its profitability, as patients now have an option to endlessly switch from HIE to HIE without incurring any additional costs. Not surprisingly, an HIE is reluctant to share patient data with other competitors, which in effect makes it a 'silo' or a 'narrow network'. It follows then that healthcare systems prefer to penalize patients switching between networks by imposing on them an additional cost in some form. For instance, a healthcare system may not prefer to share their patients' data with another system, but refusing to provide patient data when needed is not an option they enjoy. Therefore, the healthcare system may follow a policy to release patient data in a format of their choice (paper or electronic form) as a result of which patients are denied the advantages of a longitudinal health record. Much worse, they may even charge a fee from the patients for that service (Katragadda, M., personal communication, September 2, 2015). Recently, EPIC, one of the leading EHR vendors in the US was accused of designing its EHR systems to be 'closed records' that are not interoperable with other systems (Tahir, 2014). Incidentally, healthcare

providers may also be willing to cut down on their service fee in exchange for a health plan which is designed to discourage patients from seeking care outside the network with the result ‘narrow networks’ (Landman, 2015) begin to emerge.

A ‘narrow’ network results in ‘information asymmetry’ which renders patients immobile and incapable of accessing as much information as they may wish in order to exercise informed options and be free to switch between networks, if needed. Consequently, such networks are deemed to be less efficient and less consumer-centric, as they deliberately deny or limit consumer mobility or freedom which is crucial in making informed choices.

As discussed above, the dilemmas, when applied to and interpreted in the context of the US healthcare industry, provide a deep insight into the key issues afflicting the industry, which quite obviously stand in the way of accomplishing a nationwide health information network.

6.4.4 Critical Success Factors for a Sustainable Patient-Centric E-Health Ecosystem

What follows is a brief discussion of some recommendations made by the experts for stabilizing and sustaining the US e-health ecosystem:

- The benefits accruing from optimizing the use of the EHR will eventually outweigh burden of the investment in the EHR, and the subsequent maintenance costs it entails. The EHR empowers the hospitals and physicians by providing access to a connected healthcare ecosystem through which they can gain further insights into diseases and cures, leading to a more effective and better-coordinated care. By the time meaningful use stage 3 criteria are met, it is hoped, the healthcare providers will have achieved efficiencies that translate to increased earnings which, in turn, would help cover their EHR maintenance costs in total. Among other things, using the EHR would help reduce the length of an appointment possibly from 45 minutes to 15 minutes, thus saving a physician’s valuable time. The time saved could be used for more patient consultations, which in turn helps generate more revenues. Moreover, being part of an ecosystem also expands the network and the market for the healthcare providers and opens doors for new business opportunities.

- Smaller medical practices often find EHR investments forbidding, and therefore join larger healthcare networks which have already made the investment. For a subscription fee, they can access the EHR and benefit from its use, and they may recover the amount by collecting a small fee from their patients. What the patients get in return is an empowerment to create, own and access their own EHR accounts as well as the ability to decide who they share the information with.
- Private insurers have the power to ignite e-health adoption by making it mandatory and paying for it through compensatory mechanisms similar to what the federal government does through the EHR Incentive Program. In return, they gain efficiencies that will help them detect and prevent fraud, waste and abuse by healthcare providers, which in turn would result in substantial savings for them over the long run. Recent developments like EHR-facilitated e-visits are also of benefit to insurers who pay much less for their health plan holders' e-visits than what they may have to pay for their face-to-face consultations with their physicians.
- Patients can also play a role in driving e-health by insisting that their providers have EHRs; this would inevitably lead to the creation of a longitudinal health record which will be ubiquitous and portable. After all, patients have the right to demand access to information which is their own and for which they pay by way of consultation fees, charges for lab tests, costs of medications etc.
- The government (federal or state) can mandate a filing back of patient data into a government owned system, and act as the custodian of their citizens' health information. The 'big data' thus accumulated may be used not only for formulating effective health policies, but also for developing early warning and advisory mechanisms, leading to an overall improvement in population health. Availability of big data can also foster analytics and informatics opportunities which the pharmaceutical companies can use to find cures and arrest outbreaks.

In view of the massive stores of data such a system may have to accommodate, cloud-based solutions could be an excellent option both technically and economically feasible. Although there are no major players

who are currently using the cloud technology, given the exponential rate at which health information is growing, it is highly likely that in about ten years, almost all health information may be on cloud. In the near future the cloud technology will be an integral component of e-health programs, as several facets of e-health depend on the evolution of the technology for their materialization. However, there are also concerns about how the technology can ensure security and confidentiality of highly sensitive health information. Although encryption technologies could help mitigate such concerns, nothing may possibly work better than the government assuming responsibility for the security and confidentiality of the e-health ecosystem in order to maintain public confidence – similar to what the government has been doing for the national financial system by provisioning the FDIC (Federal Deposit Insurance Corporation), an independent agency which insures deposits and monitors financial institutions to ensure consumer protection.

6.5 Lessons Learnt

- There was an abundance of literature available for the US case study and this presented a challenge in terms of obtaining a balanced view and staying on course.
- The USA healthcare industry is excessively fragmented and populated with countless healthcare delivery models. The case study could only touch upon some of the dominant models. Needless to say, any situation can be turned into an opportunity and a business model by resourceful vendors. For instance HIT vendors commonly offer scribe services to physicians who are not inclined to use the EHR but nevertheless have to comply with the meaningful use criteria in order to be eligible for the EHR incentives. These HIT vendors require the physicians to register an account with them, download a software from their website and install it in a computer in their consultation room. The physicians also have to share their appointment calendar with the HIT vendor so the vendor can have a scribe waiting virtually to take notes real time while the physician attends to the patient. What comes as a surprise is that these scribes themselves may be qualified physicians based in other countries like India. It seems like the EHR

Incentive Program has provided a second career to physicians in developing countries, whether or not it has resulted in meaningful use of the EHR.

6.6 Conclusions

A meaningful transformation has long eluded the US healthcare industry possibly on account of the continued dissent among the political leadership and the other key stakeholders about 'how' such a transformation could be brought about. Several reforms have been proposed in the past, though nothing substantial seems to have been accomplished - with the possible exception of two landmark reforms - the HITECH Act of 2009 and the Patient Protection and Affordable Care Act (ACA) of 2010. Although it is too early to conclude if these reforms have succeeded and, in what measure, they have nevertheless resulted in some sweeping changes to the US healthcare industry's landscape.

It is said that, compared to other developed countries, the US healthcare system has been consistently underperforming on measures of health outcomes (Davis et al., 2014). Many experts expressed the view that a digitization of patient health records combined with an effective use of information technology would go a long way in controlling the spiraling healthcare costs and the deteriorating quality of care that plague the US healthcare industry (Bandyopadhyay et al., 2012). The government therefore decided that any reform of the healthcare industry should actually begin with establishing a national-level health information technology infrastructure. This resulted in the creation of the EHR Incentive Program which is intended to support healthcare providers in their transition to IT and to promote a meaningful use of the technology to improve healthcare outcomes. The program was successful to the point that it could spur a rapid EHR adoption among hospitals and physicians. The government, also provided grants to the states and territories to develop Health Information Exchanges (HIE) that would gradually pave the way for a seamless exchange of patient data within as well as across their jurisdictions. One of the criteria for a meaningful use of the EHR stipulates that the healthcare providers share patient data with other entities including other healthcare providers and laboratories when required, as such a step would improve patient care in terms of coordination and quality. This criterion encouraged healthcare providers to be part of an HIE so they can have access to

a platform through which they can exchange patient data with other entities and demonstrate meaningful use. However, even within an HIE, it was ensured that data exchanges were limited to transactions that benefitted the transacting members. Thus the proposition of HIE only met with mixed results owing to two key reasons. First, there is a lack of interoperability because of the absence of a will to impose common technical standards to exchange data. Second, there is a misalignment of incentives between the investors in the technology and the actual beneficiaries from the technology. These factors, if not resolved, will result in gross underutilization of the vast potential of the HIEs in respect of improving health outcomes. It is time that appropriate business models were evolved that could create sufficient values for all stakeholders of HIEs, failing which their economic sustainability would be at stake. It stands to reason that the lofty ideal of a national health information network (eHealth Exchange) can be achieved only when the HIEs, the building blocks, are in a position to sustain themselves.

6.7 Chapter Summary and Recap

The US, a world leader in medical technology, ironically also happens to be home to one of the least efficient healthcare systems in the world. The country's mammoth, unsustainable spending on healthcare has triggered several key healthcare reforms to put the country's healthcare system on the path for a major overhaul. One such reform was the HITECH Act (2009) which made provision for incentives for adoption of EHRs by physicians and hospitals. The incentive scheme adopted a carrot and stick approach to motivate EHR adoption – additional incentives if meaningful use of EHRs was demonstrated and cut-backs if the criterion was not met. The ultimate goal of this reform was to forge connectivity across the country's fragmented healthcare system in the hope that it would lead to efficiency and consequently, a drop in the country's healthcare expenditure. Although the reform no doubt spurred EHR adoption, its intended goal of connectivity has not been fully realized owing to the participation and cooperation dilemmas discussed earlier, which only confirms the major barriers to e-health identified early on in this research. A set of critical success factors has been proposed to overcome these dilemmas and make the ecosystem both patient-centric and sustainable.

The next chapter, Chapter Seven, synthesizes the results of the Singapore and the US case studies through a cross-case analysis with a view to mobilizing new knowledge from these studies. Such new knowledge as elicited by comparing and contrasting these case studies would be utilized to modify the conceptual framework which would then be compared with literature to pursue a theoretical integration. This would further lead on to the task of addressing RQ2, namely educating the critical success factors that contribute to a patient-centric, sustainable e-health ecosystem.

CHAPTER SEVEN CROSS-CASE ANALYSIS

This chapter addresses the third and final phase of this research, which is aimed at extracting insights that will help address RQ2. It may be recollected that RQ2 was aimed at deriving the critical success factors for a sustainable e-health ecosystem. As part of this chapter, a cross-case analysis of the Singapore and the US case studies is conducted and reported. The knowledge acquired through the individual within-case analyses is used to compare and contrast the cases, and produce accumulative knowledge. The new knowledge acquired in the process is used to modify the conceptual framework, the implications of which are discussed, and the modified theory compared with the literature for theoretical integration.

7.1 E-Health in Singapore and The US

Each ecosystem's journey towards e-health is unique. Several factors such as the size of the country, structure of its healthcare system, political climate, socio-economic factors and even culture may influence the journey. The key imperatives leading to the initiation of e-health to transform the healthcare ecosystem may also vary from country to country. For instance, one of the significant factors that started Singapore on its healthcare transformation journey was the 'silver tsunami'. In the US, on the other hand, the key factor driving the country's healthcare transformation journey was the skyrocketing healthcare expenditure. Regardless of the unique circumstances that lead a nation to pursue e-health in order to positively transform its healthcare industry, the underlying concerns with respect to healthcare cannot be dissimilar across healthcare systems, countries or even continents. When it comes to healthcare, each ecosystem gravitates towards the common goals of improving quality, access and equity for its citizens, and e-health is adopted for its promise to meet these goals.

Scholarly literature has recognized e-health as a promising strategy that can transform the healthcare ecosystem by integrating it and facilitating the flow of patient data in ways that can enhance the effectiveness and efficiency of healthcare (cf. Hill & Powell, 2009). It in fact presents an opportunity for global standards and best practices in order to create a common framework for sharing

and comparing health information so as to have the ability to ‘innovate on the edges instead of having to reinvent wheels’ (Stansfield, 2008). However, facilitating such an exchange of health information has always been a struggle for want of an effective model to do so (Vest, Campion Jr., & Kaushal, 2013).

The challenges involved in implementing e-health on a national scale are often underestimated. These challenges are not just limited to technical issues, but in fact have more to do with political and economic issues (Blank, 2012; Yaraghi, 2015). It is not easy to predict or resolve all of these issues without any reference to lessons learnt from similar initiatives. It is therefore worthwhile to learn from others’ successes and failures in this context. In view of this objective, it will be beneficial to develop a theoretical framework that would help conceptualize the issues with regard to the adoption and purposeful use of e-health as well as identify the critical success factors for a patient-centric, sustainable e-health ecosystem. Such a framework will particularly benefit e-health implementations in developing countries which cannot afford the luxury of failed experiments. It is hoped that in developing such a framework, RQ2 will be addressed. A cross-case analysis of the Singapore and the US case studies, it is hoped, will shed light on how e-health may be successfully implemented and sustained.

7.2 Health Statistics: Singapore vs The US

It may be recalled that the basis of selection of the two cases, namely Singapore’s NEHR and the US’ HITECH program were the purposeful sampling strategies of ‘maximum variation’ and ‘information richness’. While Singapore is considered a high-performing healthcare system, the US, on the contrary, ranks as a low-performing system, making these cases diverse. However one common trait these countries share is their propensity to quickly embrace innovation and technology in areas they perceive would benefit their nations. Thus both Singapore and the US are among the pioneers to experiment with e-health technologies, which offers scope for this research to learn from these two countries’ experiences.

It may be helpful for the cross-case analysis to begin with some most recent health statistics available for the two countries from the World Health Organization (WHO) as shown in Table 7.1.

Table 7.1.

WHO Statistics on Healthcare Indicators for 2014

Indicators	Singapore	The US
Life Expectancy at Birth (years)	83	79
Total Health Expenditure as % of Gross Domestic Product	4.9	17.1
General Government Health Expenditure as % of General government expenditure	14.2	21.3
General Government Health Expenditure as % of Total Health Expenditure	41.7	48.3
Private Health Expenditure as % of Total Health Expenditure	58.3	51.7
Out of Pocket Expenditure as % of Total Health Expenditure	54.8	11.1
Out of Pocket Expenditure as % of Private Health Expenditure	94.1	21.4
Total Health Expenditure per Capita in US\$	2752	9403
Out of Pocket Expenditure per Capita in US\$	1508	1044
Total Health Expenditure per Capita in Int\$ (PPP*)	4047	9403
Out of Pocket Expenditure per Capita in Int\$ (PPP*)	2218	1044

***PPP - Purchasing Power Parity** - An economic theory that estimates the amount of adjustment needed on the exchange rate between countries in order for the exchange to be equivalent to each country's purchasing power.

Based on 2014 statistics, Singapore is classified as a healthy country with a life expectancy of 83 years (Global Health Observatory, 2016). In 2014, the life expectancy for the US was significantly lower at 79 years despite the fact that the country's per capita expenditure more than doubled Singapore's (after purchasing power parity adjustment) in the same year. In a sense, the proportion of the US expenditure on healthcare relative to GDP is nearly four times as much as Singapore's.

Singapore's healthcare system is 'universal and unique' in the sense that it effectively combines free market principles with government control (Meng-Kin, 1998). Singapore adopts a mixed public-private healthcare delivery and financing system that is based on personal responsibility as well as social solidarity (Britnell, 2015). This, however, results in patients having to pay heavy out-of-pocket costs which make up nearly 55% of the country's total healthcare expenditure. In contrast, the US does not offer a healthcare system that is universal and well-regulated (Moses III et al., 2013). Nevertheless, the out-of-pocket expenditure incurred by its people is much less i.e. 11% of the

total healthcare expenditure. If the countries' out-of-pocket expenditure on healthcare per capita is compared after adjusting for purchasing power parity, it emerges that such spending in Singapore is nearly twice as much as in the US. The US government's expenditure on healthcare as a percentage of total healthcare expenditure is 48% which, though lower than the average for advanced economies, is higher than that of Singapore at about 42%. This discussion on the healthcare expenditure patterns in the two countries is pertinent inasmuch as it puts into perspective the key challenges confronting these healthcare systems, and how e-health can play a role in addressing these issues.

7.3 Similarities and Differences across Cases

Figure 7.1 shows the unique as well as common themes that surfaced from the two case studies, while bringing into focus both corroborating and contradicting evidence in the field. In the Venn diagram, the overlap lists themes or features that are apparent in both the ecosystems. Given the disparities in size and socio-political structure, such similarities across the two cases suggest a universal set of characteristics. The non-overlapping areas list the unique themes or features. Both the similarities and differences between the two ecosystems are discussed in this section.

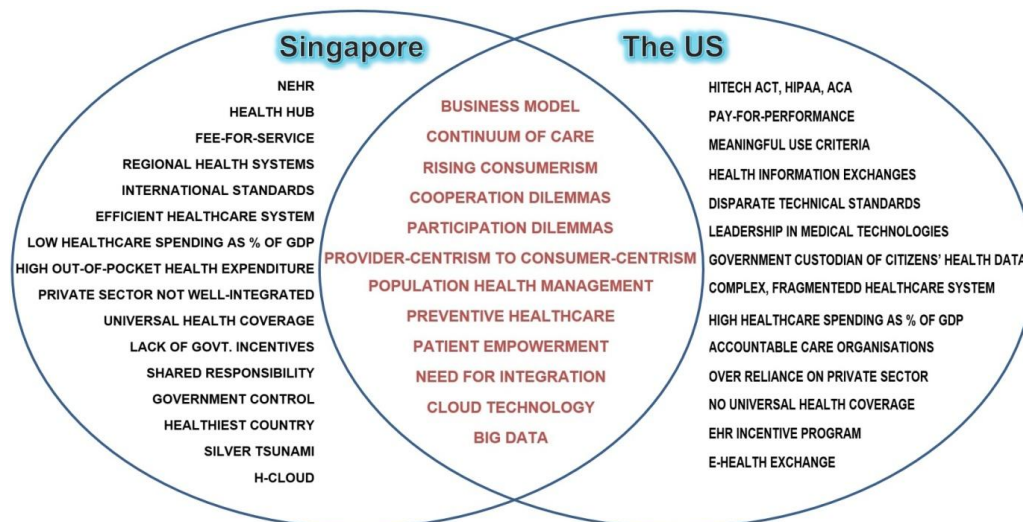


Figure 7.1. Unique and Common Themes from the Singapore and US Case Studies

As said earlier, Singapore and the US are both technologically advanced, and were among the earliest countries to initiate reforms in their healthcare systems through e-health technologies. While Singapore's major

concern was about meeting the rising healthcare demands of its ageing population, the US was primarily concerned about bringing under control the country's astronomical healthcare spending, which, left unchecked, would be unsustainable (Herzlinger, 2010). Regardless of their differing motivations for their e-health journeys, their intended destinations are common – an integrated and well-connected patient-centric e-health network that will facilitate an exchange and reuse of health data (Neupert, 2009). It may be pointed out that the benefits that accrue from a capability to exchange and reuse health data have already been discussed in earlier chapters. A well-connected e-health network should, most importantly, be able to support a continuum of care and enable the creation of a longitudinal health record for patients. Having ready and ubiquitous access to their lifelong story of treatments, tests and prescriptions not only empowers healthcare consumers, but also supports their healthcare providers with regard to making the best possible decisions relating to their healthcare. However, as noted in the literature and field study, accomplishing such a patient-centric network is not a trivial undertaking. It requires, among other things, the cooperation of several stakeholders, especially the healthcare providers. It may be reiterated that EHRs are the building blocks of e-health, and healthcare providers are the stakeholders who are well-poised to contribute them. However, securing the cooperation of healthcare providers in adopting EHR technologies still remains a challenge. This challenge was observed to be at play in the case of Singapore as well as the US. The problem inherent in the challenge is that, as a rule, healthcare providers tend to perceive the new technology as a threat to their autonomy, and are skeptical whether the projected returns would be in keeping with their investments. Their question is whether it is worthwhile investing in a technology that may put them at a disadvantage; the value they capture may not be in proportion to the value they create in terms of their investments. They may even find it hard to accept the fact that the benefits of their investments may also be shared by stakeholders whose contribution to the common cause is minimal, and who are privileged to access the technology for free. Needless to say, such a perception of misaligned incentives stems from the reduced information asymmetry and the tragedy of the digital commons resulting from EHR investments. But do healthcare providers have a choice? The next section may help answer this question.

7.4 Optimal Ecosystem: A Game Theoretic View

A simple game theoretic analysis may help put the healthcare providers' predicament in perspective. It needs to be mentioned in this context that Sharma & Bhattacharya (2013) have developed some of the classic dilemmas faced in knowledge-sharing environments using game theory principles. This thesis adapts two of these dilemmas for the purpose of illustration.

For ease and convenience of analysis, the players in the e-health ecosystem may be classified into two groups namely, producers and consumers of health data as discussed in **section 4.1.5.1**, 'E-Health Digital Data Flows: A Simplified Model'. Health data is primarily produced by healthcare providers and consumed in various ways by the other players in the ecosystem such as healthcare consumers, payers, vendors, regulators and infomediaries. In this analysis, X denotes the producers of health data namely, the healthcare providers, and Y denotes the consumers of health data namely, the other players in the ecosystem. Using mathematical notations the game can be described in the following manner:

s = number of strategies available to X

Three major strategies namely

S_1 =non-adoption of e-health (may mean no HIT investment or HIT investment for intra-enterprise benefits)

S_2 =adoption of e-health in a narrow network

S_3 = adoption of e-health in an open network,

can be considered to be available for the healthcare providers; therefore $s = 3$.

S_x = strategy profile for X, expressed as $\{S_1, S_2, S_3\}$

P = payoff derived for each strategy of X

P_x = payoff profile for X, expressed as $\{X_1, X_2, X_3\}$

P_Y = payoff profile for Y, expressed as $\{Y_1, Y_2, Y_3\}$

Figure 7.2 shows the payoff graph for X and Y.

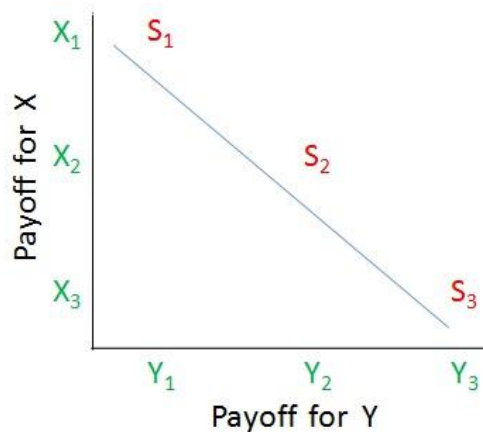


Figure 7.2. Payoff Graph for Healthcare Provider Strategies

The misalignment of incentives between the healthcare providers and the other players in the e-health ecosystem, a consequence of non-cooperative games, is evident from the payoff graph. The graph shows that the more restrictive the provider's strategy is, the less are the benefits for the other players.

However, the vast benefits of e-health cannot be forgone simply because e-health threatens the autonomy that healthcare providers have traditionally enjoyed. Moreover, it cannot be overlooked that healthcare consumers who are the ultimate beneficiaries of e-health are also the very source of the rich data in the possession of the healthcare providers. Hafen, Kossmann & Brand (2014) deplore the fact that healthcare consumers who are the source of health and health-related data have little or no control over such data, let alone their benefitting much from it. So, it is only fair that any value in e-health be defined around healthcare consumers. How much value the other players create for the healthcare consumers should be the basis of decision on the reward payable to them (Porter, 2010).

Returning to the question whether healthcare providers have the choice to shirk EHR investments, the answer is they do not, if they are mandated by the regulator to invest. But even without such a mandate from the government, they may have no choice in this matter in view of the rising healthcare consumerism, especially in the advanced markets. As a matter of fact, consumers are now said to be gaining ground in healthcare, thanks to internet trends and pro-consumer health policies (Guest & Quincy, 2013). And this trend is corroborated by evidence from the Singapore and the US case studies.

Healthcare consumers have come to expect the qualities they value in non-healthcare settings to be present in healthcare settings as well (Cordina, Kumar, & Moss, 2015). Cordina et al. (2015) argue on the strength of the findings from their study that healthcare is no different from other industries from a consumer's perspective - 'customer satisfaction' is a common expectation that needs to be met by healthcare and non-healthcare organizations alike. It is imperative, therefore, that healthcare providers rise to their consumers' demand for ubiquitous access to their health information maintained in a longitudinal record. This rising trend of healthcare consumerism has a lesson for medical professionals as well; "the message to doctors is clear: Get Online - Do Not Be Left Behind" (Chin, 2000, p.426).

A game theoretic analysis may also be helpful to evaluate how healthcare providers might choose to respond to rising healthcare consumerism. Consider a healthcare market served by two healthcare providers - A and B. Let the benchmark case be a situation where neither of the healthcare providers has adopted e-health. Adopting e-health entails costs in the form of EHR investments for the healthcare providers. Provider A serves a population size of x and has a profit that may be quantified as P . Provider B serves a population size of y and has a profit than may be quantified as Q .

A = Provider 1

B = Provider 2

x = population served by A

y = population served by B

P = A's profit in the benchmark case

Q = B's profit in the benchmark case

If A adopts e-health and B shirks e-health, or if A adopts e-health ahead of B, then x and P increase while y and Q decrease. This is because of the first mover advantage that A gains to create value for its patients in the form of electronic health records. Likewise, if B adopts e-health and A shirks e-health, or if B adopts e-health ahead of A, y and Q increase while x and P decrease.

If both providers adopt e-health around the same time, they may be able to maintain status quo in terms of the size of the population they serve. However, their profitability will now be lower as compared to the benchmark case due to their e-health-related investment and maintenance costs.

It may, therefore, be argued that the best strategy for both the providers would be to shirk investing in e-health to preserve their original profit as in the benchmark case. However, there is more to the analysis. First, A may not be aware of B's strategy and vice versa, as is the case in non-cooperative games. If A moves first, then B loses its patients to A, and if B moves first, A loses its patients to B. Of course, loss of patients comes with loss of profits (values) as well. Since there is an uncertainty regarding the other player's strategy, the best strategy for both players may be to play it safe by investing in e-health at least to maintain the status quo in terms of the size of the population they serve. Figure 7.3 shows the payoff matrix for the e-health adoption game.

		PROVIDER B	
		DOES NOT ADOPT E-HEALTH	ADOPTS E-HEALTH
PROVIDER A	DOES NOT ADOPT E-HEALTH	{ x, P y, Q }	{ x↓, P↓ y↑, Q↑ }
	ADOPTS E-HEALTH	{ x↑, P↑ y↓, Q↓ }	{ x, P↓ y, Q↓ }

{ MYOPIC STRATEGY }
{ VISIONARY STRATEGY }

Figure 7.3. Payoff Matrix for E-Health Adoption Game

Even if both the providers were to jointly decide not to adopt e-health in order to preserve their current profit ('P' amount of profit for A and 'Q' amount of profit for B as in the benchmark case), there is no guarantee that their patients will remain with them. The present day healthcare consumers have better awareness of their options and may, therefore, tend to gravitate towards options that offer them more value. For instance, when healthcare consumers venture to go on medical tourism to countries where the healthcare system offers better value for their money (McLean, 2007; Herzlinger, 2010), they may not hesitate to switch their loyalty to a provider in an alternative healthcare market within their community or region, who offers more value (in this context value refers to e-health). This will endanger the status quo for A and B both in terms of their profits, and in terms of the population sizes they serve.

Thus, in any case, the best strategy for A and B would be to adopt e-health so as to be able to offer the best value possible to their customers. Moreover, embracing e-health may place them on the path to discovering new business opportunities and new markets. For both A and B, shirking e-health may seem a good strategy initially, but it may not be very long before they realize that it is not. The strategy is ‘myopic’ in the sense it is short-sighted and may prove detrimental in the long run. As against this, both A and B investing in e-health so as not to be left behind in terms of the opportunities brought forth by e-health may be said to adopt the best long term strategy, referred to by this research as a ‘visionary strategy’.

The foregoing discussion makes it clear, therefore, that under the present circumstances healthcare providers may not have any other sustainable option except to invest in EHRs lest they should otherwise be left far behind in the e-health game. It is likely that the e-health ecosystem may not be Pareto-efficient from the providers’ perspective as it appears to make them worse off than status quo. However, with the prospect or possibility of innovative business models emerging in e-health in the future, Pareto-efficiency may be restored.

7.5 Emergent Themes and Patterns

7.5.1 Government Mandate and Incentives to Mitigate Participation and Cooperation Dilemmas

To encourage e-health adoption among healthcare providers, it would help if there is a clear mandate from the government with provision for incentives. Hill and Powell (2009) insist that a national-level agenda is necessary to make e-health a reality and Gajanayake, Sahama and Iannella (2013) identify government incentives as one of the critical factors for the success of national-level e-health implementations. The two case studies undertaken in this research also serve to prove this point. While the US case study demonstrates that incentives for EHR adoption and its meaningful use may work to some extent, the Singapore case study shows that without incentives the healthcare providers (especially private sector GP clinics) may not be inclined to invest in EHRs. This is further substantiated by an Accenture (2012) report which showed that Singapore lags behind the US in terms of healthcare IT adoption as well as

health information exchange both in the primary and secondary care sectors. The gap between the two countries is even more conspicuous in the primary care sector. The lack of integration at the primary care level is also a matter of concern as seen from the Singapore case study, and, as suggested by some informants who participated in this study, incentives from the government might facilitate better integration. It is thus evident that the participation dilemmas observed and discussed in the case studies can, to a great extent, be addressed through a government mandate and some provision for incentives. Singapore may have to consider incentivizing the private sector healthcare providers who make up a substantial 80% of the primary care sector in order to secure their participation in e-health. It may be recalled from the WHO statistics that the Singapore government foots only about 40% of the total healthcare expenditure, which is far lower than the average of 72% as in the case of most developed economies (Britnell, 2015). It may be an indicator that the health policy makers in Singapore should consider further incentivizing the players so as to augment the benefits of its investments in the NEHR, H-Cloud and HealthHub, and, more significantly, to realize the dream of '*One Patient One Record*'.

A key finding corroborated across cases as well as between research and practice is that government incentives can boost e-health adoption among healthcare providers. However, it does not suffice if they simply invest in EHRs all for the sake of realizing some intra-organizational benefits limited to their institutional settings. There will be more value to capture if they co-operate with other healthcare providers to mutually exchange patient data so as to be able to create and maintain a longitudinal patient health record. This would ultimately pave the way for a paradigm shift from provider-centrism to consumer-centrism. This, however, is by no means easy to accomplish as has been observed in the case studies. It may be recalled that competition among healthcare providers often results in cooperation dilemmas and leads to narrow networks, and information asymmetry. It has been suggested in the literature that legislation has the power to maneuver providers towards greater coordination (Fuchs, 2009) and incentives for sharing data could work as well (Neupert, 2009). Ramesh, Wu, & Howlett (2015) acknowledge that designing and enforcing effective healthcare regulations may prove unwieldy, and may

necessitate an offer of substantial healthcare subsidies from governments. However, providing incentives to healthcare providers may not be sustainable in the long run. Bandyopadhyay et al. (2012) suggest that the government should intervene in situations where the other stakeholders lack the incentive to act in the best interest of all concerned. Van Limburg et al. (2011) caution that inadequate legislation and a status quo of the traditional roles and dependencies in healthcare will only bolster inefficiencies. Thus, it is clear that a strong government mandate is indispensable to get the players, particularly the healthcare providers, actively involved in the e-health ecosystem. The second best option may be for a neutral private entity to discover a business model that will incentivize data sharing among the players (Bandyopadhyay et al., 2012). In the context of the US, such an entity is the eHealth Exchange, a public-private initiative with a mission to improve patient care. It is remarkable that, in spite of the highly fragmented nature of the US' healthcare industry, about a third of the country's population is already supported by this platform. In Singapore, this neutral entity is IHis, a wholly owned subsidiary of MoH Holdings with an arm's length relationship with the regulator.

Accenture (2012) suggests three stages in a country's journey towards connected health. Figure 7.4 depicts these stages.



Figure 7.4. Stages of Connected Health

The first stage involves planning a digital infrastructure, building it and actually using it to create health data in the form of electronic health records for healthcare consumers. The second stage involves exchanging of health information among healthcare providers, as well as between healthcare providers and patients, for effective and efficient patient care. The third stage involves advanced use of health data for purposes such as analytics and informatics that support population health management and clinical decision making.

7.5.2 Population Health Management and Big Data

It may be noted that population health management and ‘big data’ are two key themes that emerged from the Singapore and the US case studies. Population health management refers to a systematic collection and aggregation of patient data in a form that lends itself to easy access and interrogation for the purpose of sophisticated health data analytics (Accenture, 2012). Such aggregated personal data is so valuable that it is acknowledged to be an asset class to acquire which many organizations including Google and Facebook so keenly compete (Hafen et al., 2014). Population health can be effectively managed by taking advantage of the staggering amount of health data captured by a variety of sources including EHR systems, wearable devices and sensors, which, when aggregated are referred to as ‘big data’. The aggregation of these individual health data sets into big data can robustly support the development of effective strategies intended to improve healthcare quality, access and outcomes, bringing about, over a period of time, an overall improvement in population health (Kayyali et al., 2013). Developing the capability to create and use big data to power their population health management strategies is an important goal for Singapore and the US alike.

7.5.3 Preventive Healthcare

Population health management includes among other things, promoting preventive healthcare through patient engagement and patient empowerment which in turn, can lower healthcare utilization and healthcare costs. These are outcomes that are desirable for both countries, and for that matter, for any country in the world. Preventive healthcare is a key area of focus for Singapore which is confronted by the onset of a silver tsunami. If left unchecked, the silver tsunami may place a huge strain on the country’s healthcare infrastructure and take it to a point of collapse. According to a recent study by OCBC (Singapore Business Review, 2016), hospital admissions in Singapore are projected to rise to 791,000 yearly, which would imply that public hospitals have a great deal to do in terms of developing their infrastructure so as to be able to cope. Preventive healthcare is particularly crucial for Singapore which advocates personal responsibility for health without which individual healthcare costs may turn out to be phenomenal. It may be pointed out that nearly 55% of Singapore’s total healthcare expenditure is out-of-pocket, and the per capita out

of pocket expenditure in Singapore (purchasing power parity adjusted) is at least twice as much as in the US. This state of affairs has even led critics to question if Singapore ‘really’ offers universal health coverage, as it claims. In the words of Britnell (2015) who has studied healthcare systems around the world, this is the “troubling reality beneath the overall impressive performance” of Singapore’s healthcare system (p.42).

In the case of the US, population health management supported by big data is perceived to have the potential to reduce the country’s healthcare expenditure by promoting preventive healthcare, thereby improving healthcare outcomes not only in clinical terms, but also in financial terms. It may be recalled that the ACOs and P-4-P systems recently implemented by the US government’s Affordable Care Act are also mechanisms aimed at encouraging preventive healthcare and controlling healthcare costs.

7.5.4 Provider Accountability

Systems such as P-4-P and ACO implemented by the US government make healthcare providers accountable for their patients’ health outcomes and compensate them, where necessary, on the basis of how they maximize the use of preventive healthcare to improve health outcomes. Population health management can support these systems by directing physicians towards appropriate evidence-based healthcare protocols (DeVore & Champion, 2011). It is believed that the country’s enormous healthcare expenditure can be brought under control through these various complementary measures. The healthcare system costs the country so much that, if it could be put on an island and floated out into the Atlantic Ocean, it would have the fifth largest GDP in the world according to a former adviser to President Barrack Obama (Rosenthal, 2013). Although mechanisms such as P-4-P and ACO are not yet in place in Singapore, trends observed in the course of the case study such as rising healthcare consumerism and quest for transparency in healthcare pricing and outcomes, are predicted to pave the path for accountability as a design characteristic in healthcare systems.

7.5.5 Cloud Technology

Another common theme that emerged from the two case studies is cloud technology. While cloud technology is already being implemented in

Singapore, it is expected to take off in the US soon. Singapore has made remarkable strides in the use of cloud technology even to the extent of winning the prestigious DataCloud award for its innovative use of the technology to deliver value (Lee, 2015). Among other benefits that accrue from the use of the technology, Singapore embraced it mostly for its cost-effectiveness and scalability. When a small nation like Singapore can benefit tangibly from the technology, it is conceivable that the US could benefit from the technology a good deal more. The researcher recalls being told during the expert interviews that the US has been keenly watching these developments and that it may just be a matter of time before the technology takes off in the country's healthcare industry in a big way. Considering that health data is growing at an exponential rate, the cloud technology may be the way forward for the healthcare industry anywhere in the world.

7.6 Sustainable E-Health Ecosystem: Critical Success Factors

Based on the insights iteratively and incrementally gained through the within-case as well as the cross-case analyses, this thesis addresses RQ2 and recommends that the following critical success factors be taken into account in evolving a patient-centric sustainable e-health ecosystem:

7.6.1 E-health Standards for Interoperability

The ecosystem should seamlessly connect all the key players namely, Providers, Payers, Regulators, Vendors, Infomediaries and Citizens. Interoperability is a prerequisite for such an ecosystem design. Considering that healthcare is a public good, the government should lead the development of common technical standards that will facilitate interoperability in the e-health ecosystem. This is made evident by the two case studies. While Singapore has already begun taking steps towards developing a national architecture based on international standards for aggregating health data across diverse clinical systems and data models (Gunapal et al., 2016) the ONC in the US has created a roadmap to achieve nationwide interoperability by 2024 (Krumholz, Terry & Waldstreicher, 2016).

7.6.2 Health Data Custodianship

Because health data is sensitive, the government concerned or its appointed agency should act as the custodian of the data in order to instill and maintain

public confidence. A survey of 20 OECD (Organisation for Economic Co-operation and Development) countries undertaken by Oderkirk, Ronchi & Klazinga (2013) revealed that many of these countries had their national health datasets in the custody of health and/or statistical ministries. It is thus palpable that none other than a government or government-appointed agency can better fulfill the role of such a custodian who will have to carefully and objectively weigh the risk trade-off between individual privacy and public interest in making decisions regarding utilization of health data. In Singapore, this role is fulfilled by HSOR (Gunapal et al., 2016), while in the US, such custodians exist in a complex web at several levels such as states, regions, etc. (Oderkirk et al., 2013).

7.6.3 Neutral Infomediary

The infomediary that connects the players in the e-health ecosystem should be a neutral entity that fosters innovation of new business models that incentivize the players for sharing data. It may be a public entity as in the case of Singapore (HealthHub), or a public-private initiative as in the case of the US (eHealth Exchange).

7.6.4 Longitudinal Health Record

It is crucial that the e-health ecosystem is fully integrated, attracting participation and cooperation across the public and the private sector healthcare providers in the primary, secondary, tertiary, intermediate and long term care sectors. This is to ensure a continuum of care for the patients and foster the creation of a longitudinal health record for them. Moreover, being connected to the whole range of healthcare providers also promotes consumer awareness and choice. It may be recalled that continuum of care was a common theme (concern) for both Singapore and the US.

7.6.5 Accountability

An integrated ecosystem would moreover expose healthcare providers to market forces thus leading to a healthy competition. The competition will maneuver the providers to assume accountability for their patients' health outcomes and to expect to be compensated on that basis. This will result in greater efficiency in the healthcare market. Given the rising healthcare consumerism and the resultant demand for transparency in healthcare pricing

and outcomes evidenced in both case studies, an integrated healthcare system that has the potential to promulgate consumer choices through efficiency, transparency and accountability, is the way forward.

7.6.6 Balancing Efficiency and Fairness

It is known that there is always a tradeoff between efficiency and fairness (Sharma and Bhattacharya, 2013). An efficient e-health ecosystem may not be fair to the healthcare providers who have to invest in technology, share the benefits of their investment with the other players, and moreover, be exposed to competitive forces in the market. But recourse to mitigate the ‘unfairness’ meted out to them by the disruptive innovation of e-health, as it has emerged from the case studies and supported by literature, may be made available in the form of government incentives (Ramesh et al., 2015), cost-effective technologies like cloud (Nigam & Bhatia, 2016), and innovative business models (Bandyopadhyay et al., 2012) presenting new business opportunities. Disruptive innovation has ushered in affordability and accessibility in many industries ranging from steel to finance and it may just be the “right prescription” for the healthcare industry, “a treatment that is desperately needed and long overdue” (Hwang & Christensen, 2008, p.1335).

The e-health ecosystem should therefore incorporate in its design, mechanisms to foster transparency of information about the players such as healthcare providers, vendors and payers/insurers which will enable healthcare consumers to evaluate these players based on parameters that may matter to them such as cost, quality and effectiveness, and empower them to make informed decisions regarding their healthcare and healthcare related purchases. This will also improve efficiency in the market.

7.6.7 Citizen-Centrism and Population Health Management

Another trend that emerged from the case studies and is widely supported in literature is that a futuristic e-health ecosystem should be more than patient- or consumer-centric. It should in fact be designed to be citizen-centric so as to offer scope for effective population health management and preventive healthcare. It should encourage citizens to contribute health data, perhaps through an independent PHR interoperable with the EHR systems in the ecosystem.

7.6.8 Big Data and Cloud Technology

It should be part of the e-health ecosystem's design to create and use big data to support development of strategies to improve population health outcomes. While Singapore is already on its way to building a central database that would facilitate big data analytics to support population health management activities (Gunapal et al., 2016), big data is increasingly being recognized as a priority area in the US (Wang & Hajli, 2017). The sustainability of such an ecosystem may be enhanced if it is cloud-based.

7.6.9 Potential Additional Key Players

With the take-off of wearable healthcare devices, mobile health apps and big data, the e-health ecosystem may expand to include new players such as communication network providers and pharmaceutical companies. Hence provisions for these players to be part of the ecosystem should be built into the ecosystem.

7.7 Chapter Summary and Recap

As seen above, this chapter comprises a cross-case analysis of the Singapore and the US case studies undertaken as part of the research and the findings inferred from the analysis. The cross-case analysis was conducted to address RQ2 which sought to identify the critical success factors that must be considered for ensuring sustainability of e-health ecosystems. The chapter began with a comparison of the healthcare systems in both countries using latest statistics on key healthcare indicators from the WHO. Similarities and differences across these two healthcare systems as observed from the within-case analyses in chapters five and six were highlighted. Common patterns observed across these two diverse cases that were selected for the study on the basis of the purposeful sampling strategy of 'maximum variation' were of particular interest, because such patterns suggest a universal set of characteristics applicable in the context of any healthcare system in the world. Significant themes that emerged in the process were discussed, theoretically integrated, and, finally, critical success factors for developing a sustainable citizen-centric (as opposed to patient- or consumer-centric in the conceptual framework) e-health ecosystem were derived and proposed.

The next chapter presents a summary of conclusions from the study, highlights the practical implications of this study, underscores the study's contribution to the body of knowledge on e-health, acknowledges the study's limitations, and finally, concludes with suggestions for further research.

CHAPTER EIGHT CONCLUSIONS

This chapter discusses in brief the inferences and conclusions from this research and thus completes phase 3 of this research. The findings that provide answers to the research questions raised in phase 1 are summarized and the implications of these findings are discussed. The chapter, moreover, highlights the significance and relevance of this study, and its contribution to the body of knowledge on e-health. Finally, the limitations of this study are acknowledged and suggestions for further research are offered.

8.1 Summary of Key Findings: Answers to Research Questions

Research Question 1 (RQ1): *Who are the key players in a patient-centric e-health ecosystem and what are the potential values they can create and capture through digital data flows?*

8.1.1 Key Players

The findings from the case studies confirm five of the six categories of key players identified in the conceptual model, namely Providers, Payers, Vendors, Regulators and Infomediaries. The sixth player, originally identified as Patients / Consumers in the conceptual model, eventually came to be relabelled 'Citizens' upon validation of the conceptual model using the case studies of Singapore's NEHR and the US' HITECH program. It was observed that e-health initiatives in either case were directed towards a more comprehensive group of stakeholders who could be appropriately termed citizens rather than patients or healthcare consumers. The decision to rename the sixth player was also made by way of acknowledging the value that accrues from population health management and preventive healthcare activities which improve health outcomes on the one hand and reduce healthcare costs on the other. In a way, this has caused a paradigm shift - from patient- or consumer centricism to citizen-centricism.

As for the other five categories of players, they are no doubt observable in either case study with the exception of the category Payers in the case of Singapore. However, these various players are not well-connected on a unified platform as envisaged in the conceptual model. This may be attributed to the fact that both the ecosystems are still evolving. Moreover, to forge connections

among the key players and foster sharing of health information among these players, the participation and cooperation dilemmas discussed in the conceptual model and observed to be at play in both the cases need to be resolved. For this to happen, recognized interoperability standards must be promoted, adopted and implemented. And, more importantly, there must be a clear mandate from the government to drive e-health.

8.1.2 Values Created and Captured

In view of the facts mentioned in 8.1.1, it may be observed that the potential for the key players to create and capture the significant values identified in the conceptual model can only be partially realized as at this point of time. It may be recalled that **section 4.1.5**, 'Value Analysis of the E-Health Ecosystem', presented an analysis of the significant values that can be potentially generated in a well-connected e-health ecosystem. However, the findings from the two case studies reveal that both ecosystems have yet to develop the level of connectedness required for the value flows envisaged in the conceptual model to be realized.

In Singapore, the NEHR connects the public sector healthcare providers and just a section of the primary healthcare providers in the private sector. Given that 80% of primary healthcare is provisioned by private healthcare providers, it needs to be said that the integration of the healthcare system which actually begins at the level of primary care, is at risk. This diminishes the possibility for a longitudinal health record to be created. A longitudinal health record supports a continuum of care by facilitating health data exchange and reuse across the entire spectrum of healthcare providers in both the public and private sectors. Significant values that can be generated in an e-health ecosystem on account of a longitudinal health record are lost as a result. The emerging infomediary namely HealthCloud attempts to bring together various categories of players such as the Patients, Providers, Regulators and Vendors, but how well and when connectivity among all these players will be enabled is still unclear at this point in time. It also remains to be seen if Payers will be included in the ecosystem at a later point of time. More significant values can be created only if all the above discussed player categories are made part of the ecosystem with connectivity forged among them. The ecosystem will then

possess the capability to stimulate transparency, competition, cooperation and accountability among the various players, which in turn, will empower consumers by promoting awareness and choices.

In the US, many of the significant values identified in the conceptual model are observed in the ecosystem. However, these values exist at various levels and in a variety of business models, owing to the country's highly fragmented healthcare system that is dominated by private healthcare providers. Many of these values are often restricted to 'narrow networks', that are reluctant to share patient data with other competing networks. This has led to a narrow set of transactions taking place within these networks as against the vast potential of a well-connected e-health ecosystem to support more broad-based and meaningful transactions. As a consequence, the possibility of a longitudinal health record for healthcare consumers, a prerequisite to support continuity of care, is very much endangered. Attempts are underway to bring all these values onto a unified platform namely the eHealth Exchange, so as to form a nationwide health information exchange. With about 50% of the US hospitals and more than 100 million patients already on board the platform, the challenge for eHealth Exchange lies in getting the remaining players on board. This can be accomplished only if connectivity among the smaller units of HIEs at the regional / community levels is achieved.

Research Question 2 (RQ2): *What are the critical success factors for developing a sustainable patient-centric e-health ecosystem?*

The cross-case analysis of the two unfolding national-level e-health initiatives in Singapore and the US presented in Chapter Seven, sheds light on the critical success factors that must be taken into account for developing a sustainable e-health ecosystem. It facilitates as well a grasp of the key issues surrounding e-health implementations and an understanding of the ways these issues can be tackled and resolved.

The two cases studied have significantly focused on the need for e-health initiatives to be undertaken on a national scale and made citizen-centric. A key aspect of such a citizen-centric e-health initiative would be putting in place a longitudinal health record for citizens who are the ultimate beneficiaries of healthcare. A longitudinal health record should among other things be interoperable facilitating in the process ease and convenience of exchange and

reuse of health information among the various stakeholders. The case studies show that what is primarily needed to make this happen is a clear vision and mandate from the government concerned. The US government, for instance, adopted a carrot-and-stick approach in respect of EHR adoption and use, which not only facilitated adoption and use of the EHR technology, but also accelerated the process of integrating healthcare services. In the case of Singapore however, for want of a clear mandate and well-defined incentives, EHR take-up among the private sector healthcare providers was much less than expected or hoped for.

It is thus evident that government intervention is crucial for initiating and developing an integrated, citizen-centric e-health. A citizen-centric e-health ecosystem is bound to generate a huge amount of health data and should therefore be designed to support an exponential growth of such data. This can be achieved best by using cloud technology which would likely ensure economy and scalability among other benefits. The huge quantum of data in the system thus designed may then be harnessed for big data analytics which has the potential to drive productivity, innovation, competition, accountability, new values and business models in healthcare.

8.2 Implications of the Present Study

The present study casts light on the key issues surrounding the design and implementation of e-health ecosystems, suggests how these issues may be addressed, and, finally, derives a critical success factor framework which is crucial for the success of e-health implementations. The larger picture that emerges from such a framework developed on the basis of lessons learnt from two case studies of national-level e-health implementations will likely benefit both ongoing and prospective e-health initiatives, particularly in developing countries that cannot afford the luxury of failed experiments.

Extrapolating the findings presented in the previous section, it may then be stated that any futuristic e-health ecosystem, needs to be a national-level system so as to be able to cater to its citizens, the ultimate beneficiaries of healthcare.

A citizen-centric ecosystem should:

- i) provide citizens with ubiquitous access to their longitudinal electronic health records and afford them the ability to co-create their health profiles;
- ii) connect citizens with all the other players that could possibly support them in their healthcare;
- iii) foster an environment that affords easy access to the information citizens need in order to help them arrive at carefully considered decisions regarding their healthcare;
- iv) reward the other players primarily on the basis of the value they create for the citizens;
- v) prevent players from commercially exploiting citizens' health data and ensure that the citizens' trust in the privacy and confidentiality of their health data is on no account compromised;
- vi) encourage citizens to play a more active role in their healthcare by creating health awareness and promoting preventive healthcare among them.

Such a citizen-centric e-health ecosystem can only be created by a neutral entity having no conflict of interests.

The natural candidate for this role is a country's government. Needless to say, no private entity would come forward to invest heavily in an ecosystem without expecting to capitalize on it and, possibly, without compromising on the interests of the citizens who are the sources of health data, a major asset in the ecosystem. Equally important to remember is the fact that the benefits that accrue from an exchange and reuse of health data cannot be harvested in full except through a mandate from the government with or without a provision for incentives. A citizen-centric e-health ecosystem should therefore be government-led and connect the citizens to the other players who support them in their healthcare such as the providers, vendors, and payers/insurers. Given the vast stores of data that will be available in the ecosystem, it may ideally be hosted on a cloud platform. In short, a sustainable e-health ecosystem will have to be citizen-centric, government-led and cloud-based.

8.3 Contributions of the Present Study

The present study highlights facets of e-health that have hitherto not been explored at all or explored only minimally. It may not be an exaggeration to say that the present study has succeeded in highlighting such crucial facets with a thoroughness not seen in earlier studies. Since 2000 when the term e-health was coined, a fairly large number of studies have emerged: some focusing largely on the relevance of health e-commerce for e-health business models (Parente, 2000; Aggrawal & Travers, 2001; Joslyn, 2001; Wen & Tan, 2003); some examining the potential values that HIEs could create in healthcare by functioning as intermediaries (deBrantes, Emery, Overhage, Glaser & Marchibroda, 2007); and some others highlighting the technical design aspects of the EHR (Raghupathi & Kesh, 2009; Paun et al., 2011). No doubt these studies were significant but the fact remains that they all centred around specific facets of e-health, without broaching the significant issue of a business model that could perpetuate significant values in the ecosystem.

On the other hand, there were also studies that drew attention to the lack of evidence in favor of EHRs (DesRoches et al., 2010; Wiedemann, 2012; Kellermann and Jones, 2013), and the lack of clarity in terms of how a health IT platform can be organized to facilitate an exchange of health information among the stakeholders (Hillestad, & Keeler, 2014; Bergmo, 2015).

From the above discussion, two clear observations emerge. First, most of the e-health-related studies are narrowly-focused on a select few facets of e-health without much reference to the larger picture of an e-health ecosystem. Second, there is still a lack of demonstrable evidence in terms of how e-health should be organized for viability and sustainability.

It is believed that the present study has made a key contribution by filling some of the above-mentioned gaps in e-health literature. The study has provided a deep insight into the broad range of issues involved in e-health adoption by key players. Some of the significant issues explored in this study are the participation and cooperation dilemmas faced by healthcare providers, lack of recognized interoperability standards to support seamless exchange and reuse of health data, absence of a clear mandate from the government and lack of government incentives to spur EHR adoption. The study moreover derived a critical success factor framework which can be utilized to proactively

conceptualize the impediments to sustainable e-health. Such a framework that is based on the successes and failures encountered in e-health initiatives in Singapore (a high-performing country in healthcare) and the US (a low-performing country in healthcare) will prove crucial for designing and implementing viable e-health ecosystems. The framework may particularly benefit developing countries which will sooner or later venture into e-health. A further important contribution of this study is the up-to-date, holistic overview it provides of the e-health ecosystems shaping up in Singapore and the US. All this put together may be said to have significantly added to the current body of knowledge.

8.4 Limitations of the Present Study

Before concluding this thesis, it is necessary to acknowledge some major limitations of this study. To begin with, the data from the field, though rich, was limited. Despite the effort made to systematically identify and reach out to as many potential informants as possible, the eventual response rate was less than desired. This may, to some extent, be attributed to the potential informants' lack of familiarity with the topic of e-health which, even today, is still evolving. To make up for the shortage of data from the field, a variety of documents had to be relied upon to develop as holistic a view on the topic of interest as possible. It is a matter of doubt, however, whether such a unified view of the topic could have been achieved even if more data through interviews had been made available. It may be pointed out that documents are also accepted as a major source of data in qualitative studies (Charmaz, 2014). As a matter of fact, documents, as sources of data, are perceived to be more objective and, therefore, more reliable than interviews (Charmaz, 2014).

Another limitation of the current study is that the digital flows in the ecosystem were not variously categorized into data, information and knowledge. Raw data, it may be pointed out, is typically captured as patient records either through a medical practitioner or sensors. This data has to be contextualized and, sometimes, analytics helps in transforming it into information. Knowledge would include the social capital of relationships among practitioners as well as among healthcare consumers in the social media. The present research does not adequately distinguish between the quality of

such data, information and knowledge, and does not take into account the fact that the upward transformation from data to information to knowledge may bring about higher value activities.

8.5 Suggestions for Further Research

- A suggestion for further work that emerges from the present study is the need for tracking the values created and enhanced as the digital flows transition from data to information to knowledge.
- Equally challenging would be the task to probe how Singapore's e-health ecosystem can help address the issues of high per capita out-of-pocket expenditure and rising hospital readmission rate. Given the country's ageing population and the impending silver tsunami, acquiring the capability to create and use big data to drive population health management initiatives is particularly important for Singapore. The silver tsunami confronting Singapore is predicted to place a huge strain on the country's public healthcare infrastructure which, at its current capacity can only meet one-fourth of the projected demand for hospital beds by 2030 (YahooNews, 2016). Preventive healthcare, an aspect of population health management, is hence crucial for Singapore, more so, because of the country's emphasis on personal responsibility for health. It may be recalled from the discussion in the previous chapter that the per capita out -of -pocket expenditure in Singapore is twice as much as that in the US and that the country's hospital readmission rate has steadily risen to a level comparable to that in the US. Hence research is much needed in the areas mentioned above.
- Yet another suggestion worth considering would be to organize a much larger study along similar lines so as to confirm the validity of the critical success factors of a sustainable e-health ecosystem as identified and highlighted in this research. Equally commendable would be an attempt to evolve alternative models of the e-health ecosystem based on big data and analytics.

It is hoped that the present study will help inspire improvements in the present model of e-health for the benefit of all stakeholders involved in the ecosystem. In the meanwhile, the inferences from this study give one ground to hope that a health cloud is not just a viable proposition, but one capable of

transforming the healthcare industry all over the globe, possibly culminating in 'collaboration for citizen-centric value' rather than 'competition for dollars'.

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APPENDICES

Appendix A. EXPERT INTERVIEW TEMPLATE

Dear Sir / Madam,

I am a doctoral student from Nanyang Technological University, Singapore. I am working in the area of e-health, and in particular, my research interest is in **e-health business models**. I have done some preliminary work on the e-health ecosystem, based on which I have identified the primary healthcare market players and the values they create* and capture* in the e-health market space. I am writing to seek help from knowledgeable practitioners like you, to validate my preliminary work which was primarily based on literature and industry observations. Such validation will help me focus my research efforts on the key players in e-health and the really critical issues facing them. I sincerely hope you will be able to assist me in this research.

Please let me have your judgment after carefully going through the background provided below.

I: E-Health ecosystem

The healthcare market has players at two levels – **primary** and **secondary**. At the primary level of the healthcare continuum are market players who use health information to provide patient care directly or indirectly (by supporting direct providers of patient care). These primary healthcare market players have been described in the table below:

Table A1.

Primary Healthcare Market Players

Players	Role
Patients	Recipients of health services, often labeled by their financial status: insured or uninsured, privately or publicly insured, with or without financial assets, etc. for the purposes of Financial Case Management ¹ and Clinical Case Management ² (Busch, 2008).
Providers	Any clinical setting and professional staff that designs, implements, and/or executes any healthcare initiative which may be part of a wellness or illness program (Busch, 2008).
Third-Party Vendors	A large group of diverse market players who play a supporting role to the Providers in their provision of healthcare. These players include health IT vendors, medical equipment vendors, pharmaceutical vendors, transportation services, laboratories, legal systems, billing agents etc. (Busch, 2008).
Payers	Any entity that processes the claims payment transactions of healthcare episodes on behalf of plan sponsors. A plan sponsor is an entity that funds a health program – private insurance plans, government-sponsored plans, employer-sponsored plans etc. (Busch, 2008).
Infomediaries	Organizations that gather pertinent health information from various sources, and syndicate, aggregate and distribute it to foster patient-centric health care (Busch, 2008; Morales-Arroyo & Sharma, 2009).
Regulators	Public and private organizations that develop capabilities for standards-

¹ Discipline of creating a financial plan to meet the patient’s healthcare needs (Busch, 2008)

² Includes current healthcare initiatives and past treatment regimes (Busch, 2008)

	based, secure and confidential exchange of health information to improve the coordination of care among the e-health market players (Blumenthal, 2009).
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*The terms “value created” and “value captured” are defined on page 3, in section **Background II**.

Secondary market players on the other hand, use health information in roles other than direct and indirect patient care activities. These are public and private organizations focusing on public health, patient autonomy and clinical case management activities (Busch, 2008).

Based on this background, we have attempted to diagrammatically represent the e-health ecosystem which is as shown in Figure 1.



Figure A0.1. E-Health Ecosystem

Questions:

In your judgment, would you agree with our identification of the six primary healthcare market players? Please point out any omissions or redundancies and state your reason(s) correspondingly.

Does the e-health ecosystem above adequately model reality?

Would it be a fair assessment to state that e-health would only work if it brings about cost efficiency as well as improved services?

II: Value created vs. value captured by primary healthcare market players

Value is “created” when a player develops its core competencies, capabilities and advantages to perform work activities that differentiate it from competitors, and “captured” when the firm derives economic returns in relation to the value it creates (Shafer, Smith, & Linder, 2005).

In the context of e-health, every player in e-Health “creates a value” that benefits other players, thereby giving rise to a compelling proposition in the e-health market space to collaborate to “create and capture value” rather than “compete for dollars”. However the outcomes of such a proposition may vary from player to player, thus begging the question if the “value captured” justifies the “value created”, for all the players involved.

For a sustainable e-health market space, it is critical that the participation of each player be justified in “creating” values for the network in exchange for a compelling value that can be “captured” from the network.

Table A2.

Value Created Vs. Value Captured

Primary Healthcare Market Players	Value created	Value captured
1. Patients	<ul style="list-style-type: none"> <input type="checkbox"/> Health data (Neupert, 2009) <input type="checkbox"/> Personal health records (Peters et al., 2009) <input type="checkbox"/> Healthcare ecommerce (B2C, C2C) (Parente, 2000; Eysenbach, 2001) 	<ul style="list-style-type: none"> <input type="checkbox"/> Ubiquitous access to health records (Burkhard, 2009) <input type="checkbox"/> Patient-centric healthcare (Burkhard, 2009) <input type="checkbox"/> Increased healthcare choices (Joslyn, 2001) <input type="checkbox"/> Lower healthcare costs (Wen & Tan, 2003) <input type="checkbox"/> Empowerment to make informed choices (Purcarea, 2009)
2. Providers	<ul style="list-style-type: none"> <input type="checkbox"/> Electronic medical / health records (Hill et al., 2007) <input type="checkbox"/> Improved quality of care (Walker et al., 2005) <input type="checkbox"/> Tele-healthcare delivery (Hill & Powell, 2009) <input type="checkbox"/> Evidence-based medicine (Busch, 2008) <input type="checkbox"/> Preventive healthcare (Chang et al., 2009) <input type="checkbox"/> Medical informatics (Raghupathi & Kesh, 2009) <input type="checkbox"/> Reduced medical errors (Vishwanath & Scamurra, 2007) 	<ul style="list-style-type: none"> <input type="checkbox"/> Improved operational efficiencies (Wen & Tan, 2003) <input type="checkbox"/> Enhanced cost-effectiveness (Vishwanath & Scamurra, 2007) <input type="checkbox"/> Training and education of physicians (Wickramasinghe, Fadlalla, Geisler, & Schaffer, 2005) <input type="checkbox"/> Cost-effective e-procurement of medical supplies (Wen & Tan, 2003) <input type="checkbox"/> New business opportunities created by the eHealth network (B2B, B2C) (Parente, 2000)
3. Third-Party	<ul style="list-style-type: none"> <input type="checkbox"/> Direct access to products / 	<ul style="list-style-type: none"> <input type="checkbox"/> Electronic interface to access and

Vendors	<p>services by customers (Wen & Tan, 2003)</p> <ul style="list-style-type: none"> □ Targeted marketing facilitated by data aggregation (Parente, 2000) 	<p>target the gamut of healthcare customers - healthcare providers, patients, insurers etc. (Wen & Tan, 2003)</p> <ul style="list-style-type: none"> □ Decreased marketing costs (Wen & Tan, 2003) □ Reduced R & D costs (Wen & Tan, 2003) □ Increased business opportunities (B2B, B2C etc.) due to direct access to a large pool of healthcare customers (Payton, 2003)
4. Payers	<ul style="list-style-type: none"> □ Electronic interface for claims management (Walker et al., 2005) □ Electronic interface for direct purchase of plans by customers bypassing agents (Whitten et al., 2001) <ul style="list-style-type: none"> □ Research and analytics facilitated by data aggregation (Wen & Tan, 2003) □ Targeted information delivery to customers facilitated by data aggregation (Parente, 2000) 	<ul style="list-style-type: none"> □ Improved efficiency in claims handling (Wen & Tan, 2003) □ Cost savings (Walker et al., 2005) □ Easier implementation of healthcare regulations (Wen & Tan, 2003) □ Increased business opportunities (B2B, B2C etc.) due to direct access to a large pool of healthcare customers (Parente, 2000)
5. Infomediaries	<ul style="list-style-type: none"> □ Total digital health systems (Raghupathi & Kesh, 2009) □ A digital platform to facilitate exchange and reuse of health data among players in the healthcare market (Raghupathi & Kesh, 2009; Morales-Arroyo & Sharma, 2009) □ Improved efficiencies for players in the healthcare market (Wen & Tan, 2003) □ Reduced costs for players in the healthcare market (Wen & Tan, 2003) 	<ul style="list-style-type: none"> □ New markets brought about by syndication, aggregation and distribution of health data (Morales-Arroyo & Sharma, 2009) □ New business opportunities and revenues to be tapped in the form of subscription fees, advertisement revenues, ecommerce transactions (Parente, 2000)
6. Regulators	<ul style="list-style-type: none"> □ Improvement in quality of healthcare (Blumenthal, 2009) □ Regulations to protect privacy / security of health data (Blumenthal, 2009) □ Standards for interoperable healthcare systems to facilitate exchange and reuse of health data (Goldstein, 2009) 	<ul style="list-style-type: none"> □ Improved health of populations (Blumenthal, 2009) □ Improved efficiency of healthcare systems (Blumenthal, 2009) □ Lower healthcare expenditure (Hill & Powell, 2009)

Questions:

The following questions pertain to Table 2.

Do you think we have adequately identified the sources of values **created** and **captured** by the six primary healthcare market players? If not, please state the player(s) and specify your reason(s).

Do you think the “value created” is *typically greater than* the “value captured” for any of the six players? Please state the player(s) and specify your reason(s).

Do you think the “value created” is *typically less than* the “value captured” for some players? Please state the player(s) and specify your reason(s).

In your judgement, who among the six players *captures the greatest value* from e-health? And who *creates the greatest value*?

In your judgement, who among the six players *captures the least value* from e-health? And who *creates the least value*?

Creating more value than a player captures is not sustainable. Do you agree?

Capturing more value than a player creates may be profitable for a given time, but not sustainable in the long run. Do you agree?

The e-health eco-system can grow only if there is fairness and efficiency. Do you agree?

Thank you for sharing your expert views.

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Appendix B. EXPERT INTERVIEWS CODING SCHEME

I. E-Health Ecosystem

I. Q1: In your judgement, would you agree with our identification of the six primary healthcare market players? Please point out any omissions or redundancies and state your reason(s) correspondingly.

S/N	Expert Response	Code
1	Yes, I do agree with the market players. I guess Patient would be just one of the category in another broader category of Recipients. So I think it would be appropriate if you can name the category differently for e.g. Recipients or Customers/Consumers. I suggested this as not all the recipients are actually patients.	AGREE WITH SIX PRIMARY PLAYERS IDENTIFIED HEALTHCARE CONSUMERS MORE INCLUSIVE THAN PATIENTS
2	Not sure if Infomediaries are necessary. In my opinion primary players are the State, Employers and the Society. Employers gain productivity through surveillance.	INFOMEDIARIES NOT A KEY PLAYER.
3	Yes	AGREE WITH SIX PRIMARY PLAYERS IDENTIFIED.
4	Also need to consider research institutions, medical education systems, Universities, scientists – they seem to affect patient care directly with their treatment options.	AGREE WITH SIX PRIMARY PLAYERS IDENTIFIED. RESEARCH INSTITUTES, UNIVERSITIES ALSO KEY PLAYERS
5	The six players identified covers in concept the entities that participate in the primary healthcare market	AGREE WITH SIX PRIMARY PLAYERS IDENTIFIED
6	You may want to include Next-of-Kin (NOK) who companied their parents or friends to seek treatment. Especially, those who are elderly, information (treatment plan) usually flow to NOK rather than the patients. Most of the time, it is the NOK who make the decision on behalf of the patients.	AGREE WITH SIX PRIMARY PLAYERS IDENTIFIED. NEXT-OF-KIN ALSO A KEY PLAYER
7	I would put pharmaceuticals as a separate category as a primary healthcare player, given their direct impact on healthcare in drugs provision and price management.	AGREE WITH SIX PRIMARY PLAYERS IDENTIFIED. PHARMACEUTICALS ALSO A KEY PLAYER.
8	Your primary market is all right (that is you have rightly identified the ‘players’) but your secondary market you have identified the	AGREE WITH SIX PRIMARY MARKET PLAYERS IDENTIFIED

S/N	Expert Response	Code
	'games' rather than the 'players'.	SECONDARY MARKET PLAYERS ARE JUST FUNCTIONS THAN ROLES.
9	In general Yes, however, overlapping roles are found. Depending on level of detail, providers can also be Infomediaries as can the Government.	AGREE WITH SIX PRIMARY MARKET PLAYERS IDENTIFIED OVERLAPPING ROLES FOUND
10	Yes	DEPENDING ON LEVEL OF DETAIL PROVIDERS CAN PLAY ROLE OF INFOMEDIARIES AGREE WITH SIX PRIMARY MARKET PLAYERS IDENTIFIED.
11	No. There are levels of data use, but the levels can & should be separated along personal/functional lines: between patient and care providers, patient and specific direct-care "vendors" (this is a vague term). Regulators should NEVER have access to personal health data unless in the aggregate. Vendors generally should not have full access to all health data, but may have access to select relevant-to-activity information. Payers should be separated from health data in ways that promote efficiency of care, not efficiency of payer metrics. So Primary market players should be limited to patients and doctors/care providers, and possibly patient-centric Infomediaries (not industry or legislative). Secondary market players are most vendors, regulators, industry-level Infomediaries, and others that you have listed on that level.	DO NOT AGREE WITH SIX PRIMARY MARKET PLAYERS IDENTIFIED PERSONAL HEALTH DATA IS SENSITIVE. ACCESS TO HEALTH DATA MUST BE WELL DEFINED AND CONTROLLED.
12	"Patients" is a narrow definition. "Provider" should include patients, their family and sometimes their domestic helpers too as they play an active role in their healthcare. Research institutes and universities need a special mention.	THE TERM 'PATIENT' IS NARROW. PATIENTS, THEIR FAMILY, AS WELL AS HELPERS CAN ALSO BE CONSIDERED AS PROVIDERS. RESEARCH INSTITUTES,

S/N	Expert Response	Code
		UNIVERSITIES ARE ALSO KEY PLAYERS.

I. Q2: Does the e-health ecosystem above adequately model reality?

S/N	Expert Response	Code
1	Yes, the model captures almost all the aspects of the ecosystem.	CLOSE TO REALITY
2	To some extent	CLOSE TO REALITY
3	Yes	MODELS REALITY
4	Yes	MODELS REALITY
5	In essence, Yes.	MODELS REALITY
6	There is a trend driving into population health, I don't know how your model will fit it. Patients → Hospital → GP/Polyclinic/Step-community hospital → Homecare Hospitals are decanting stable patients back into community to avoid choking up the hospital resources.	DOES NOT DIRECTLY MODEL SINGAPORE. DOES NOT CONSIDER POPULATION HEALTH.
7	-	NO RESPONSE
8	I feel the model is very USA specific.	CLOSE TO USA.
9	In general Yes, however, overlapping roles are found. Depending on level of detail, providers can also be Infomediaries as can the Government.	MODELS REALITY. OVERLAPPING ROLES FOUND.
10	Yes	MODELS REALITY
11	No. There are two realities: the current model in the US (which is largely driven by industry interests, not the health of the nation's citizenry) and a more ideal state as modeled by other countries, including Canada. It's important for you to make clear if you're working toward an extension of the current industry-centric model or otherwise.	NEED TO CLARIFY IF THE MODEL IS AN EXTENSION OF CURRENT MODEL IN THE UNITED STATES.
12	"Provider" should capture the whole range including traditional providers e.g. TCM practitioners, acupuncturists, etc.	MODELS REALITY. INCLUDE INFORMAL PROVIDERS.

I. Q3. Would it be a fair assessment to state that e-health would only work if it brings about cost efficiency as well as improved services?

S/N	Expert Response	Code
1	I wouldn't fully agree with the statement. E-Health is actually pretty broad a word and classifies many more things than only the patient doctor relation which is the main place where the cost comes in picture. I	DO NOT FULLY AGREE. E-HEALTH A BROAD TERM. COVERS MORE THAN PATIENT-

S/N	Expert Response	Code
	would see the ecosystem to be more of a platform for “Continuing Medical Education” concept. It enables the R&D of a lot more than just patient care.	DOCTOR RELATIONSHIP PLATFORM PLATFORM SHOULD SUPPORT CONTINUING MEDICAL EDUCATION AND R&D DO NOT AGREE
2	No. Does not capture the externalities related to a healthy population. E.g. chronic disease prevention, disease management & control, and wellness.	E-HEALTH SHOULD ADDRESS POPULATION HEALTH ISSUES - WELLNESS, PREVENTION, DISEASE MANAGEMENT
3	Yes	E-HEALTH WORKS WELL WHEN IT IS COST EFFICIENT WITH IMPROVED SERVICES.
4	Absolutely Must	E-HEALTH WORKS WELL WHEN IT IS COST EFFICIENT WITH IMPROVED SERVICES.
5	For e-health to work, the various key stakeholders must achieve some forms of wins. For example, patients must benefit from the implementation (e.g. improved level and quality of care), vendors must have sustainable recurring revenue etc. The benefits must be enjoyed across the spectrum or compensated by another entity (e.g. the Govt. paying for the infrastructure. Even this must translate to benefits like ability to utilise data for diseases trending or sharing of medical records across different providers to achieve a consistent health/medical record for the patient).	E-HEALTH WORKS WELL WHEN IT IS COST EFFICIENT WITH IMPROVED SERVICES. MUST BE A WIN-WIN ARRANGEMENT FOR ALL STAKEHOLDERS EXCHANGE AND REUSE OF HEALTH DATA
6	Not necessarily	DO NOT FULLY AGREE SERVICE IMPROVEMENT IS CRUCIAL.
7	Definitely a valid assumption, given any business model will work only if there is cost efficiency. It is important to note that cost efficiency does not mean zero cost to the patients. Many models have shown that patients are willing to pay a premium for improved, personalised healthcare services.	E-HEALTH WORKS WELL WHEN IT IS COST EFFICIENT WITH IMPROVED SERVICES. EFFICIENCY DOES NOT MEAN ZERO COST TO PATIENTS. PATIENTS MAY BE WILLING TO PAY A PREMIUM FOR VALUE.

S/N	Expert Response	Code
8	Cost will always be an issue as far as healthcare is concerned, and you will never get any buyer if you ask for a trade-off for lower costs but poorer services. So, both need to be looked into, that is improved services at lower costs (higher cost-efficiency). The question now is whether the healthcare system can recover the IT investments that need to be made through highly efficient and improved services.	E-HEALTH WORKS WELL WHEN IT IS COST EFFICIENT WITH IMPROVED SERVICES. ROI FOR PROVIDERS MUST BE ADDRESSED.
9	No. Decision for e-health is a political one. Yes, at the provider level and would add the ability to carry out research.	E-HEALTH IS A POLITICAL DECISION.
10	In Order for the E Health to work, it must bring down the cost of health care in the remote area and also improve the services. Otherwise, it may not work as people see no value in using E Health. This is the main reason why E-Health is not commonly used now.	E-HEALTH WORKS WELL WHEN IT IS COST EFFICIENT WITH IMPROVED SERVICES.
11	No. E-health will be enacted in multiple ways whether it brings efficiencies in cost and services, or not. Right now there are myriad models extending the reach of different power bases without any efficiencies being realized by both sides. In fact, some industry players (insurance companies, for example) are pushing doctors' offices to comply with requirements that are tremendously burdensome on the doctors' offices.	COST EFFICIENCY AND SERVICE IMPROVEMENT DEPENDS ON THE BUSINESS MODEL ROI FOR PROVIDERS MUST BE ADDRESSED.
12	Not necessarily. It should be economically sustainable and adds value. E-Health would work (equitable). Aggregate benefits to society.so long as the nett benefit to the society is positive, e-health should work. Provider loses out even in "steady-state" (not just in the initial stage). Govt. should subsidise EHR investment costs.	DO NOT FULLY AGREE E-HEALTH WORKS WHEN THE AGGREGATE BENEFITS TO SOCEITY IS POSITIVE. ROI FOR PROVIDERS MUST BE ADDRESSED. GOVERNMENT MUST SUBSIDISE INVESTMENT COSTS.

II. Value Created versus Value Captured by Players

II. Q1. Do you think we have adequately identified the sources of values **created** and **captured** by the six primary healthcare market players? If not, please state the player(s) and specify your reason(s).

S/N	Expert Response	Code
1	<p>Yes, the value created and captured seem to be very good. I would still suggest the below:</p> <ol style="list-style-type: none"> 1. For the patient I think it would be good if you can outline the cost and time effectiveness including the fact that the service can be global (Anytime – Anywhere). 2. For the providers this can be another very good platform for Education. 	<p>IDENTIFIED SOURCES OF VALUES CREATED AND CAPTURED ARE ADEQUATE</p> <p>INCLUDE COST AND TIME EFFECTIVENESS AND UBIQUITOUS ACCESS AS VALUES CAPTURED FOR PATIENTS</p> <p>CAN SERVE AS A PLATFORM TO EDUCATE PROVIDERS</p>
2	Providers – Prevention and wellness	PREVENTION AND WELLNESS VALUES CREATED BY PROVIDERS
3	Yes	IDENTIFIED SOURCES OF VALUES CREATED AND CAPTURED ARE ADEQUATE
4	Yes	IDENTIFIED SOURCES OF VALUES CREATED AND CAPTURED ARE ADEQUATE
5	On a whole, the key values are presented above	IDENTIFIED SOURCES OF VALUES CREATED AND CAPTURED ARE ADEQUATE
6	<p><u>Provider:</u> Value created/Captured: - Proven Care Community Care /Primary Care / Population Health Value created: Faster Care (Reduce appointment wait time if these stable patients can be seen back in the community) Value captured: Able to provide care for much needed/urgent cases</p>	<p>IDENTIFIED SOURCES OF VALUES CREATED AND CAPTURED ARE ADEQUATE</p> <p>CAPABILITY TO PRIORITIZE ATTENTION TO MORE DESERVING CASES</p>
7	-	NO RESPONSE
8	-	NO RESPONSE
9	Yes, if it was so straight forward, why hasn't EMR actually happened?	IDENTIFIED SOURCES OF VALUES CREATED AND CAPTURED ARE ADEQUATE
10	Yes	EMR IS A FAILURE IDENTIFIED SOURCES OF VALUES CREATED AND CAPTURED ARE

11	No. E-health is a broad ecosystem where the values created and captured are yet to be discovered. For example, patients can recognize the benefits (value) of having better access to more information about their own diseases, and can (and do) add to community-based research and discovery about possible and alternative treatments. This widens their choice of treatments and providers that's possibly outside the scope of Jocelyn or Purcurea.	ADEQUATE SOME VALUES YET TO BE DISCOVERED CO-CREATION OF VALUE BY PATIENTS ALTERNATIVE MEDICINE
12	Yes. Suggest to be more explicit in terms of beneficiaries of value created and captured.	IDENTIFIED SOURCES OF VALUES CREATED AND CAPTURED ARE ADEQUATE IDENTIFY THE BENEFICIARIES

II. Q2. Do you think the “value created” is *typically greater than* the “value captured” for any of the six players? Please state the player(s) and specify your reason(s).

S/N	Expert Response	Code
1	No, it looks pretty fine and well defined.	VALUE CAPTURED CORRESPONDS WITH VALUE CREATED
2	Everyone captures more value than they create	VALUE CAPTURED CORRESPONDS WITH VALUE CREATED
3	None	VALUE CAPTURED CORRESPONDS WITH VALUE CREATED
4	Providers – from adopting an e-health mode of treatment delivery they are yet to reap the full benefits of the high investments. E-health at this point in time is yet to evolve to preserve the productivity of providers.	PROVIDERS CAPTURE LESS VALUE THAN THEY CREATE PROVIDERS INCUR HIGH INVESTMENT COST
5	The value created can only be quantified when it is utilised in the correct context. It is difficult to determine for sure if the value created is greater than value captured without a suitable context provided.	DIFFICULT TO DETERMINE WITHOUT CONTEXT
6	No comments.	NO COMMENTS
7	There needs to be more discussion on the measurement of value created or captured. For example, market supply and demand is a dynamic factor and plays a role in establishing that 'value', besides clinical and	DIFFICULT TO DETERMINE WITHOUT CONTEXT

S/N	Expert Response	Code
	economic outcomes.	
8	-	NO RESPONSE
9	-	NO RESPONSE
10	Yes, the value created for the patients will be bigger than value captured as they will then be able to assess to different providers of the health care.	PROVIDERS CAPTURE LESS VALUE THAN THEY CREATE PROVIDERS INCUR HIGH INVESTMENT COST
11	That depends on politics. Right now our system in the US is heavily weighted toward industry benefits and away from patient value and care.	VALUE AND CARE ARE NOT IN FAVOUR OF PATIENTS IN THE US DUE TO POLITICAL FACTORS.
12	Providers create more value than they capture because of EHR investments.	PROVIDERS CAPTURE LESS VALUE THAN THEY CREATE PROVIDERS INCUR HIGH INVESTMENT COST

II. Q3. Do you think the “value created” is *typically less than* the “value captured” for some players? Please state the player(s) and specify your reason(s).

S/N	Expert Response	Code
1	No, Same as before it is well captured.	VALUE CAPTURED CORRESPONDS WITH VALUE CREATED
2	No	VALUE CAPTURED CORRESPONDS WITH VALUE CREATED
3	None	VALUE CAPTURED CORRESPONDS WITH VALUE CREATED
4	At a certain level, Health IT companies (EHR vendors) have as yet to integrate fully with other legacy or administration systems – compartmentalization within hospital systems exist.	EHR VENDORS ARE CAPITALISING ON LACK OF INTEROPERABILITY ACROSS SYSTEMS WITHIN HOSPITALS
5	The value created can only be quantified when it is utilised in the correct context. It is difficult to determine for sure if the value created is greater than value captured without a suitable context provided.	DIFFICULT TO DETERMINE WITHOUT CONTEXT
6	No comments.	NO COMMENTS
7	-	NO RESPONSE
8	-	NO RESPONSE
9	-	NO RESPONSE

S/N	Expert Response	Code
10	-	NO RESPONSE
11	That depends on politics. Right now our system in the US is heavily weighted toward industry benefits and away from patient value and care.	VALUE AND CARE ARE NOT IN FAVOUR OF PATIENTS IN THE US DUE TO POLITICAL FACTORS.
12	Patients are the ultimate beneficiaries of e-health. They create least value than they capture.	PATIENTS ARE THE ULTIMATE BENEFICIARIES. PATIENTS CREATE LEAST VALUE THAN THEY CAPTURE.

II. Q4. In your judgement, who among the six players *captures the greatest value* from e-health? And who *creates the greatest value*?

S/N	Expert Response	Code
1	I would give this both to the Care Receivers as they are the key players in this ecosystem with the support from the providers. All the other players play the supporting part in the system.	PATIENTS CREATE AND CAPTURE GREATEST VALUE.
2	a. Providers b. Providers	PROVIDERS CREATE AND CAPTURE GREATEST VALUE.
3	As a third-party vendor, I would be tempted to say we create the greatest value. This is because, we are the conduit thru which the services reach the patients in the most effective and efficient manner	THIRD-PARTY VENDORS CREATE THE GREATEST VALUE.
4	Patient captures greatest value – nothing compares to being able to get better health options with e-health- beats hands down any profits that may be earned by any other entity. At this point in time, regulators/Government create maximum value until indices begin to show better health values because of the adoption of e-health.	PATIENTS CAPTURE GREATEST VALUE. REGULATORS CREATE GREATEST VALUE AS THEY INITIATED E-HEALTH ADOPTION.
5	This is really subjective as it depends on different healthcare system. E.g. If a pharmaceutical company obtains the information and utilised the data to determine what sort of drugs are commonly used in a certain region, proceeds to produce in bulk as to lower cost, this is beneficial. However, if the pharmaceutical company utilised the data to then create novelty drugs that serves the same for lesser purposes just	GREATEST VALUE CREATED OR CAPTURED DEPENDS GREATLY ON THE MOTIVE OF THE PLAYERS.

S/N	Expert Response	Code
	to utilised revenue (e.g. make certain drugs less effective so the dosage will increase etc.), then it is not beneficial.	
6	Patient captures greatest value from e-health. Provider creates the greatest value.	PATIENTS CAPTURE GREATEST VALUE. PROVIDERS CREATE GREATEST VALUE.
7	-	NO RESPONSE
8	-	NO RESPONSE
9	Patients and Public	PATIENTS CAPTURE GREATEST VALUE.
10	The patients will capture the greatest values. If the E Health works really well, the government will create the greatest value for them as it will lower the overall cost of the public health care.	PATIENTS CAPTURE GREATEST VALUE. REGULATORS CREATE GREATEST VALUE AS THEY INITIATED E-HEALTH ADOPTION.
11	-	NO RESPONSE
12	a. Patients (followed by Vendors) b. Providers (primary healthcare sector)	PATIENTS CAPTURE GREATEST VALUE. PROVIDERS CREATE GREATEST VALUE.

II. Q5. In your judgement, who among the six players *captures the least value* from e-health? And who *creates the least value*?

S/N	Expert Response	Code
1	Infomediaries creates the least value and Regulators Capture the least value.	REGULATORS CAPTURE LEAST VALUE. INFOMEDIARIES CREATE LEAST VALUE.
2	a. Regulators b. Patients	REGULATORS CAPTURE LEAST VALUE. PATIENTS CREATE LEAST VALUE.
3	The regulators perform several overlapping functions and hence create the least value.	REGULATORS CAPTURE LEAST VALUE.
4	Payers create least value – adoption of e-health and other technologies have not reduced cost of healthcare to the patient, premiums still growing, benefits shrink.	NO RESPONSE NO RESPONSE PAYERS CREATE LEAST VALUE.

5	This is really subjective as it depends on different healthcare system. E.g. If a pharmaceutical company obtains the information and utilised the data to determine what sort of drugs are commonly used in a certain region, proceeds to produce in bulk as to lower cost, this is beneficial. However, if the pharmaceutical company utilised the data to then create novelty drugs that serves the same for lesser purposes just to utilised revenue (e.g. make certain drugs less effective so the dosage will increase etc.), then it is not beneficial.	LEAST VALUE CREATED OR CAPTURED DEPENDS GREATLY ON THE MOTIVE OF THE PLAYERS.
6	Payers capture the least value from e-health. Infomediaries create the least value.	PAYERS CAPTURE LEAST VALUE. INFOMEDIARIES CREATE LEAST VALUE.
7	-	NO RESPONSE
8	-	NO RESPONSE
9	Providers create/capture least value in the fee-for-service model	PROVIDERS CREATE/CAPTURE LEAST VALUE IN FEE- FOR-SERVICE MODEL.
10	Infomediaries capture the least value from E-Health. The patient creates the least value	INFOMEDIARIES CAPTURE LEAST VALUE. PATIENTS CREATE LEAST VALUE.
11	-	NO RESPONSE
12	a. Providers b. Patients (followed by vendors if unsuccessful)	PROVIDERS CAPTURE LEAST VALUE. PATIENTS CREATE LEAST VALUE.

II. Q6. Creating more value than a player captures is not sustainable. Do you agree?

S/N	Expert Response	Code
1	No, I would say it creates an imbalance but is still sustainable.	CREATING MORE VALUE THAN THAT CAPTURED BY A PLAYER IS SUSTAINABLE DESPITE CREATING AN IMBALANCE
2	Yes	CREATING MORE VALUE THAN THAT CAPTURED BY A PLAYER IS NOT SUSTAINABLE.

3	Yes	CREATING MORE VALUE THAN THAT CAPTURED BY A PLAYER IS NOT SUSTAINABLE.
4	Yes	CREATING MORE VALUE THAN THAT CAPTURED BY A PLAYER IS NOT SUSTAINABLE.
5	It really depends on what value is being created.	SUSTAINABILITY OF E-HEALTH ECOSYSTEM DEPENDS ON WHAT VALUE IS BEING CREATED.
6	Yes	CREATING MORE VALUE THAN THAT CAPTURED BY A PLAYER IS NOT SUSTAINABLE.
7	-	NO RESPONSE
8	-	NO RESPONSE
9	-	NO RESPONSE
10	Yes	CREATING MORE VALUE THAN THAT CAPTURED BY A PLAYER IS NOT SUSTAINABLE.
11	-	NO RESPONSE
12	Yes	CREATING MORE VALUE THAN THAT CAPTURED BY A PLAYER IS NOT SUSTAINABLE.

II. Q7. Capturing more value than a player creates may be profitable for a given time, but not sustainable in the long run. Do you agree?

S/N	Expert Response	Code
1	Yes, I do agree with this. It again creates an Imbalance but will stumble the ecosystem this time as the supporting players will find it hard to meet the challenge.	NOT SUSTAINABLE FOR A PLAYER TO CAPTURE MORE VALUE THAN IT CREATES
2	Yes	IMBALANCE IN ECOSYSTEM NOT SUSTAINABLE FOR A PLAYER TO CAPTURE MORE VALUE THAN IT CREATES
3	Yes	NOT SUSTAINABLE

		FOR A PLAYER TO CAPTURE MORE VALUE THAN IT CREATES
4	Yes, if market forces are allowed to have a free play and regulation (Government) is fair and equitable. Subsidies or cross subsidies can create this imbalance. In healthcare, there are reasons to believe social interests may play an important role from a regulator point of view than profits	NOT SUSTAINABLE FOR A PLAYER TO CAPTURE MORE VALUE THAN IT CREATES
5	It really depends on what value is being created.	SUSTAINABILITY OF E- HEALTH ECOSYSTEM DEPENDS ON WHAT VALUE IS BEING CREATED.
6	May not be applicable in Singapore context. 70% of patients are subsidised patients (the medical charges are subsidised by government).	NOT SUSTAINABLE FOR A PLAYER TO CAPTURE MORE VALUE THAN IT CREATES
7	-	NO RESPONSE
8	-	NO RESPONSE
9	-	NO RESPONSE
10	Yes	NOT SUSTAINABLE FOR A PLAYER TO CAPTURE MORE VALUE THAN IT CREATES
11	-	NO RESPONSE
12	No. As long as it is pareto-efficient (i.e. not worse off their status quo)	SUSTAINABLE FOR A PLAYER TO CAPTURE MORE VALUE THAN IT CREATES IF ECOSYSTEM IS PARETO-EFFICIENT.

II. Q8. The e-health eco-system can grow only if there is fairness and efficiency. Do you agree?

S/N	Expert Response	Code
1	Yes, Agree Fully.	GROWTH OF E-HEALTH ECO-SYSTEM POSSIBLE ONLY IF IT IS FAIR AND EFFICIENT
2	Yes	GROWTH OF E-HEALTH ECO-SYSTEM POSSIBLE ONLY IF IT IS FAIR AND EFFICIENT
3	Yes	GROWTH OF E-HEALTH ECO-SYSTEM POSSIBLE ONLY IF IT IS FAIR AND EFFICIENT

4	-	NO RESPONSE
5	The e-health eco-system will grow as long as the payer sees justification, the technology is suitable (need not be cutting edge) and the end-users are willing to adopt it.	GROWTH OF E-HEALTH ECO-SYSTEM POSSIBLE ONLY IF IT IS FAIR AND EFFICIENT
6	All your players need to be open and willing to share information. Too many silos within the healthcare system, even there's are silos within hospital.	SILOS IN HOSPITALS/HEALTHCARE SYSTEMS DETERIORATES GROWTH OF E-HEALTH ECO-SYSTEM.
7	Economic sustainability is critical to the growth of an ecosystem. EHealth is still in early stage, and new business models are still being developed. At the same time, a concerted effort by the government to establish basic infrastructure, standards and regulation will be necessary.	GOVERNMENT MUST SUBSIDISE INTIAL INVESTMENT.
8	-	NO RESPONSE
9	Suggest you link E-Health advances to reimbursement system	GROWTH OF E-HEALTH ECO-SYSTEM POSSIBLE ONLY IF IT IS FAIR AND EFFICIENT
10	Yes, and the government plays a key role in making it work.	GROWTH OF E-HEALTH ECO-SYSTEM POSSIBLE ONLY IF IT IS FAIR AND EFFICIENT
11	Again that depends on who is defining "fair" and "efficient."	PERSPECTIVE OF FAIRNESS AND EFFICIENCY VARIES FOR PLAYERS
12	Yes. Provided there is not a wide disparity in terms of values created and captured	GROWTH OF E-HEALTH ECO-SYSTEM POSSIBLE ONLY IF IT IS FAIR AND EFFICIENT

Appendix C. CASE STUDY INTERVIEW TEMPLATE

Date:

Name:

Company:

Designation:

Dear Sir / Madam,

I am a doctoral student from Nanyang Technological University, Singapore. I am working in the area of e-health, and in particular, my research interest is in determining the design characteristics of a successful **e-health business model**. I sincerely hope you will be able to assist me in this research.

1. What is the status of e-health in Singapore?
2. How would you describe your participation in / contribution to e-health in Singapore?
3. What are the challenges in implementing e-health in Singapore, in your opinion?
4. Who are the key stakeholders / players who should participate in e-health to harness the full benefits of e-health?
5. How can we encourage or ensure participation from these players?
6. How will e-health benefit its various stakeholders and most importantly, Singapore?

Thank you!

Appendix D. CASE STUDY INTERVIEWS CODING SCHEME

SINGAPORE

1. What is the status of e-health in Singapore?

Expert Response #1	Code
Singapore is faced with a 'silver tsunami' which is due to impact the city-state in the next couple of decades. This tsunami will result in severe bed / resource crunches in hospitals, affecting productivity. Considering that 80% of healthcare costs are incurred in the last few years of an individual's life time, healthcare's focus in Singapore has to shift towards providing better intermediate and long term care for the elderly. It is also very important to step up 'preventive healthcare' in preparation for an ageing population. This might mean ushering in 'Smart Homes' equipped with monitoring systems to enable management of chronic health conditions. Such 'Smart Homes' may be supported by Cloud, SaaS, and mobile technologies.	SILVER TSUNAMI WILL AFFECT HEALTHCARE PROUCTIVITY. 80% OF AN INDIVIDUAL'S HEALTHCARE COSTS IS INCURRED IN THE LAST FEW YEARS OF THEIR LIFE TIME. BETTER INTERMEDIATE AND LONG TERM CARE FOR ELDERLY. PREVENTIVE HEALTHCARE PREPARES FOR AGEING POPULATION
Another initiative towards this end is N-HELP, which addresses the operational, clinical, and financial needs of participating nursing homes, primarily voluntary healthcare organizations, and helps boost productivity in these outfits. N-HELP is connected to the NEHR (National Electronic Health Record), the patient-centric longitudinal health record envisioned for Singapore, and thereby supports timely data flows of residents' health information across different healthcare institutions	SMART HOMES AID DISEASE MANAGEMENT N-HELP AIMS AT NURSING HOMES' PRODUCTIVITY N-HELP IS LINKED TO NEHR
E-health in Singapore is primarily aimed at improving patient experience, increasing productivity in healthcare institutions, and promoting interoperability among disparate health information systems. However, Singapore is currently lagging behind countries like USA and Japan in terms of providing Continuum of Care. The model that will work going forward is the health cloud model which will offer Software as a Service (SaaS), and include care coordinators from the various healthcare institutions.	NEHR CAPTURES LATEST HEALTH RECORDS OF RESIDENTS. IMPROVED PATIENT EXPERIENCE NO CONTINUUM OF CARE HEALTH CLOUD IS THE FUTURE
Expert Response #2	Code
Singapore is making good progress in terms of e-health. To realize Singapore's vision of 'One Patient – One Medical Record', the National Electronic Health Record (NEHR) initiative was launched in 2010, and is now in its second phase of implementation. The grand plan is for the NEHR to be eventually migrated to H-Cloud, the Consolidated Healthcare Cloud that will host	NEHR ENVISIONS ONE PATIENT-ONE MEDICAL RECORD NEHR WILL BE HOSTED ON H-CLOUD PRIMARY CARE

mission critical systems for all public hospitals, specialty centres and polyclinics. Even primary care providers can connect to NEHR through NEHR web services / CLEO (Clinic Electronic Medical Records and Operations). Although the current focus is on the public healthcare sector, it is expected that the private healthcare institutions will also be consolidated under H-Cloud in due course. The H-Cloud is owned by IHiS which is a 100% subsidiary of MOH Holdings Pte. Ltd., and serves as their project management wing for healthcare projects.

The ‘silver tsunami’ phenomenon about to impact Singapore soon is shifting the focus of healthcare to long-term care. Some initiatives towards this end are Smart Hospitals, Smart Mat, etc. To elaborate on Smart Mat, it is a non-intrusive device that can capture breathing / heart rates, which are important parameters in clinical monitoring. In addition, it can also determine the quality of sleep, and send timely alerts e.g. fall alerts. It is flexible enough to be mounted on mattresses or cushions in home / clinical settings. This may be an answer to the national bed crunch faced in Singapore hospitals which can stretch the waiting time for a hospital bed to up to 12 hours. Proof-of-concept for Smart Mat is underway in the Changi Prison Medical Centre.

PROVIDERS ACCESS NEHR VIA WEBSERVICES

PRIVATE HEALTHCARE INSTITUTIONS MAY BE ALLOWED TO SHARE H-CLOUD

SILVER TSUNAMI SHIFTS FOCUS TO LONG-TERM CARE

SMART MAT IS A NON-INTRUSIVE DEVICE

SMART MAT WORKS IN HOME / CLINICAL SETTINGS

SMART MAT AIMS TO TACKLE NATIONAL BED CRUNCH

SMART MAT IS IN POC STAGE AT CHANGI PRISON MEDICAL CENTRE

2. How would you describe your participation in / contribution to e-health in Singapore?

Expert Response #1

My company, Napier Healthcare is a global company headquartered in Singapore. We are a healthcare 2020 technology enabler focused on patient-centric care delivery in tertiary hospitals, intermediate to long term care institutions, primary care institutions and home care. Our offerings include Hospital Information System (HIS), Loop Patient Referral Management System, , Electronic Medical Record (EMR), , and solutions for intermediate to long term care. A special mention goes to our Loop Patient Referral Management System which is a cloud solution that helps healthcare providers effectively manage care transitions and patient referral processes.

Expert Response #2

H-Cloud is owned by IHiS, and facilitated by ST Electronics (Info Software) Systems. Our target is to make the mission critical

Code

NAPIER HEALTHCARE IS A TECHNOLOGY ENABLER.

PATIENT-CENTRIC CARE

OFFERS EMR, HOSPITAL INFORMATION SYSTEM, AND LOOP PATIENT REFERRAL MANAGEMENT SYSTEM

LPRMS IS A CLOUD SOLUTION

COVERS INTERMEDIATE TO LONG TERM CARE SOLUTIONS

Code

ST ELECTRONICS (INFO-SOFTWARE SYSTEMS) FACILITATES H-CLOUD OWNED

Expert Response #1	Code
systems in the various healthcare institutions interoperable by year 2017, and have these migrated to H-Cloud. We have already migrated 500 over servers and 200 over applications of various healthcare institutions, to H-Cloud.	BY IHIS. H-CLOUD PROMOTES HEALTHCARE SYSTEMS' INTEROPERABILITY.

3. What are the challenges in implementing e-health in Singapore, in your opinion?

Expert Response #1	Code
<p>The current e-health business model may not be exactly sustainable for a number of reasons:</p> <ul style="list-style-type: none"> - In Singapore, the model is pay-for-service rather than pay-for-performance which is the model in the US. In a pay-for-performance model, hospitals that demonstrate high quality of care, will be incentivised through reimbursements. - The current model in Singapore does not seem to support care transition and the resulting continuum of care as there is no way for a transparent exchange of information. - For example, there is no 'loop' to track general practitioners' (primary care providers') patient referrals to hospitals. <i>(This is something Napier Healthcare is hoping to address through our Loop Patient Referral Management System.)</i> <p>Although the health cloud (H-Cloud) is underway, data residency and sovereignty issues (simply put, 'who owns what?') need to be addressed and resolved to the satisfaction of the stakeholders.</p>	<p>CURRENT E-HEALTH BUSINESS MODEL IS NOT SUSTAINABLE.</p> <p>SINGAPORE MUST ADOPT PAY-FOR-PERFORMANCE MODEL</p> <p>LACK OF TRANSPARENCY IN EXCHANGE OF INFORMATION.</p> <p>CARE TRANSITION AND CONTINUUM OF CARE NEED TRANSPARENCY.</p> <p>PRIMARY CARE PROVIDERS' PATIENT REFERRALS MUST BE TRACKED.</p> <p>H-CLOUD MAY FACE DATA RESIDENCY, SOVEREIGNTY ISSUES.</p>

Expert Response #2	Code
<p>Setting up and maintaining an H-Cloud is a challenge in itself. The various healthcare institutions in Singapore have been functioning like silos, having their own infrastructures, and running their own applications. These silos need to be made interoperable, consolidated, and migrated to H-Cloud, which steps involve heavy initial investments. Although the Government subsidizes these costs to some extent, the healthcare institutions also have to deploy their own funds for the purpose. Although there was some initial resistance to this initiative, it was overcome gradually when these healthcare institutions started seeing the bigger picture and were convinced by the long-term benefits of such a direction. Loss of 'business' to other healthcare institutions as</p>	<p>H-CLOUD OFFERS INTEROPERABLE PLATFORM FOR HEALTHCARE INSTITUTIONS.</p> <p>HEALTHCARE INSTITUTIONS SUFFER FROM HEAVY INITIAL INVESTMENT COSTS DESPITE GOVERNMENT SUBSIDY.</p> <p>H-CLOUD OFFERS LONG-TERM BENEFITS.</p>

a result of the H-Cloud is not a concern among the public sector healthcare institutions which are already facing a resource crunch and struggling to meet the healthcare needs of the public.

LOSS OF BUSINESS IS NOT A CONCERN TO PUBLIC SECTOR PLAYERS AS THEY WILL BE RELIEVED OF RESOURCE CRUNCH.

4. Who are the key stakeholders / players who should participate in e-health to harness the full benefits of e-health?

Expert Response #1

The key stakeholders in e-health are General Practitioners, Vendors, Government, Payers, Patients, and of course, a Service Provider (Infomediaries) who will be able to bring all these stakeholders together on a common platform (an IT system) which will be based on a sustainable business model.

Code

E-HEALTH KEY STAKEHOLDERS INCLUDE GENERAL PRACTITIONERS, VENDORS, GOVERNMENT, PAYERS, PATIENTS AND INFOMEDIARIES.

INFOMEDIARIES BRING E-HEALTH STAKEHOLDERS TOGETHER.

E-HEALTH NEEDS A COMMON IT PLATFORM TO WORK.

E-HEALTH DEPENDS ON A SUSTAINABLE BUSINESS MODEL.

Expert Response #2

The Government, healthcare institutions, insurance companies and the public are the key stakeholders. The NEHR comprises EHR (Electronic Health Record) as well as PHR (Personal Health Record). The health data acquired by healthcare institutions is housed in the EHR. On the other hand, PHR may collect health data in the form of readings from Smart Homes. This can be viewed as health data contribution by the public to the NEHR. Data is also contributed by insurance companies to the NEHR in the form of claims data. All these data sources add to the comprehensiveness of an individual's health record.

Code

E-HEALTH KEY STAKEHOLDERS INCLUDE GOVERNMENT, HEALTHCARE INSTITUTIONS, INSURANCE COMPANIES AND THE PUBLIC.

NEHR INCLUDES EHR AND PHR.

EHR IS HEALTH DATA ACQUIRED BY HEALTHCARE INSTITUTIONS.

SMART HOME INITIATIVES CAN CREATE DATA FOR PHR, WHICH CAN LINK TO NEHR

NEHR IS A COLLECTION OF CITIZENS' COMPREHENSIVE HEALTH RECORDS.

5. How can we encourage or ensure participation from these players?

Expert Response #1

An interoperable system based on the Continuum of Care Document Architecture (CCDA) devoid of any incentives to stakeholders will not work. The system should provide for some incentives for the key players to cooperate and share information, not

Code

INCENTIVES WILL ENCOURAGE KEY PLAYERS COOPERATION AND INFORMATION SHARING

GENERAL PRACTITIONERS MAY BE MOTIVATED TO USE NEHR USING A PAY-PER-USE MODEL

necessarily in monetary terms. As for encouraging participation from General Practitioners, a more effective method to get them to leverage the NEHR may be to move from the monthly subscription model to a pay-per-use model. A two-way model may be better where a healthcare institution that pays for access to health information in the NEHR, also gets paid / incentivised in some way when it contributes information to the NEHR. This may be a more sustainable model and will also resolves issues related to data residency and sovereignty. Healthcare institutions may also consider charging patients nominally (like \$1 per healthcare episode) for creating / maintaining their records.

To gain the participation of the general public / patients, PHR systems may be sponsored by insurers. Insurers may go a step further and incentivise their policy-holders to use the PHR system which will in turn facilitate preventive healthcare versus the less than ideal diagnostic healthcare which increases costs for the insurers.

Expert Response #2

It is our recommendation that the Next Generation Nationwide Broadband Network (NGNBN) which facilitates Smart Homes and Smart Mat, be fully sponsored by the Singapore Government for the benefit of its citizens. 80% of the NGNBN infrastructure is already in place, and the network is expected to be fully operational by 2025.

Call Centres should be established, ideally within hospitals, to monitor smart homes so as to be able to direct healthcare resources to where they are most needed.

Homes may be made 'smart' through NGNBN, smart phones and a base kit (like the one for MIO TV) which will enable the public to subscribe to healthcare services they require, and pay for these based on their level of consumption of such services ('pay as you use').

OVER MONTHLY SUBSCRIPTIONS.

HEALTHCARE INSTITUTIONS MAY BE MOTIVATED TO USE NEHR FOR A TWO-WAY MODEL.

TWO-WAY MODEL ENSURES CONTRIBUTION TO NEHR AND INCENTIVES TO HEALTHCARE INSTITUTIONS.

TWO-WAY MODEL PROMOTES SUSTAINABLE E-HEALTH.

NOMINAL FEE TO MAINTAIN HEALTHCARE RECORD MAY BE CHARGED TO PATIENTS.

INSURERS MAY SPONSOR PHR SYSTEMS

PHR SYSTEMS PROMOTE PREVENTIVE HEALTHCARE

INSURERS FACE HIGHER COSTS DUE TO DIAGNOSTIC HEALTHCARE

PHR SYSTEMS ENCOURAGE PATIENT/PUBLIC PARTICIPATION.

Code

NGNBN FACILITATES SMART HOME INITIATIVES

NGNBN MUST BE FULLY SPONSORED BY GOVERNMENT

HOSPITALS MUST MONITOR SMART HOMES IN ORDER TO MANAGE HEALTHCARE RESOURCES

SMART HOME MAY REQUIRE NGNBN, SMART PHONES, AND A BASE KIT.

PUBLIC MAY WELCOME PAY-AS-YOU-USE MODEL FOR SMART HOME HEALTHCARE SERVICES.

6. How will e-health benefit its various stakeholders and most importantly, Singapore?

Expert Response #1

E-health will help the Government in keeping healthcare costs low for their citizens. Insurers and Payers will also benefit from the renewed focus on 'preventive healthcare'.

Expert Response #2

Singapore benefits from e-health if its people benefit from it. E-health will help ease bed/resource crunch in hospitals, pave the way for smarter healthcare – resulting in a shift from reactive to proactive healthcare.

Code

LOWER HEALTHCARE COSTS.

PREVENTIVE HEALTHCARE IS BENEFICIAL.

Code

E-HEALTH REDUCES BED CRUNCH.

E-HEALTH LEADS TO SMARTER HEALTHCARE AND SHIFTS REACTIVE HEALTHCARE TO PREVENTIVE HEALTHCARE.

THE UNITED STATES OF AMERICA

1. What is the status of e-health in the US?

Expert Response #1	Code
<p>E-health from a medical perspective is fairly advanced since gaining momentum a few years ago, not the least due to reforms pursued by the Federal Government and cost pressures. Health plan exchanges, mandates for e- health records and insurance cover expansion have spurred technology deployments quadrupling e health platform deployments since 2011.</p> <p>Government reports that there is almost a 60% compliance with e health mandates at the physician level and perhaps higher at the hospital level. All this has also led to the adoption of intelligent medical devices that have a higher degree of interoperability and addressing consumer health informatics.</p> <p>On the ground, we see many physicians still handicapped by lack of proper tools for effective caregiving. There are groups that are resistant to technology intrusion in to their treatment rooms. It is a highly evolving area that has achieved much and still has to travel far to reach a true e-health environment.</p>	<p>FAIRLY ADVANCED FROM A MEDICAL PERSPECTIVE</p> <p>E-HEALTH PLATFORM DEPLOYMENTS QUADRUPLED SINCE 2011 DUE TO FEDERAL GOVT. MANDATES</p> <p>60% COMPLIANCE WITH E-HEALTH MANDATES AT PHYSICIAN LEVEL</p> <p>ADOPTION OF INTELLIGENT INTEROPERABLE MEDICAL DEVICES TO SUPPORT CONSUMER HEALTH INFORMATCS</p> <p>GROUPS RESISTANT TO TECHNOLOGY LACK TOOLS FOR EFFECTIVE CAREGIVING</p>
<p>Expert Response #2</p> <p>80%-90% of the US hospitals have some form of e-health. Individual clinics and community providers collaborate with the nearest hospital to be part of an e-health system. Healthcare providers are in a way compelled to opt for e-health as the US government has mandated this and set a deadline for year 2020. Healthcare providers who do not comply with this mandate will be penalized in the form of cut-back on reimbursements. On the other hand, healthcare providers who transition to e-health and furthermore meet the criteria for meaningful use, will be incentivised.</p>	<p>Code</p> <p>80% - 90% OF HOSPITALS HAVE SOME FORM OF E-HEALTH</p> <p>CLINICS AND COMMUNITY PROVIDERS COLLABORATE WITH NEAREST HOSPITAL TO BE PART OF AN E-HEALTH SYSTEM</p> <p>HEALTHCARE PROVIDERS FORCED TO OPT FOR E-HEALTH DUE TO FEDERAL GOVT. MANDATES</p> <p>DEADLINE SET FOR 2020</p> <p>PENALTIES FOR NON-COMPLIANCE THROUGH CUT BACKS</p> <p>INCENTIVES FOR ADOPTION AND MEANINGFUL USE</p>

2. How would you describe your participation in / contribution to e-health in the US?

Expert Response #1	Code
<p>1. The biggest challenge was use of paper and entering the same data more than once.</p> <p>We develop interfaces with and between hospital systems and ancillary providers to eliminate this malaise. Also, we help physicians with no access to interoperable systems by creating work flow platforms that can carry instructions and medical records. Though not the most efficient option, this is a cost effective option.</p> <p>2. Secondly, treatment capture in EMR has dragged physician productivity down. We use scribe services to capture the physician notes in the EMR and generate the report for his sign off. Again not the most efficient, but it allows groups to be compliant with electronic record capture whilst minimizing productivity losses</p> <p>3. EMR technologies are still evolving and hence the CPT / ICD codes that are auto generated by the EMR is subject to review. We resolve this by external manual audit to ensure the EMR can auto correct through a self-learning mechanism. We have alternately developed tools based on Snomed CT to auto code based on NLP techniques. Use of our tools can significantly eliminate the coding conundrum for large hospital based groups.</p>	<p>BIGGEST CHALLENGE TO SURMOUNT WAS PAPER RECORDS AND MULTIPLE DATA ENTRIES</p> <p>DEVELOP INTERFACE WITH HOSPITAL SYSTEMS AND BETWEEN HOSPITAL SYSTEMS</p> <p>CREATE WORK FLOW PLATFORMS THAT CARRY INSTRUCTIONS AND MEDICAL RECORDS FOR PHYSICIANS WITH NO ACCESS TO INTEROPERABLE SYSTEMS. NOT EFFICIENT BUT COST-EFFECTIVE</p> <p>OFFER SCRIBE SERVICES TO CAPTURE PHYSICIAN NOTES IN THE EMR AND GENERATE REPORT FOR PHYSICIAN SIGN OFF. NOT EFFICIENT BUT SATISFIES COMPLIANCE</p> <p>EMR TECHNOLOGY STILL EVOLVING SO AUTO-GENERATED AUDIT CPT/ICD CODES SUBJECT TO REVIEW</p> <p>RESOLVE THROUGH EXTERNAL MANUAL AUDIT TO ENSURE EMR CAN AUTO-CORRECT THROUGH SELF-LEARNING MECHANISM</p> <p>OUR TOOLS ELIMINATE THE CODING CONUNDRUM FOR LARGE HOSPITAL-BASED GROUPS</p>
<p>Expert Response #2</p> <p>Sutter Health is a not-for profit healthcare organization having a strong presence in Northern California, Oregon, and Hawaii. It is one of the biggest healthcare systems in the US which has more than a million patients covered by its EHR systems and generates 9 billion dollars in revenues. Earnings are re-invested in patient care to achieve quality and innovation in healthcare. The Sutter Health network not only includes hospitals but also individual</p>	<p>Code</p> <p>A NOT-FOR-PROFIT HEALTHCARE ORGANIZATION WITH PRESENCE IN N.CALIFORNIA, OREGON & HAWAII</p> <p>ONE OF THE BIGGEST HEALTHCARE SYSTEMS IN THE US</p> <p>MORE THAN 1 MILLION PATIENTS COVERED BY EHR SYSTEMS</p> <p>GENERATES 9 BILLION DOLLARS IN REVENUES. EARNINGS REINVESTED TO ACHIEVE QUALITY AND</p>

providers like clinics as well as community providers. It allows the healthcare providers in its network to document their patients' medical information online without having to do any paper work. The individual providers that are part of the Sutter Health network gain access to its EHR system (EPIC) and the resources supporting this system, by paying a subscription fee. Currently, the incentives offered by the US government help these individual providers cover these payments. Earlier, not only the individual providers, but also their patients, had to pay to access their EHR, message their doctors, etc. But these services are no longer paid services for the patients, the costs being absorbed by Sutter Health.

70-80% of the EHR market in the US belongs to EPIC, AllScripts and Cerner. Some e-health systems other than Sutter Health that are supported by EPIC are Kaiser Permanente, Stanford, UC Davis and John Muir. Because EPIC facilitates easier transfer of medical records from other systems powered by its open source configuration, it is likely to make inroads into several other hospitals in the future. One notable hospital making a switch from their existing system (Cerner) to EPIC is Mayo Clinic. Although such a switch involves exorbitant costs, it is considered a necessary move for the purpose of gaining access to a bigger share of the market.

Sutter Health itself uses 24 modules of EPIC and hence receives continuous support from EPIC.

While Sutter Health is a non-profit organization, its insurance arm, Sutter Health insurance is a for-profit organization that offers 2 health plans: HMO that covers only network providers and PCO that covers all providers.

INNOVATION IN HEALTHCARE

NETWORK INCLUDES CLINICS AND COMMUNITY PROVIDERS WHO HAVE ACCESS TO SUTTERHEALTH'S EHR SYSTEM (EPIC) FOR A SUBSCRIPTION FEE

CURRENTLY INCENTIVES OFFERED BY THE GOVT. COVERS THE SUBSCRIPTION FEES

EARLIER, THE INDIVIDUAL PROVIDERS AND THEIR PATIENTS HAD TO PAY FOR ACCESS TO THE EHR

PATIENTS NO LONGER HAVE TO PAY, COSTS ABSORBED BY SUTTER HEALTH

70%-80% OF EHR MARKET IN US BELONGS TO EPIC, ALLSCRIPTS AND CERNER PUT TOGETHER

EPIC ALSO SUPPORTS KAISER PERMANENTE, STANFORD, UC DAVIS AND JOHN MUIR

EPIC POWERED BY OPEN-SOURCE CONFIGURATION CAN FACILITATE EASIER TRANSFER OF MEDICAL RECORDS FROM OTHER SYSTEMS

EPIC LIKELY TO MAKE INROADS INTO SEVERAL OTHER HOSPITALS IN FUTURE. MAYO CLINIC MAKING A SWITCH FROM CERNER TO EPIC

ALTHOUGH A COSTLY DECISION, NECESSARY FOR GAINING ACCESS TO A BIGGER SHARE OF MARKET

SUTTERHEALTH USES 24 MODULES OF EPIC AND RECEIVES CONTINUOUS SUPPORT FROM EPIC

SUTTERHEALTH NOT-FOR-PROFIT BUT ITS INSURANCE ARM IS FOR-PROFIT.

SUTTERHEALTH INSURANCE OFFERS 2 HEALTH PLANS: HMO COVERING ONLY NETWORK PROVIDERS AND PCO COVERING ALL PROVIDERS

3. What are the challenges in implementing e-health in the US, in your opinion?

Expert Response #1

A. Physician acceptance. The aging caregiver population is slow to adapt and adopt latest technologies. Since the technologies themselves are evolving, a large group of physicians/hospitals are waiting to catch the maturity curve much later.

B. Costs. Many small and rural groups do not have the resources to invest and maintain e-health platforms. Though Federal budget support is available, these groups fear long term costs that may not be subsidized.

C. Delayed Implementation: Many implementations of e-health initiatives fail and result in cost escalation due to improper specifications, poor understanding of the physician business by the e-health company and interoperability with legacy and other systems

Expert Response #2

The transition from paper to digital records was achieved by manual data entry as well as scanning of medical documents which were subsequently verified and filed. This was time and resource-intensive. It had to be done this way because labs have a language of their own. The EHR (in this case, EPIC) understands HL7 and hence is able to “translate” and capture any communication between points A and B. Another challenge is that there is no real-time exchange of information between insurance companies and healthcare organizations. Yet another challenge was in terms of how e-health was received by the physicians. The older generation of physicians were not as receptive to e-health as their younger counterparts. EHR interfaces had to be customized for the healthcare providers and this

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OLDER PHYSICIANS SLOW TO ADAPT AND ADOPT LATEST TECHNOLOGY

SINCE TECHNOLOGY ITSELF EVOLVING, PHYSICIANS / HOSPITALS WAITING TO CATCH MATURITY CURVE MUCH LATER

SMALL / RURAL GROUPS DO NOT HAVE THE RESOURCES TO INVEST AND MAINTAIN E-HEALTH PLATFORMS

THOUGH FEDERAL BUDGET SUPPORT AVAILABLE, SOME GROUPS FEAR LONG-TERM COSTS THAT MAY NOT BE SUBSIDIZED

MANY E-HEALTH IMPLEMENTATIONS FAIL AND FURTHER ESCALATE COSTS DUE TO IMPROPER SPECS, POOR UNDERSTANDING OF PHYSICIAN BUSINESS AND INTEROPERABILITY WITH LEGACY & OTHER SYSTEMS

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TRANSITION FROM PAPER TO DIGITAL RECORDS ACHIEVED BY MANUAL DATA ENTRY, SCANNING MEDICAL DOCUMENTS WHICH WERE SUBSEQUENTLY VERIFIED AND FILED

TRANSITION WAS TIME AND RESOURCE INTENSIVE BUT NO CHOICE AS LABS HAVE A LANGUAGE OF THEIR OWN

EHR (EPIC) UNDERSTANDS HL7 AND HENCE ABLE TO TRANSLATE AND CAPTURE BETWEEN POINTS A AND B

ANOTHER CHALLENGE – NO REAL TIME EXCHANGE OF INFORMATION BETWEEN PROVIDERS AND PATIENTS

OLDER GENERATION PHYSICIANS NOT AS RECEPTIVE TO E-HEALTH AS

was supplemented with user trainings and manuals. If implementing EHRs is a costly affair, maintaining these systems is equally expensive as substantial resources need to be deployed for the purpose.

COMPARED TO THEIR YOUNGER COUNTERPARTS

EHR INTERFACES HAD TO BE CUSTOMIZED FOR PROVIDERS AND SUPPLEMENTED WITH USER TRAININGS AND MANUALS

IMPLEMENTING EHRS IS COSTLY, MAINTENANCE EQUALLY COSTLY AS SUBSTANTIL RESOURCES INVOLVED

4. Who are the key stakeholders / players who should participate in e-health to harness the full benefits of e-health?

Expert Response #1

- a. Physicians groups, Office staff and Hospital Information Management Departments – understand the benefits of a connected healthcare ecosystem for care enhancement, cost reduction in the long run ,reduced utilization and better insight into diseases and cure
- b. patients: by insisting on e-health initiatives by his/her care giver
- c. pharma / clinical R&D : better data availability means analytics and informatics opportunities for developing cure and arresting outbreaks.
- d. Government: e-health can drive health policies, early warning mechanisms and advisory mechanisms

Code

PHYSICIANS, HOSPITALS UNDERSTAND BENEFITS OF A CONNECTED HEALTHCARE ECOSYSTEM FOR CARE ENHANCEMENT, COST REDUCTION, REDUCED UTILIZATION, BETTER INSIGHTS INTO DISEASES AND CURES

PATIENTS SHOULD INSIST ON E-HEALTH INITIATIVES BY THEIR PROVIDERS

FOR PHARMACEUTICALS CLINICAL R&D DATA AVAILABILITY FACILITATES ANALYTICS AND INFORMATICS OPPORTUNITIES TO DEVELOP CURES AND ARREST OUTBREAKS

FOR GOVERNMENT E-HEALTH CAN DRIVE HEALTH POLICIES, EARLY WARNING MECHANISMS AND ADVISORY MECHANISMS

Expert Response #2

The key stakeholders in my opinion are the government, healthcare providers, patients, pharmacies, laboratories and insurance companies.

Code

GOVERNMENT
HEALTHCARE PROVIDERS
PATIENTS
LABORATORIES
INSURANCE COMPANIES

5. How can we encourage or ensure participation from these players?

Expert Response #1

Private Insurance can ignite e-health by making it mandatory and paying for it through a compensatory mechanism (just like what Fed. Govt.

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PRIVATE INSURERS CAN IGNITE E-HEALTH BY MAKING IT MANDATORY AND PAYING FOR IT THROUGH A COMPENSATORY MECHANISM LIKE

does). In the long run, private insurances gain by efficiencies, prevention of fraud, waste and abuse by physicians.

Patients insist on electronic health records that is single source and accessible by all his/her caregivers.

Expert Response #2

The US government encourages e-health adoption by healthcare providers through incentives for adoption and penalties for non-adoption. The government's incentives are primarily aimed at covering the head-start costs and roll-over costs for an EHR system, and will come to an end after a healthcare provider achieves the 'meaningful use stage 3' criteria. Subsequent costs like the ongoing maintenance costs have to be borne by the healthcare providers. But by the time a healthcare provider meets the meaningful use stage 3 criteria, it would have achieved efficiencies which would translate to increased earnings, and which in turn, should help cover the maintenance costs. For instance, one such efficiency achieved is in terms of the average length of an appointment which has been found to have reduced from 45 to 15 minutes, enabling a doctor to see more patients /day, and thus generate more revenues. Individual healthcare providers (clinics) that are affiliated to Sutter Health will continue to incur subscription and support costs after the incentives are phased out. While some of these clinics attempt to recover their EHR-related costs by charging their patients for access to the EHR system, some others simply absorb it and give their patients free access to the system.

Investing in and transitioning to e-health not only results in increased efficiencies, but also expands the network / market for the healthcare provider. However a small number of

THE FEDERAL GOVERNMENT DOES

IN THE LONG RUN, PRIVATE INSURERS GAIN BY EFFICIENCIES, PREVENTION OF FRAUD, WASTE AND ABUSE BY PHYSICIANS

PATIENTS SHOULD INSIST ON ELECTRONIC HEALTH RECORDS WHICH IS LONGITUDINAL AND ACCESSIBLE BY ALL PROVIDERS

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THE GOVT. OFFERS INCENTIVES FOR ADOPTION AND PENALTIES FOR NON-ADOPTION.

GOVT.'S INCENTIVES AIMED AT COVERING HEAD START COSTS AND ROLL OVER COSTS FOR AN EHR SYSTEM AND WILL COME TO AN END WHEN MEANINGFUL USE STAGE 3 CRITERION IS MET

SUBSEQUENT COSTS LIKE ONGOING MAINTENANCE COSTS TO BE BORNE BY THE PROVIDERS

BY THE TIME MEANINGFUL USE STAGE 3 CRITERIA ARE MET EFFICIENCIES WOULD BE ACHIEVED WHICH WOULD TRANSLATE TO INCREASED EARNINGS WHICH IN TURN SHOULD COVER MAINTENANCE COSTS

FOR INSTANCE, LENGTH OF AN APPOINTMENT HAS BEEN FOUND TO HAVE REDUCED FROM 45 MINS. TO 15 MINS ENABLING A DOCTOR TO SEE MORE PATIENTS / DAY AND THUS GENERATE MORE REVENUES

INDIVIDUAL HEALTHCARE PROVIDERS (CLINICS) WILL CONTINUE TO INCUR SUBSCRIPTION AND SUPPORT COSTS AFTER THE INCENTIVES ARE PHASED OUT.

SOME OF THESE INDIVIDUAL PROVIDERS ATTEMPT TO RECOVER THEIR EHR-RELATED COSTS BY CHARGING THEIR PATIENTS FOR ACCESS TO THE SYSTEM AND SOME OTHERS JUST ABSORB THE COSTS

individual healthcare providers find taking that step daunting because they are uncertain about the ROI. They prefer to incur the penalty associated with non-adoption which according to them may be far lower as compared to the long-term maintenance costs associated with an EHR system.

Considering this deterring factor, it is not unfair for a clinic to charge its patients a reasonable amount for access to their heavily-invested in EHR system. In return, the patients can have their own EHR accounts, take ownership of their health information and control who they share their health information with.

The government on its part, can mandate filing back of health information into a cloud-based government system, and act as the custodian of its citizens' health information. This can be made possible if EHRs were open-source like the e-commerce systems.

INVESTING IN E-HEALTH NOT ONLY LEADS TO INCREASED EFFICIENCIES BUT ALSO EXPANDS THE NETWORK / MARKET FOR THE PROVIDER

A SMALL NUMBER OF HEALTHCARE PROVIDERS FIND THE INVESTMENT DAUNTING DUE TO UNCERTAIN ROI. THEY PREFER TO INCUR PENALTIES FOR NON-ADOPTION WHICH IN THEIR OPINION MAY BE LOWER AS COMPARED TO THE LONG TERM MAINTENANCE COSTS ASSOCIATED WITH EHR SYSTEMS

NOT UNFAIR FOR A CLINIC TO CHARGE ITS PATIENTS A REASONABLE AMOUNT FOR ACCESS TO THEIR HEAVILY INVESTED IN EHR SYSTEM

IN RETURN PATIENTS CAN HAVE THEIR OWN EHR ACCOUNTS, TAKE OWNERSHIP OF THEIR HEALTH INFORMATION AND CONTROL WHO THEY SHARE THEIR INFORMATION WITH

GOVT. CAN MANDATE FILING BACK OF HEALTH INFORMATION INTO A CLOUD-BASED GOVT. SYSTEM AND ACT AS THE CUSTODIAN OF ITS CITIZEN'S HEALTH INFORMATION

THIS IS POSSIBLE IF EHRS WERE OPEN-SOURCE LIKE THE E-COMMERCE SYSTEMS

6. How will e-health benefit its various stakeholders and most importantly, the US?

Expert Response #1

At a high level, US scores poorly compared to peers on most health parameters despite multi fold budget. That correction is possible to some extent with e-health measures. The cost of a healthcare transaction is v high compared to similar transactions in other industries. Those wasted dollars can be channeled to research and coverage of indigent population. Obvious benefits to patients include better care, lesser number of repeat

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US SCORES POORLY COMPARED TO PEERS ON MOST HEALTH PARAMETERS DESPITE MULTIFOLD BUDGET

CORRECTION POSSIBLE WITH E-HEALTH MEASURES

COST OF A HEALTHCARE TRANSACTION VERY HIGH COMPARED TO SIMILAR TRANSACTIONS IN OTHER INDUSTRIES. WASTED DOLLARS CAN

procedures and quicker determination of diagnosis. Whilst e-health may benefit most stakeholders, physicians may see pressure on their business. The clinical side will be efficient but that efficiency will cut into the high margins of the past in the business. For insurances and regulatory authority, this will mean lesser waste fraud and abuse.

BE CHANNELLED TO RESEARCH AND COVERAGE OF INDIGENT POPULATION

BENEFITS TO PATIENTS INCLUDE BETTER CARE, LESS NUMBER OF REPEAT PROCEDURES, QUICKER DETERMINATION OF DIAGNOSIS

WHILE BENEFITS ACCRUE TO OTHER STAKEHOLDERS, PHYSICIANS FEEL PRESSURES.

CLINICAL SIDE WILL BE EFFICIENT BUT EFFICIENCY WILL CUT INTO THE HIGH MARGINS OF THE PAST IN THE BUSINESS

FOR INSURANCE COMPANIES AND REGULATORS, BENEFITS ARE LESS WASTE, FRAUD AND ABUSE

Expert Response #2

Healthcare providers gain efficiencies which translate into savings / increased revenues for them. E-visits and wireless communication between healthcare providers and patients are all made possible now. These advances have resulted in considerable cost and resource savings for healthcare providers. As for patients, they gain ubiquitous access to their health information via the EHR system that maintains their longitudinal health record. Developments like e-visits not only benefit patients and providers, but also insurance companies that pay less for e-visits as compared to face-to-face consultations. The government has its population's health information readily accessible online and overall, e-health will lead to improvements in the population's health.

Code

HEALTHCARE PROVIDERS GAIN EFFICIENCIES THAT TRANSLATE INTO SAVINGS / INCREASED REVENUES FOR THEM

E-VISTS AND WIRELESS COMUUNICATIN BETWEEN PROVIDERS AND PATIENTS POSSIBLE NOW

ADVANCES HAVE RESULTED IN CONSIDERABLE COST AND RESOURCE SAVINGS FOR HEALTHCARE PROVIDERS

PATIENTS GAIN UBIQUITOUS ACCESS TO THEIR HEALTH INFORMATION VIA EHR THAT MAINTAINS THEIR LONGITUDINAL HEALTH RECORD

DEVELOPMENTS LIKE E-VISITS ALSO BENEFIT INSURERS AS THEY PAY LESS FOR E-VISITS AS COMPARED TO FACE-TO-FACE CONSULTATIONS

GOVT. HAS ITS POPULATION'S HEALTH INFORMATION READILY ACCESSIBLE ONLINE

OVERALL, E-HEALTH WILL LEAD TO IMPROVEMENTS IN POPULATION'S HEALTH

7. What is your opinion on the potential of cloud technology to transform healthcare in the US?

Expert Response #1

Cloud is an integral component of the e-health program. Several facets of e-health continue to depend on evolution of the cloud technology to be effective. High and easy availability, data porting and limitless storage enable e-health as is the lower cost of cloud storage. However some concerns regarding data safety and security continue to be held out against cloud storing sensitive health data.

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CLOUD AN INTEGRAL COMPONENT OF THE E-HEALTH PROGRAM

SEVERAL FACETS OF E-HEALTH CONTINUE TO DEPEND ON THE EVOLUTION OF THE CLOUD TECHNOLOGY TO BE EFFECTIVE

HIGH AND EASY AVAILABILITY, DATA PORTING, LIMITLESS STORAGE, LOWER STORAGE COST ENABLE E-HEALTH

CONCERNS REGARDING DATA SAFETY AND SECURITY CONTINUE TO BE HELD OUT AGAINST CLOUD STORING SENSITIVE DATA

Expert Response #2

There are no major players on cloud yet. Government policies and grants to support this direction may encourage healthcare providers to embrace the cloud technology in the future. Ten years down the line, it is likely that all health information may be on cloud considering the exponential rate at which health information is growing. Security and confidentiality of data are of course key concerns with respect to the cloud technology, but these can be overcome with the help of encryption technologies which are ever-evolving. The government should assume the responsibility to guard the e-health system to maintain public confidence - similar to what they have been doing with the national financial system through the FDIC (Federal Deposit Insurance System).

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NO MAJOR PLAYERS ON CLOUD YET

GOVT. POLICIES AND GRANTS TO SUPPORT THIS DIRECTION MAY ENCOURAGE HEALTHCARE PROVIDERS TO EMBRACE THE CLOUD TECHNOLOGY IN FUTURE

10 YEARS DOWN THE LINE IT IS LIKELY THAT ALL HEALTH INFORMATION MAY BE ON CLOUD CONSIDERING THE EXPONENTIAL RATE AT WHICH HEALTH INFORMATION IS GROWING

SECURITY AND CONFIDENTIALITY OF DATA ARE KEY CONCERNS W.R.T. CLOUD. CAN BE OVERCOME WITH ENCRYPTON TECHNOLOGIES WHICH ARE EVER-EVOLVING

GOVT. SHOULD ASSUME THE RESPONSIBILITY TO GUARD THE E-HEALTH ECOSYSTEM TO MAINTAIN PUBLIC CONFIDENCE – SIMILAR TO WHAT THEY HAVE BEEN DOING WITH THE NATIONAL FINANCIAL SYSTEM THROUGH THE FDIC (FEDERAL DEPOSIT INSURANCE SYSTEM)

Appendix E. LIST OF PUBLICATIONS AND CONFERENCES /

WORKSHOPS ATTENDED

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ⁱ Manhattan Research LLC Survey, 2007

ⁱⁱ Manhattan Research LLC Survey, 2013

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^{iv} <http://www.marketsandmarkets.com/Market-Reports/healthcare-it-252.html>

^v <http://www.veriskhealth.com/>

^{vi} www.keas.com

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