

The adoption of ICT in Malaysian public hospitals: the interoperability of electronic health records and health information systems

By

NOORHASRULNIZAN MOHAMMAD NOOR

A Doctoral Thesis

Submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy of Loughborough University

August 2015

©by Noor Hasrul Nizan bin Mohammad Noor 2015

ABSTRACT

There have been a number of researches that investigated ICT adoption in Malaysian healthcare. With the small number of hospitals that adopt ICT in their daily clinical and administrative operations, the possibility to enable data exchange across 131 public hospitals in Malaysia is still a long journey. In addition to those studies, this research was framed under six objectives, which aim to critically review existing literature on the subject matter, identify barriers of ICT adoption in Malaysia, understand the administrative context during the pre and post-ICT adoption, and recommend possible solutions to the Ministry of Health of Malaysia (MoHM) in its efforts to implement interoperable electronic health records (EHR) and health information systems (HTIS). Specifically, this research aimed to identify the factors that had significant impacts to the processes of implementing interoperable EHR and HTIS by the MoHM. Furthermore, it also aimed to propose relevant actors who should involve in the implementation phases. These factors and actors were used to develop a model for implementing interoperable EHR and HTIS in Malaysia. To gather the needed data, series of interviews were conducted with three groups of participants. They were ICT administrators of MoHM, ICT and medical record administrators of three hospitals, and physicians of three hospitals. To ensure the interview feedback was representing the context of EHR and HTIS implementation in Malaysia, two hospital categories were selected, which included the hospitals with HTIS and non-HTIS hospitals. The government documents were then used to triangulate the feedback to ensure dependability, credibility, transferability and conformity of the findings. Two techniques were used to analyse the data, which were thematic analysis and theme matching. These two techniques were modified from its original method, known as pattern matching. The originality of this research was presented in the findings and methods to transform them into solutions and provide recommendation to the MoHM. In general, the results showed that the technological factors contributed less to the success of the implementation of interoperable EHR and HTIS compared to the managerial and administrative factors. Four main practical and social contributions were identified from this research, which included synchronisation of managerial elements, political determination and change management transformation, optimisation of use of

existing legacy system (Patient Management System) and finally the roles of actors. Nevertheless, the findings of this research would be more dependable and transferrable if more participants had been willing to participate especially among the physicians and those who managed the ICT adoptions under the MoHM.

Keywords: Malaysian healthcare, Malaysian health information systems, electronic health records in Malaysia, Patient Management System, Theme matching healthcare, Malaysian interoperability, ICT adoption in Malaysian healthcare, qualitative health research.

ACKNOWLEDGEMENT

I would like to express my gratitude to my supervisors, Mr. Ian Murray and Dr Steve Proberts. Due to their enthusiasm, critical evaluation, encouragement and patience, I truly have a memorable journey through my doctoral candidacy at Loughborough University under the Department of Information Science. I have benefitted immensely from the on-going engagement in critical discussion with them. Their insights and constant feedback have had a tremendous impact in helping me complete my doctoral study. I deeply appreciate their approaches in supervising me and I will further extend the knowledge gained from my relationship with them to benefit my future students.

I would also like to extend my appreciation to the Malaysian Government and my employer, International Islamic University of Malaysia (IIUM) for giving me the opportunity to do my doctoral study at the Loughborough University.

I would also like to say thank you to the Deputy General Director of the Ministry of Health of Malaysia who had given me permissions to interview number of his staff at the ministry's divisions and hospitals. This research would not attain its findings without their cooperation, whom I noticed were very busy but still willing to spend their valuable time for the interview sessions. For that, I would like to say thank you for all of you.

My appreciative gratitude is also to the staff of Pantai Medicare Sdn. Bhd, especially to my friend who is the Manager of IT Divison, Mr. Noor Hisham Ghazali. They had evaluated my interview questions during the pilot study and suggested modifications to tackle the real issues concerning the implementation of interoperable HTIS and EHR in Malaysian public hospitals. Their suggestions were based on their experiences handling insurance claims with the public hospitals.

My debts and gratitude are also to my friends who have been helping me financially and morally throughout this journey. My thanks to Mohsen Abdul Kadir, Nik Ahmad Kamal, Nazman Yahya, Ahmad Ismal, Dzakwan, Azrayn Borhan, Kamrul Ariffin Saaidi Ali Firdaus, Akmal, Saiful Barin and finally to my spiritual mentor Mr. Harun bin Deraman and Mr. Karim.

I have been blessed by God Almighty with a wonderful wife, who never has any doubt of my ability to complete my thesis writing. Thank you darling for your support and encouragement! To my beloved daughters, Nur Hasya Fatihah, Nur Husna Faqihah, and Nur Hafaa Fasihah, thanks for your patience during my absences. My greatest gratitude is also to my mother and father in-laws who provide a shelter to my family when I have no money to pay for the rent after my scholarship has finished. My thanks is also to my in-laws, Hanafiah, Hanisah, Hasanah, and Hazilah for the never ending financial support to my family during this candidacy.

To my mother Hjh. Shamsiah binti Hassan whose prayers have strengthened me when I am weak and vulnerable. Thanks mom, for your supports I will always love you.

DEDICATION

I dedicate this thesis to my wife, Wan Hafizah Wan Hassan, my mother, Hjh. Shamsiah binti Hassan, and to my spiritual leader Mr. Harun and Karim. Thank you for your love, support and encouragement.

TABLE OF CONTENTS

| | |
|------------------------------|--|
| TABLE OF CONTENTS | ii |
| LIST OF ABBREVIATIONS | ii |
| LIST OF TABLES | iv |
| LIST OF FIGURES | Vi |
| CHAPTER ONE | |
| INTRODUCTION | |
| 1.1 | General introduction..... 1 |
| 1.1.1 | Structure of the thesis..... 1 |
| 1.2 | Background of the research..... 3 |
| 1.3 | Problem statement of this research..... 4 |
| 1.3.1 | Focus of this research..... 5 |
| 1.3.2 | Social technical systems and ICT adoption in healthcare..... 8 |
| 1.4 | Justification of the research..... 13 |
| 1.5 | Conceptual framework..... 15 |
| 1.5.1 | Research questions..... 16 |
| 1.5.2 | Research aim and objectives..... 17 |
| | |
| CHAPTER TWO | |
| LITERATURE REVIEW | |
| 2.1 | Introduction..... 19 |
| 2.2 | Discussion of terms..... 19 |
| 2.2.1 | Health information systems..... 19 |
| 2.2.1.1 | Hospital information systems..... 20 |
| 2.2.2 | Electronic health records (EHR)..... 22 |
| 2.2.2.1 | Electronic Patient Record and Electronic Medical Record 24 |
| 2.2.2.2 | The reference model of EHR 26 |
| 2.2.3 | Interoperability..... 29 |
| 2.2.4 | Public hospitals..... 31 |
| 2.3 | The adoption of ICT in seven developed countries..... 31 |
| 2.3.1 | United Kingdom..... 31 |
| 2.3.1.1 | Overview of the United Kingdom's health care system... 31 |
| 2.3.1.2 | The adoption of ICT in United Kingdom health care..... 31 |
| 2.3.2 | Canada..... 38 |
| 2.3.2.1 | Overview of the Canadian health care system..... 38 |
| 2.3.2.2 | The adoption of ICT in Canadian health care..... 38 |
| 2.3.3 | Australia..... 41 |
| 2.3.3.1 | Overview of the Australian health care system..... 41 |
| 2.3.3.2 | The adoption of ICT in Australian health care..... 41 |
| 2.3.4 | New Zealand..... 46 |
| 2.3.4.1 | Overview of New Zealand's health care system..... 46 |
| 2.3.4.2 | The adoption of ICT in New Zealand health care..... 46 |
| 2.3.5 | Singapore..... 49 |

| | | |
|---------|---|----|
| 2.3.5.1 | Overview of the Singaporean health care system..... | 49 |
| 2.3.5.2 | The adoption of ICT in Singaporean health care..... | 51 |
| 2.3.6 | Hong Kong..... | 52 |
| 2.3.6.1 | Overview of Hong Kong's health care system..... | 52 |
| 2.3.6.2 | The adoption of ICT in Hong Kong health care..... | 54 |
| 2.3.7 | Taiwan..... | 55 |
| 2.3.7.1 | Overview of the Taiwanese health care system..... | 55 |
| 2.3.7.2 | The adoption of ICT in Taiwanese health care..... | 56 |
| 2.3.8 | Lessons learned from ICT adoption in developed countries..... | 57 |
| 2.3.8.1 | Government initiatives and commitment..... | 59 |
| 2.3.8.2 | Independent research into project assessment..... | 59 |
| 2.3.8.3 | Infrastructural readiness..... | 60 |
| 2.3.8.4 | The priority of standards and technical specifications..... | 60 |
| 2.3.8.5 | Implementation methods..... | 61 |
| 2.3.8.6 | Managing the vendors..... | 61 |
| 2.4 | Barriers to ICT adoption: EHR implementation..... | 62 |
| 2.5 | The governance and political issues in EHR and ICT adoption..... | 63 |
| 2.5.1 | The outsourcing of ICT procurement..... | 64 |
| 2.5.2 | The issue of human resource competency to manage ICT adoption in health care..... | 65 |
| 2.6 | Physicians' resistance to ICT adoption..... | 65 |
| 2.7 | The role of standards in ICT adoption..... | 66 |
| 2.7.1 | Standards for interoperable electronic health records..... | 67 |
| 2.7.1.1 | ISO/TR 20514: Health Informatics-electronic Health Record: Definition, Scope and Context..... | 67 |
| 2.7.2 | HL7 and DICOM in electronic health records..... | 68 |
| 2.7.2.1 | HL7..... | 68 |
| 2.7.2.2 | DICOM..... | 69 |
| 2.8 | The relevancy of open-source software (OSS) in ICT and EHR adoption.. | 70 |
| 2.9 | The model for the integration of applications in general organisations..... | 73 |
| 2.9.1 | The model for the integration of applications in health care..... | 75 |
| 2.10 | Direction of the research and the literature review..... | 77 |

CHAPTER THREE

AN OVERVIEW OF THE MALAYSIAN HEALTH CARE SYSTEM

| | | |
|---------|---|----|
| 3.1 | Introduction..... | 79 |
| 3.2 | The administrative systems in Malaysia..... | 79 |
| 3.3 | Overview of the Malaysian health delivery system..... | 81 |
| 3.4 | ICT adoption in Malaysian health care..... | 88 |
| 3.4.1 | ICT initiatives in the Malaysian public sector..... | 88 |
| 3.4.2 | ICT initiatives in health care..... | 88 |
| 3.4.2.1 | Implementing interoperable EHR in Malaysia..... | 96 |
| 3.5 | Conclusion..... | 99 |

CHAPTER FOUR

RESEARCH METHODOLOGY

| | | |
|-----|------------------------|-----|
| 4.1 | Introduction..... | 100 |
| 4.2 | Research Paradigm..... | 100 |

| | | |
|---------|---|-----|
| 4.2.1 | Types of research paradigm..... | 100 |
| 4.2.2 | Interpretivist paradigm and this research..... | 103 |
| 4.3 | Research Approach..... | 104 |
| 4.3.1 | Qualitative and quantitative research..... | 104 |
| 4.3.2 | Justification of the qualitative research approach for this research..... | 106 |
| 4.4 | Research Design..... | 107 |
| 4.4.1 | The case study research design..... | 111 |
| 4.4.1.1 | A study's questions..... | 111 |
| 4.4.1.2 | Propositions..... | 111 |
| 4.4.1.3 | Units of analysis..... | 113 |
| 4.4.1.4 | The logic linking the data to the propositions..... | 113 |
| 4.4.1.5 | The criteria for interpreting the findings..... | 114 |
| 4.5 | Case study method of inquiry..... | 114 |
| 4.5.1 | Methods of inquiry in the qualitative research approach..... | 114 |
| 4.5.2 | Justification of the case study method for this research..... | 114 |
| 4.5.3 | The selection of single case study..... | 116 |
| 4.6 | Data Collection..... | 117 |
| 4.6.1 | The formation of case study data..... | 117 |
| 4.6.2 | Settings and participants..... | 120 |
| 4.6.3 | Interviews..... | 123 |
| 4.6.4 | Documents and archives..... | 125 |
| 4.6.5 | Triangulation..... | 130 |
| 4.7 | The overview of data analysis..... | 131 |
| 4.7.1 | The familiarity of data..... | 133 |
| 4.7.1.1 | Data reduction..... | 133 |
| 4.7.1.2 | Transcribing and translating the data (interviews)..... | 133 |
| 4.7.2 | Data coding..... | 133 |
| 4.7.3 | Searching and reviewing the themes..... | 139 |
| 4.7.3.1 | Creating and naming the themes..... | 140 |
| 4.7.3.2 | Thematic mapping..... | 143 |
| 4.8 | Theme matching..... | 143 |

CHAPTER FIVE
DATA ANALYSIS

| | | |
|---------|---|-----|
| 5.1 | Introduction..... | 146 |
| 5.2 | First proposition..... | 149 |
| 5.2.1 | The infrastructures that affect EHR..... | 150 |
| 5.2.1.1 | Electricity infrastructure..... | 150 |
| 5.2.1.2 | ICT infrastructure..... | 153 |
| 5.2.1.3 | The infrastructure to support the Patient Management System.... | 156 |
| 5.2.1.4 | The legacy systems and ICT infrastructures..... | 157 |
| 5.2.2 | Infrastructure for interoperability..... | 159 |
| 5.2.2.1 | Support for inter hospital data exchange..... | 159 |
| 5.2.2.2 | Support for inter-department data exchange..... | 161 |
| 5.3 | Second proposition..... | 163 |
| 5.3.1 | The management of ICT procurement..... | 164 |
| 5.3.1.1 | Stages of approval..... | 164 |
| 5.3.1.2 | The implementation method for ICT procurement..... | 168 |
| 5.3.1.3 | Vendor management..... | 174 |

| | | |
|---------|---|-----|
| 5.3.2 | The issue of direct negotiation..... | 176 |
| 5.3.2.1 | The unsuitability of direct negotiation..... | 176 |
| 5.3.2.2 | The feasibility of direct negotiation..... | 179 |
| 5.3.3 | The issue of intellectual property..... | 180 |
| 5.3.3.1 | Freedom over the software..... | 180 |
| 5.3.3.2 | Efforts to be less dependent on vendors..... | 182 |
| 5.4 | Third proposition..... | 183 |
| 5.4.1 | The level of competency to manage EHR and HTIS..... | 183 |
| 5.4.1.1 | The level of innovation..... | 184 |
| 5.4.1.2 | Technical competency..... | 189 |
| 5.5 | Fourth proposition..... | 191 |
| 5.5.1 | The hierarchical system of ICT procurement at the MoHM..... | 192 |
| 5.5.1.1 | The authority of each hierarchy..... | 194 |
| 5.5.1.2 | Reasons to have those committees..... | 197 |
| 5.5.2 | External interference in ICT procurement..... | 198 |
| 5.5.2.1 | Types of external interference..... | 199 |
| 5.5.2.2 | The implications of external interference..... | 203 |
| 5.6 | Fifth proposition..... | 205 |
| 5.6.1 | The role of standards..... | 206 |
| 5.6.1.1 | Technical factors for interoperability..... | 207 |
| 5.6.1.2 | Inter-department and inter-hospital interoperability..... | 210 |
| 5.7 | Sixth proposition..... | 216 |
| 5.7.1 | The key terms in open-source technology..... | 217 |
| 5.7.1.1 | Open-source software and free software..... | 217 |
| 5.7.1.2 | Free and open-source software (FOSS) licence..... | 219 |
| 5.7.1.3 | Proprietary software..... | 220 |
| 5.7.2 | The application of open-source technology in Malaysian health care..... | 221 |
| 5.7.2.1 | Financial and licensing implications..... | 222 |
| 5.7.2.2 | The directives for open-source software..... | 227 |
| 5.8 | Seventh proposition..... | 234 |
| 5.8.1 | The factors that affect the level of acceptance..... | 234 |
| 5.8.1.1 | The attitudes of physicians in perceiving ICT..... | 235 |
| 5.8.1.2 | The incomplete phases of ICT procurement..... | 239 |
| 5.8.1.3 | Supports for HTIS and EHR implementation..... | 241 |
| 5.8.2 | The benefits of electronic health records and HTIS..... | 244 |
| 5.8.2.1 | Storage and retrieval..... | 244 |
| 5.8.2.2 | The improvement in health service delivery..... | 250 |
| 5.8.2.3 | Medical data exchange..... | 254 |
| 5.8.2.4 | Reduction of mistakes..... | 259 |
| 5.9 | Eighth proposition..... | 261 |
| 5.9.1 | Intangible barriers..... | 262 |
| 5.9.1.1 | The issue of change management..... | 263 |
| 5.9.1.2 | The outsourcing of ICT programmes and integration..... | 264 |
| 5.9.1.3 | External factors..... | 267 |
| 5.9.1.4 | Legal issues..... | 269 |
| 5.9.2 | Tangible barriers..... | 273 |
| 5.9.2.1 | Manageable procurement plan for addressing electricity infrastructure issues..... | 273 |
| 5.9.2.2 | Communication and networking infrastructure..... | 276 |
| 5.10 | Ninth proposition..... | 277 |

| | | |
|----------|--|-----|
| 5.10.1 | The current administration of ICT by the MoHM..... | 278 |
| 5.10.1.1 | The managerial role of MoHM for ICT..... | 278 |
| 5.10.1.2 | A failure to execute the plan..... | 280 |
| 5.10.1.3 | The absence of a policy for standardisation..... | 283 |
| 5.10.2 | The administrative issues of managing ICT for health care..... | 284 |
| 5.10.2.1 | Inspection..... | 285 |
| 5.10.2.2 | Bureaucracy..... | 286 |
| 5.10.3 | The potential problem of using an external agency to manage ICT in Malaysian health care..... | 287 |
| 5.10.3.1 | The authority of independent agency..... | 288 |
| 5.10.3.2 | Security and confidentiality issues..... | 290 |
| 5.11 | The key findings from the propositions..... | 290 |
| 5.11.1 | The key findings from the first proposition..... | 291 |
| 5.11.2 | The key findings from the second proposition..... | 292 |
| 5.11.3 | The key findings from the third proposition..... | 293 |
| 5.11.4 | The key findings from the fourth proposition..... | 294 |
| 5.11.5 | The key findings from the fifth proposition..... | 295 |
| 5.11.6 | The key findings from the sixth proposition..... | 296 |
| 5.11.7 | The key findings from the seventh proposition..... | 297 |
| 5.11.8 | The key findings from the eighth proposition..... | 298 |
| 5.11.9 | The key findings from the ninth proposition..... | 299 |
| 5.12 | Conclusion..... | 300 |

CHAPTER SIX

DISCUSSION: MODELS TO ADDRESS THE FACTORS AFFECTING THE INTEROPERABILITY OF HTIS/EHR IN MALAYSIA

| | | |
|-------|---|-----|
| 6.1 | Introduction..... | 302 |
| 6.2 | Infrastructural management..... | 303 |
| 6.2.1 | Changes in managing the ICT infrastructures..... | 303 |
| 6.2.2 | Managing the existing ICT infrastructures..... | 305 |
| 6.3 | Workflow management of administrators and users..... | 307 |
| 6.3.1 | Participation of stakeholders and users in the HTIS and EHR project... .. | 308 |
| 6.3.2 | Diversity of professions and knowledge gap | 310 |
| 6.4 | Innovative culture..... | 311 |
| 6.4.1 | Instilling the innovative culture among MoHM members..... | 312 |
| 6.5 | Leadership..... | 313 |
| 6.5.1 | Division of power..... | 314 |
| 6.5.2 | Changes in MoHM-vendor relations..... | 316 |
| 6.5.3 | Intellectual property management..... | 317 |
| 6.5.4 | The internal and external setup..... | 318 |
| 6.5.5 | Independent agencies to manage HTIS..... | 319 |
| 6.6 | Open-source software alternatives..... | 320 |
| 6.6.1 | Transformation in HTIS procurement..... | 320 |
| 6.7 | Standard appraisal..... | 322 |
| 6.7.1 | Supporting factors for standard adoption..... | 323 |
| 6.8 | Physicians' acceptance..... | 325 |
| 6.8.1 | Change management initiatives..... | 325 |

CHAPTER SEVEN

ACTORS AND MODEL FOR HTIS AND EHR INTEROPERABILITY

| | | |
|---------|--|-----|
| 7.1 | Introduction..... | 328 |
| 7.2 | The actors..... | 328 |
| 7.2.1 | Actors from the literature perspectives..... | 329 |
| 7.2.2 | The proposed actors..... | 331 |
| 7.2.2.1 | Actors from infrastructural management..... | 332 |
| 7.2.2.2 | Actors from workflow management improvement..... | 332 |
| 7.2.2.3 | Actors from innovative culture..... | 334 |
| 7.2.2.4 | Actors from leadership..... | 334 |
| 7.2.2.5 | Actors from OSS alternatives | 335 |
| 7.2.2.6 | Actors from standards appraisal..... | 336 |
| 7.2.2.7 | Actors from physicians' acceptance..... | 336 |
| 7.2.2.8 | Verification of actors | 337 |
| 7.3 | Model to implement interoperable EHR in Malaysia | 340 |
| 7.3.1 | Lessons from the model..... | 342 |

CHAPTER EIGHT

CONCLUSION AND RECOMMENDATIONS

| | | |
|---------|---|-----|
| 8.1 | Introduction..... | 346 |
| 8.2 | Attainment of research objectives..... | 347 |
| 8.2.1 | First research objective..... | 347 |
| 8.2.2 | Second research objective..... | 348 |
| 8.2.3 | Third research objective..... | 349 |
| 8.2.4 | Fourth research objective..... | 349 |
| 8.2.5 | Fifth research objective | 350 |
| 8.3 | Statement of Contribution and research novelty..... | 350 |
| 8.3.1 | Theoretical contribution..... | 351 |
| 8.3.1.1 | The theme matching method of data analysis..... | 351 |
| 8.3.1.2 | ICT adoption in healthcare for developing countries of Asian | 351 |
| 8.3.2 | Practical Contributions in the Malaysian Context..... | 352 |
| 8.3.2.1 | Managing HTIS and EHR interoperability in Malaysian public hospitals..... | 352 |
| 8.3.2.2 | Political determination and change management programme | 352 |
| 8.3.2.3 | The potentials of Patient Management System (PMS) | 353 |
| 8.3.2.4 | The significant roles of actors in ICT adoption in Malaysian healthcare | 354 |
| 8.3.3 | Recommendations to the Ministry of Health of Malaysia | 354 |
| 8.4 | Research limitations and recommendations for further work | 356 |
| | REFERENCES..... | 357 |

GLOSSARY OF ABBREVIATIONS

| | |
|--------|---|
| BS EN | : British Standards European Norms |
| CCIS | : Critical Care Information Systems |
| CDA | : Clinical Document Architecture |
| CEN | : European Committee for Standardisation (Comité Européen de Normalisation) |
| CEO | : Chief Operating Officer |
| CIS | : Chief Information Officer |
| CME | Continuing Medical Education |
| CMS | : Clinical Management System |
| CSS | : Clinical Support System |
| CSSD | : Central Sterilisation and Supply Department |
| DBH | : District Health Boards |
| DHCP | : Dynamic Host Configuration Protocol |
| DICOM | : Digital Imaging and Communications in Medicine |
| DSS | : Decision Support System |
| EAI | : Enterprise Application Integration |
| EHR | : Electronic Health Records |
| EKOS | : EKOS Company |
| EMR | : Electronic Medical Records |
| EMRX | : Electronic Medical Record Exchange |
| EPR | : Electronic Patient Records |
| EPU | : Economic Planning Unit |
| ESCAP | : Economic and Social Commission for Asia and the Pacific |
| GNU | : GNU's Not Unix |
| GDP | : Growth Domestic Product |
| GP | : General Practices |
| GPCG | : General Practice Computing Group |
| HA CMS | : Hospital Authority Clinical Management System |
| HIMSS | : Healthcare Information Management and Support Services |
| HIS | : Hospital Information System |
| HIT | : Health Information Technology |
| HISS | : Hospital Information Support System |
| HL7 | : Health Level 7 |
| HTIS | : Health Information System |
| ICEHR | : The Integrated Care Electronic Health Records' |
| ICT | : Information Communication Technology |
| ICU | : Implementation Coordination Unit |
| ILTS | : Intermediate and Long-term Care |
| IM&T | : Information Management and Technology |
| ISO | : Organisation for Standardisation |
| ITWG | : Exploit IT Maximally Workgroup |
| LHP | : Lifetime Health Plan |
| LHR | : Lifetime Health Records |
| LIS | : Laboratory Information System |
| MAMPU | : Malaysian Administrative Modernisation Planning Unit |
| MDEC | : Multimedia Development Corporation |
| MoHM | : Ministry of Health of Malaysia |
| MyHIX | : Malaysian Health Information Exchange |
| NEHTA | : National E-health Transition Authority |

NHS CRS : National Health Services Clinical Record Services
NHG : National Health Group
NHS : National Health Services
NHI : National Health Infrastructure
NIHN : National Health Information Network
NII : National Information Infrastructure
NPfIT : National Programme for IT
OSS : Open Source Software
PACS : Picture Archiving Communication System
PhIS : Pharmacy Information System
PLHP : Personalised Lifetime Health Plan
PMI : Person Master Index
PMS : Patient Management System
RIS : Radiology Information System
RFP : Request for Proposal
SingHealth : Singapore Health
SMS : Short Messaging Services
SNOMED CT : Systematised Nomenclature of Medicine Clinical Terms
SOAP : Simple Object Access Protocol
TPC : Tele Primary Care

LIST OF TABLES

| Tables | Subjects | Pages |
|---------------|--|--------------|
| Table 1.3.2A | : A summary of key findings from the previous study | 10 |
| Table 1.3.2B | : Socio-technical systems and focus of the research | 11 |
| Table 2.2.1.1 | : Functionalities of hospital information system | 21-22 |
| Table 2.2.2.1 | : Evolvement of EHR and links with other terms of EPR and EMR | 24-25 |
| Table 2.2.2.2 | : Hierarchy Components of the EHR Extract Reference Model | 26-27 |
| Table 2.2.3 | : Differences between traditional EHR and incorporated version of EHR | 30 |
| Table 2.3.5.1 | : The type of health service providers in Singapore | 50 |
| Table 2.3.6.1 | : The number of Hong Kong attendees to health services in 2010 | 53 |
| Table 2.3.6.2 | : Programmes under first phase of EHR implementation in Hong Kong | 54-55 |
| Table 2.3.7.1 | : The categories of health institutions in Taiwan | 56 |
| Table 2.3.8 | : Differences of healthcare systems between seven countries (United Kingdom, Canada, Australia, New Zealand, Singapore, Hong Kong, Taiwan) | 58 |
| Table 3.3.A | : Health statistics for Malaysian healthcare | 84 |
| Table 3.3.B | : The types of hospitals and their functions | 86-87 |
| Table 3.4.2A | : List of information systems used in Malaysian healthcare institutions | 89-92 |
| Table 3.4.2B | : The HIS and non-clinical modules for HTIS hospitals | 93-94 |
| Table 3.4.2.1 | : The Lifetime Health Plan and its subsystems | 97-98 |
| Table 4.2.1 | : Comparison of three research paradigms with respect to their methodological stances | 101-102 |
| Table 4.2.2 | : The interpretivism and this research | 104 |
| Table 4.3.1 | : Other similar research and their approach | 105-106 |
| Table 4.5.2 | : Examples of similar research that use case studies. | 116 |
| Table 4.6.1 | : Type of data collection techniques used in case study method of inquiry | 117-119 |
| Table 4.6.2A | : Details of the participants and data collection settings | 122 |
| Table 4.6.2B | : Meetings with the research participants | 123 |
| Table 4.6.4 | : The document details | 125-129 |
| Table 4.7 | : Phases of thematic analysis | 132 |
| Table 4.7.2 | : Illustration of codes | 134-139 |
| Table 4.7.3.1 | : Categories of themes and their codes | 140-143 |
| Table 5.1A | : Illustration of interviewees | 146-147 |
| Table 5.1B | : The propositions and respective themes | 148-149 |
| Table 5.2.1 | : The four categories of infrastructures | 150 |
| Table 5.2.1.2 | : The issues in ICT infrastructures | 154 |

| Tables | Subjects | Pages |
|----------------|---|--------------|
| Table 5.2.2 | : The types of interoperability | 159 |
| Table 5.3.1 | : Two issues in managing ICT procurement | 164 |
| Table 5.3.1.1 | : The categories of approval stages | 164 |
| Table 5.3.1.2 | : The categories of implementation method of ICT procurement | 169 |
| Table 5.3.1.2A | : Programmes and performance indicators for ICT strategic planning of Malaysian public sector | 171-172 |
| Table 5.3.2 | : The issues of direct negotiation | 176 |
| Table 5.3.3 | : Issues of intellectual property in HTIS procurement | 180 |
| Table 5.4.1 | : Levels of competency of MoHM's administrators | 183 |
| Table 5.4.1.1 | : The issues in level of innovation and competency | 184 |
| Table 5.5.1 | : The issues in hierarchies | 192 |
| Table 5.5.2 | : The type of external influences | 198 |
| Table 5.5.2.1 | : Categories of external interferences | 199 |
| Table 5.5.2.2 | : Two implications from external interferences | 203 |
| Table 5.6.1 | : Roles of standards | 206 |
| Table 5.6.1.1B | : Summary of recommended technical standards for Telemedicine projects | 209 |
| Table 5.6.1.2 | : The issues of interoperability | 211 |
| Table 5.7.2 | : The supporting variables in application of open source technology in Malaysian healthcare | 221 |
| Table 5.7.2.1 | : The issues in financial and licensing implication | 222 |
| Table 5.7.2.2 | : Reactions to Open Source Software directive | 227 |
| Table 5.8.1 | : Classification of quotations that discuss factors affecting the acceptance | 235 |
| Table 5.8.1.1 | : Categories of discussion | 235 |
| Table 5.8.1.2 | : Issues in incomplete phase of ICT procurements | 239 |
| Table 5.8.1.3 | : The classification of infrastructural inadequacy | 241 |
| Table 5.8.2 | : Benefits of EHR | 244 |
| Table 5.8.2.1 | : Issues in storage and retrieval | 244 |
| Table 5.8.2.2 | : Categories of improvement | 250 |
| Table 5.8.2.3 | : Issues in medical data exchange | 254 |
| Table 5.9 | : Level of EHR barriers in Malaysia | 262 |
| Table 5.9.1 | : The classification of intangible barriers | 262-263 |
| Table 5.9.1.3 | : Categories of external influences | 267 |
| Table 5.9.1.4 | : Categories of legal issues | 270 |
| Table 5.9.2 | : The classification of tangible barriers | 273 |
| Table 5.9.2.1 | : Classification of reasons for insufficient electricity infrastructures | 274 |
| Table 5.9.2.2 | : Issues in ICT infrastructures | 276 |
| Table 5.10.1 | : Classification of intangible barriers | 278 |
| Table 5.10.1.1 | : Managerial organisation of EHR in other countries | 279-280 |
| Table 5.10.1.2 | : The financial allocation for ICT in MoHM for 2010 and 2011 | 282 |

| Tables | Subjects | Pages |
|---------------|--|--------------|
| Table 5.10.2 | : Issues in administration of ICT in healthcare | 285 |
| Table 5.10.3 | : The potential problems under intangible barriers | 288 |
| Table 7.2.2.8 | : Confirmation of actors by the interviewees | 338-339 |

LIST OF FIGURES

| Figures | Subjects | Pages |
|-----------------|---|--------------|
| Figure 1.5 | : The Conceptual Framework | 15 |
| Figure 2.2.2.1 | : Archetype specification by dADL | 28 |
| Figure 2.3.1.2 | : The spectrum of NHS healthcare information systems | 32 |
| Figure 2.3.3.2 | : NEHTA interoperability framework | 45 |
| Figure 2.9 | : EAI framework for application integration in organisations | 74 |
| Figure 2.9.1A | : Factors that influence the adoption of EAI in healthcare | 76 |
| Figure 2.9.1B | : Factors for success and failure in HTIS implementation | 76 |
| Figure 2.10 | : Literature and nine issues of this research | 77 |
| Figure 3.3.A | : Health service providers in Malaysia | 83 |
| Figure 3.4.2 | : Different classifications of HTIS modules between two hospitals | 95 |
| Figure 4.4 | : Research Design | 110 |
| Figure 4.7.3 | : Coding process using the Atlas.ti | 139 |
| Figure 4.8 | : Theme matching model | 144 |
| Figure 5.3.1.1A | : The allocation of power to approve based on the incurred cost of ICT procurements | 166 |
| Figure 5.5.1 | : The flow of processes in ICT procurement at MoHM | 193 |
| Figure 5.7.2.2 | : Number of Open Source Software implementation in MoHM | 229 |
| Figure 5.10.1.3 | : The recommended standards for integration | 283 |
| Figure 6.2.1.A | : Current model of ICT infrastructural management | 304 |
| Figure 6.2.1B | : New model for ICT infrastructural management | 304 |
| Figure 6.2.2 | : New model for migration and usability of existing ICT infrastructures | 306 |
| Figure 6.3.1A | : Current participation of stakeholders and users in HTIS projects | 308 |
| Figure 6.3.1B | : New model of HTIS workflow management | 309 |
| Figure 6.3.2 | : A new model to bridge knowledge gaps in HTIS projects | 311 |
| Figure 6.4.1 | : New model of innovative culture | 313 |
| Figure 6.5.1 | : New model of division of power for top and middle management | 315 |
| Figure 6.5.2 | : New model of MoHM-vendor relations | 317 |
| Figure 6.6.1 | : New model of HTIS procurement using OSS | 322 |
| Figure 6.7.1A | : Standard adoption lifecycle | 323 |
| Figure 6.7.1B | : A new model for standard adoption in HTIS project management | 324 |
| Figure 6.8.1 | : Change management programme of MoHM | 326 |
| Figure 7.3 | : Model to implement interoperable HTIS and EHR in Malaysian public hospitals | 341 |

CHAPTER ONE

INTRODUCTION

1.1 General introduction

This chapter introduces the context for this research. It starts with a brief overview of the background of the research, the aims and objectives, problem statements, research questions, their justification and conceptual framework.

1.1.1 Structure of the thesis

The structure of the thesis is as follows. Chapter One introduces the research and provides a statement of the problem in sections 1.1, 1.2 and 1.3. The problem statement is divided into nine issues in section 1.3.1. Section 1.4 explains the justification of the research and its relevancy for ICT adoption in Malaysian health care. The following section 1.5 describes the conceptual framework of this research and two key aspects of it, which are the research questions and the aim and objectives of the work.

The literature review in Chapter Two considers the nine components of the problem statement based on previous studies. The chapter starts with definitions of relevant terms in section 2.2. Section 2.3 illustrates the implementation of ICT in health care in seven developed countries. The issues of barriers to implementing electronic health records (EHR) are outlined in section 2.4. Section 2.5 briefly discusses the issues of ICT governance in health care by focusing on EHR implementation. Section 2.6 discusses the issue of physicians' resistance to, and acceptance of, ICT and EHR adoption. The description of the role of standards in implementing interoperable EHR is highlighted in section 2.7. Section 2.8 highlights the adoption of open-source technology in health information systems (HTIS). The final section discusses the conceptual models from previous studies that discuss the identification of factors and actors in implementing technological healthcare systems.

Introduction

Chapter Three discusses health care in Malaysia. It starts with an overview of administrative systems in Malaysia. The discussion aims to outline certain elements contributing to the implementation of interoperable EHR and HTIS. The chapter also discusses ICT initiatives in the Malaysian public sector and health care in particular. It aims to present the efforts of the Malaysian government to widen the use of ICT in the public sector.

Chapter Four presents the Research Methodology used in this research. It starts by discussing the research paradigm which shaped the selection of a qualitative approach and case study research method. Section 4.5 discusses the case study method of inquiry and its relation to a qualitative approach. The next section, 4.6, discusses the data collection techniques, which include the formation of the case study and the settings and participants. It also highlights the triangulation technique that the researcher used for both semi-structured interviews and archival documents. Section 4.7 illustrates the techniques used to analyse the data, which were thematic analysis and theme matching.

Chapter Five expands the data analysis into more detail by testing the derived themes with nine propositions that shape this study. It is the longest chapter in this research, as it discusses in length the findings from the interviews and recommendations from the governmental documents. The findings for each proposition are reported at the end of this chapter in section 5.11.

Chapter Six presents seven factors affecting the interoperability of EHR and HTIS in Malaysia. The identification of those factors is one of the research outcomes and they are addressed through models of action plans. The models also represent recommendations to the Ministry of Health Malaysia (MoHM) on how to improve ICT project management in Malaysian healthcare.

Chapter Seven highlights another two outcomes from this research, which include identification of actors and development of an implementation model for interoperable HTIS and EHR. Actors refer to those who are accountable for performing specific duties in ICT adoption programmes for Malaysian public

hospitals. The implementation model is a combination of factors, sub-factors, actors, and relationship between factors.

Chapter Eight summarises the research accomplishment in terms of its attainment of the research aim and objectives, answers to the research questions, limitations of the research and suggestions for further research.

1.2 Background of the research

The adoption of ICT in health care has been slow compared to other industries (Grimson et al., 2000, p. 49; Carrol, 2003, p. 4; Kitch et al., 2003, p. 115; Urowitz et al., 2008, p. 2). Even developed countries like Canada, Australia, the United Kingdom and the United States have not fully adopted ICT in their health care systems (Jha et al., 2008), and, being a developing country, Malaysia still has some way to go. According to the Ministry of Health of Malaysia (2009e), only 16 out of 130 public or government-funded hospitals have hospital information systems, none of which can interoperate. Currently, patient records are only stored in hospitals where the patients receive their treatment, and no sharing mechanism exists for inter-hospital relationships. For referral cases, it takes a significant amount of time before physicians can access data from the patients' records. This practice does not only happen in hospitals with manual information processes, but also in hospitals that have already adopted total hospital information systems, because these systems are, as previously mentioned, not interoperable (Ministry of Health of Malaysia, 2009e).

Currently, very few empirical studies have been conducted to identify the factors and actors affecting the adoption of interoperable health information systems (HTIS) and electronic health records (EHR) in Malaysian public hospitals. The Ministry of Health of Malaysia (MoHM) has confirmed the non-existence of interoperability of HTIS and EHR across Malaysian public hospitals. This research aims to contribute input for the MoHM, in its efforts to implement interoperable HTIS and EHR.

Introduction

Both officials from MoHM and practitioners from the private sector assess this research as relevant. During the interview sessions, many MoHM officials appreciated this research as relevant to MoHM foci in implementing EHR. According to them, the failure of a national project in 1997 to integrate all HTIS in Malaysia under Telehealth gave a new dimension to decision-makers on how to approach the implementation. This research contributes some of the findings that they are looking for. During the pilot study, the private sector considered this study to be practical, as it does not heavily emphasise technology, which, according to them, does not contribute much to successful EHR implementation.

1.3 Problem statement of this research

Discrete and non-interoperated health information systems are a common situation in Malaysia. In 1997, the Malaysian government attempted to implement a national project to integrate all HTIS in Malaysia into a single system known as the Lifetime Health Plan (LHP). But unfortunately the LHP project was abandoned halfway through. One of the health information systems that supported LHP was the Lifetime Health Records (LHR). Identifying the importance of the ability to share patient record summaries, the Malaysian government proposed in the Ninth Malaysian Plan (2006-2010) to re-implement the LHR project. The number of hospitals with hospital information systems has increased since then, but it is still low compared to the total sum of hospitals, at around 11% of 131 hospitals. Considering the diversity of HTIS being procured by MoHM every year, including those under direct negotiation projects, interoperability is still far from being accomplished.

This qualitative research aims to identify factors and actors that are important to implementing interoperable HTIS and EHR across Malaysian public hospitals. The researcher chose a case study method using semi-structured interviews and document references, in order to identify the issues surrounding the successful implementation of an interoperable HTIS. The researcher was able to bring to light the problems in previous LHP projects, significant factors and actors for interoperable HTIS and EHR implementation and propose an implementation model. The population group involved in this research includes a sample of those

Introduction

who have been managing, administering, leading and making decisions for ICT projects for MoHM, and using the systems. They are government officials, both administrators and medical officers, from two divisions of MoHM and three hospitals. Those hospitals consist of two hospitals with hospital information systems and one hospital that is still using a paper-based system.

With regard to previous empirical studies that are relevant to this research, only a small number discuss ICT adoption or electronic health records in Malaysian public hospitals, though existing literature includes concept papers on how to conceptually implement or theoretically harness ICT in Malaysian health care. (Karim & Ahmad, 2010; Mohan & Razali., 2004, pp. 221-224; Daud, 2007; Asefzadeh & Moradi, 2005, pp. 32-35; Zaitun & Termanini, 2007, pp. 24-26; Suleiman, 2001, pp. 103-112; Senik, 2003, pp. 5-8; Ibrahim, 2004, pp. 6-8;).

A number of studies have also been conducted that propose factors that influence ICT adoption in health organisations outside Malaysia, for example Kimberly & Evanisko (1981), Kim & Michelman (1990), Themistocleous (2004), Khoubati et al. (2006), Khoubati & Themistocleous (2007).

From the foregoing assessment of the literature and history of failed HTIS implementation the research is founded upon an investigation of nine fundamental issues which will be discussed in the next section.

1.3.1 Focus of this research

Previous research has suggested a number of factors that have influenced the implementation of successful ICT adoption in healthcare. For example, Khoubati et al. (2006) identify fourteen factors that contribute to successful ICT adoption in healthcare and Brender (2010) discusses seven factors that represent external and internal determinants to successfully implement ICT in health care. All of these factors are discussed in section 2.9. To fit with the Malaysian healthcare environment, this research has matched those twenty-one factors (by Khoubati et al. and Brender) with official documents by MoHM and the work of Everett Rogers (2003). As a result, nine issues are identified as discussed in this section. These issues frame the scope of this thesis.

Introduction

The infrastructure to support the complexity of HTIS and EHR

The infrastructure that supports EHR and HTIS implementation can be categorised into two types: basic electricity infrastructure and ICT that includes software and hardware. Between the 7th Malaysian Plan (1996-2000) and the 9th Malaysian Plan (2006-2010), a huge amount was spent on improving these infrastructures (Economic Planning Unit 1996, 2001, 2006). Nevertheless, the targeted outcome, to improve ICT penetration into health care, is still limited as only 16 out of 131 hospitals have hospital information systems (11%). The first proposition in Chapter Five elaborates upon this issue in detail.

Departmental-based ICT procurement

There are 3292 health agencies in Malaysia (see Chapter 3, Table 3.3A). This figure includes eight non-MoHM hospitals. This research focuses on public hospitals, which also have a variety of departments that specialise in medical services. Ibrahim (2002, pp.423-424) identified that the number of departments in public hospitals depends on the size and type of hospital. Normally, for medium sized hospitals, there are 21 clinical and three administrative departments. Since there is no national ICT procurement plan for these departments, ICT projects based on departmental needs are inevitable. The second proposition in Chapter Five elaborates upon this issue in detail.

Human resource competency

Human resource competency determines the success of an organisation. There are around 80 officials who are graduates in computer science or ICT in the two division of IT in MoHM. They are the project managers and secretaries for ICT procurement meetings. The number itself suggests high complexity in managing human resources for implementing interoperable EHR. The third proposition in Chapter Five elaborates upon this issue in detail.

The hierarchical administrative system in Malaysia

The administrative system in Malaysia is hierarchical. Directives and communications are given from the top down. Directives and communications are delivered through circulars, cabinet decisions, letters and public announcements.

Introduction

The negative impact of this administrative style is that it promotes lobbying at top levels, which influences decisions in relation to ICT. An example of the lobbying effect is the direct negotiation of ICT procurements. The fourth proposition in Chapter Five discusses this issue in detail.

The selection of standards by MoHM to enable interoperability

Standards determine whether data can be shared across different information systems. They determine the compatibility, interoperability, interconnectivity, scalability, portability and real-time data sharing (Ministry of Health 1997). This research aims to understand the actual role of the standards based on the ICT environment in Malaysian health care and why the same standards have not enabled interoperability. The fifth proposition in Chapter Five discusses this issue in detail.

The use of open-source software (OSS) technology in health care

Being open and free to share makes open source software theoretically feasible to be used in Malaysian health care. The GNU public licence enables this software to be shared, used and improved by the users. Encouragement of OSS by Malaysian government departments such as Malaysian Administrative Modernisation and Management Planning Unit (MAMPU) shows a level of awareness among central agencies of the benefits of this technology (MAMPU 2010a). Knowing the level of adoption of this technology, and the perceptions of those who manage ICT projects in MoHM, enables an understanding of the real potential of OSS. The sixth proposition in Chapter Five discusses this issue in detail.

The acceptance of and resistance to EHR and HTIS by physicians

The willingness of stakeholders to use electronic health records is also a major issue for Malaysian hospitals seeking to implement interoperable electronic health records. Abd Ghani et al. (2008a, p. 88), in their comparative study of EHR adoption in five Asian countries, conclude that utilisation of ICT in Malaysia as a tool to improve health service delivery is still low. Doctors are still not fully using computers when recording patients' health data. Paper-based records are still widely used and kept in hospital premises. Computers are used primarily to

handle administrative work rather than for clinical use or patient-record management. The seventh proposition in Chapter Five elaborates upon this issue in detail.

The tangible and non-tangible barriers faced by MoHM in implementing interoperable EHR and HTIS

The ‘Telemedicine Blueprint’ (1997) is a document that explains in detail the technical and non-technical requirements of implementing interoperable EHR and HTIS. The failure to implement the interoperable EHR programme in 2000 suggests the importance of identifying the tangible and non-tangible barriers in the implementation. The eighth proposition in Chapter Five discusses this issue in detail.

The delegation of managerial power to an external agency to manage ICT in health care

The statutory body in the Malaysian government executes specific core business under the respective ministries. Its establishment prompted the researcher to examine the feasibility of that organisation to manage ICT for health care. The findings may contribute to implementing interoperable EHR and HTIS. The ninth proposition in Chapter Five elaborates upon this issue in detail.

1.3.2 Social technical systems and ICT adoption in healthcare

Social technical systems are important aspects in the field of ICT adoption in healthcare (Holden & Kalsh 2010, p. 166). It is important to appreciate that any IT system is likely to form part of socio-technical system where the IT system must be considered as part of a wider system which also involves a human aspect. As such, changes, which are defined by Foster-Fishman (2007, p. 197) as “*intentional process designed to alter the status quo by shifting and realigning the form and function of a targeted system*” must consider both technical and non-technical aspects. Different terms are used in different studies to describe changes in social-technical systems in healthcare. Plsek (1999, p. 438) for example, used ‘*innovative thinking*’ to describe the changes whereas other researchers used ‘*system thinking*’ (Leischow et al. 2008, p.198; Trochim et al. 2006, p.539;

Introduction

Rothschild et al. 2005, p. 395; Waldman 2006, p. 273;). The requirement to consider additional elements in applying new procedures and processes in medical environment was highlighted by Solberg et al. (1997, p. 272). According to them, to apply new system into medical care processes required more than input, process and outputs because of the complexity of its processes.

In conceptualising the '*system thinking*' in healthcare system, Leischow et al. (2008, p. 202) recommended four steps to successfully apply the changes in healthcare systems. Those steps are listed below:

- Develop and apply system methods and processes
- Build and maintain network relationships
- Build system and knowledge capacity
- Encourage transformation to a system culture

According to them (2008, p. 202), these four steps represent both internal and external elements in health organisations that require modifications before new changes in working systems can be applied. They also perceive them as exemplifying the systems thinking because they identify and provide frameworks to understand complex relationships in complex organisation for example, healthcare organisations.

In relation to this, Carayon (2012, p. 3851) proposes in her model, five elements that compose '*work system*' under socio-technical environment. Those elements are technology and tools; organisations; persons; tasks; and environment. In a literature analysis study, Ammenwerth et al. (2006) identified the impacts of socio-technical systems to determine the success of IT adoption in healthcare. They proposed a model known as FITT (Fit between Individuals, Tasks and Technology) to elaborate this element. The latest case study by Waterson (2014) has suggested that social-technical systems are the main factors that affect ICT adoption in healthcare in United Kingdom under NPfIT. The summary of the findings is shown in Table 1.3.2A.

Introduction

Table 1.3.2A: A summary of key findings from the study by Waterson (2014, p. 158)

| Findings | Details of the findings |
|---|---|
| Healthcare staff are not necessarily resistant to HIT but they may be reluctant to use HIT | Staff's reluctance to adopt new HIT systems often comes about for good reasons. The systems that are not fit for purpose will increase the workload and cause potential unsafe environment to the patient. |
| A method of 'whole systems' of social-technical approach is significant across multiple levels of system designs and implementation | HIT requires coordination and cooperation between multiple agencies and organisational groups (internal and external parties). The concerns and requirements of these groups have to be considered in parallel with additional process-oriented such as working practices and routines as well as technical factors. Furthermore, national healthcare system at the macro level needs to be parallel with the local healthcare authority. |
| HIT implementation needs to suit larger complex and dynamic socio-technical system | Healthcare is not like a production line process. Healthcare involves many loops based on constant feedbacks between different stakeholders and has many different routes, mechanisms to achieve task completion. |
| HIT can act to improve but also threaten patient safety - careful attention needs to be paid to avoid medical errors. | HIT requires careful evaluation and proper design activities to reduce potential errors that can cause harm to patients. |
| HIT necessitates an evolutionary approach to long-term change management | The changes brought about HIT need to be seen in a longer-term context. The context needs to be reviewed by constant cycles of assessment especially in analysis and design cycles. |
| HIT can cause working in less paper environment or in 'paper-light. However, paperless 'working' environment is almost certainly a 'myth' | There are still big needs for paper-based documents and other materials in health working environment and within its workflows. |

These three studies have directed the researcher to identify relevant stakeholders and confirm the suitability of those nine issues (section 1.3.1), in relation to ICT adoption in Malaysian healthcare. Table 1.3.2B shows the relationship between elements from those studies with nine issues that are highlighted.

Introduction

Table 1.3.2B: Socio-technical systems and focus of the research

| Socio-technical systems (Summaries from three studies) | Nine issues (Section 1.3.1) | Potential stakeholders to clarify these issues |
|---|--|--|
| Technology and tools | <ul style="list-style-type: none"> • Infrastructures to support the complexity of HTIS and EHR | <ul style="list-style-type: none"> ➤ IT officials from both MoHM and Malaysian public hospitals who manage or administer the issues related to infrastructures ➤ Users (physicians and hospital administrators) who have experiences with either sufficiency or insufficiency of existing infrastructures to support ICT adoptions in Malaysian public hospitals |
| | <ul style="list-style-type: none"> • The selection of standards by MoHM to enable interoperability | <ul style="list-style-type: none"> ➤ IT officials from both MoHM and Malaysian public hospitals involve directly or indirectly in the issue of standards for HTIS. |
| | <ul style="list-style-type: none"> • The use of open-source software (OSS) technology in healthcare | <ul style="list-style-type: none"> ➤ IT officials from both MoHM and Malaysian public hospitals who are dealing with evaluate the suitability of any technology to be applied in Malaysian healthcare. |
| Organisations | <ul style="list-style-type: none"> • Department-based | <ul style="list-style-type: none"> ➤ Administrative |

Introduction

| Socio-technical systems (Summaries from three studies) | Nine issues (Section 1.3.1) | Potential stakeholders to clarify these issues |
|---|---|---|
| | <p>ICT procurement</p> <ul style="list-style-type: none"> • The hierarchical administrative system in Malaysia | <p>officer who manage the proposals and requests from health agencies under MoHM on ICT procurement processes</p> <ul style="list-style-type: none"> ➤ Circulars and official letters from Malaysian government about procedures to apply ICT in government agencies. |
| Persons / Individuals | <ul style="list-style-type: none"> • Human resource competency • The acceptance of and resistance to EHR and HTIS by physicians | <ul style="list-style-type: none"> ➤ Administrative officer who manage the proposals and requests from health agencies under MoHM on ICT procurement processes ➤ Users (physicians and hospital administrators) who have experiences using EHR and HTIS. |
| Environment | <ul style="list-style-type: none"> • The tangible and non-tangible barriers faced by MoHM in implementing interoperable EHR and HTIS | <ul style="list-style-type: none"> ➤ Administrative officer who manage the proposals and requests from health agencies under MoHM on ICT procurement processes ➤ Circulars and official letters from Malaysian government about procedures to apply ICT in government |

Introduction

| Socio-technical systems (Summaries from three studies) | Nine issues (Section 1.3.1) | Potential stakeholders to clarify these issues |
|---|------------------------------------|---|
| | | agencies. |

1.4 Justification of the research

Investigation of the above issues should help fill the research gaps in the adoption of information technology by health care organisations, particularly the factors related to the interoperability of electronic health records (EHR) and health information systems (HTIS). Consideration of these issues should also provide more information to address some of the points resulting from the previous studies mentioned below.

According to Raghupathi and Kesh (2007; 2009, pp. 66-68), there are four factors that limit the interoperability of electronic health records. The first is that the technology is often vendor driven, which causes the systems to be rigid. Second is the difficulty of securing compliance with generalised standards. Third is the complexity of the health care delivery processes, and finally, the unwillingness of providers to share their technology and ideas. The current solutions for electronic health records are mostly relational databases that have been traditionally developed based on closely coupled technology.

In their quantitative study of the practice of ICT outsourcing in Malaysian public agencies, Arshad and Mohamed (2007, pp. 121-123) highlight the first reason given by Raghupathi and Kesh (2007) for the shortcomings of vendor-driven technology to support interoperability. The shortcomings are inappropriate ICT outsourcing, transfer of technology, poor documentation, vendor management, transparency in awarding the ICT projects and the specifications included in the Request for Proposal (RFP) documents. An attempt to explain these issues is made through objective two (see section 1.5.2), which aims to identify the barriers faced by Malaysian hospitals in ICT adoption, particularly as it concerns electronic health records. The barriers include both technical and non-technical components.

Introduction

The issue of standards compliance (Raghupathi & Kesh, 2007) also justifies this research. Since 1997, the MoHM has formulated a clear directive to all health care agencies about standards in ICT procurement. Every procurement or development of applications to be used in hospitals under MoHM must be HL7 and DICOM compliant (Ministry of Health, 2009e). Recent ICT strategic planning (Ministry of Health, 2008) also highlights the issues of optimisation of use in ICT procurement, which should be a result of this directive. This issue will be tackled through the answer to research question two (see section 1.5.1), which addresses the relevance of standards in supporting interoperability.

With regards to the gaps in the research related to the adoption of electronic health records in general, Lobach and Detmer (2007, pp. 105-110) identified seven areas that are not well tackled by researchers when evaluating electronic health records.

These seven gaps are listed below:

1. The issues related to system development.
2. The issues related to system implementation.
3. The impact of electronic health records in the clinical setting.
4. The policies that will protect patient health information.
5. The policies related to the patient's unique identifier.
6. The policies related to access to personal health information.
7. The issues related to universal standards.

Ontologically, Lobach and Detmer (2007) compress these seven issues into two main challenges or barriers to electronic health record adoption. The first main challenge is related to the selection of methodology to evaluate electronic health record adoption. The second main barrier is related to the data derived from electronic health records. All of the seven sub-issues are directly related to the scope of this research.

Since 1997, under various plans, Malaysian health care has been in the process of widening the use of HTIS and EHR in health care. However, further research is required to identify the factors that influence the adoption of interoperable

electronic health records as they apply to the Malaysian context. Mat Taib (2005), in his PhD thesis, suggests that further research to evaluate implementation of interoperable EHR and HTIS in Malaysian health care supports this.

1.5 Conceptual framework

A conceptual framework provides the foci of the research. In designing the conceptual framework, Pickard (2007, pp. 39-40) suggests that the research questions and objectives are the key issues. The research questions emphasise the reasons why interoperable EHR has not been achieved in Malaysian public hospitals. The research objectives are formulated to provide answers to the research questions but with emphasis on statements of the problems that direct the anticipated outcomes of this research. Figure 1.5 illustrates the conceptual framework of this research.

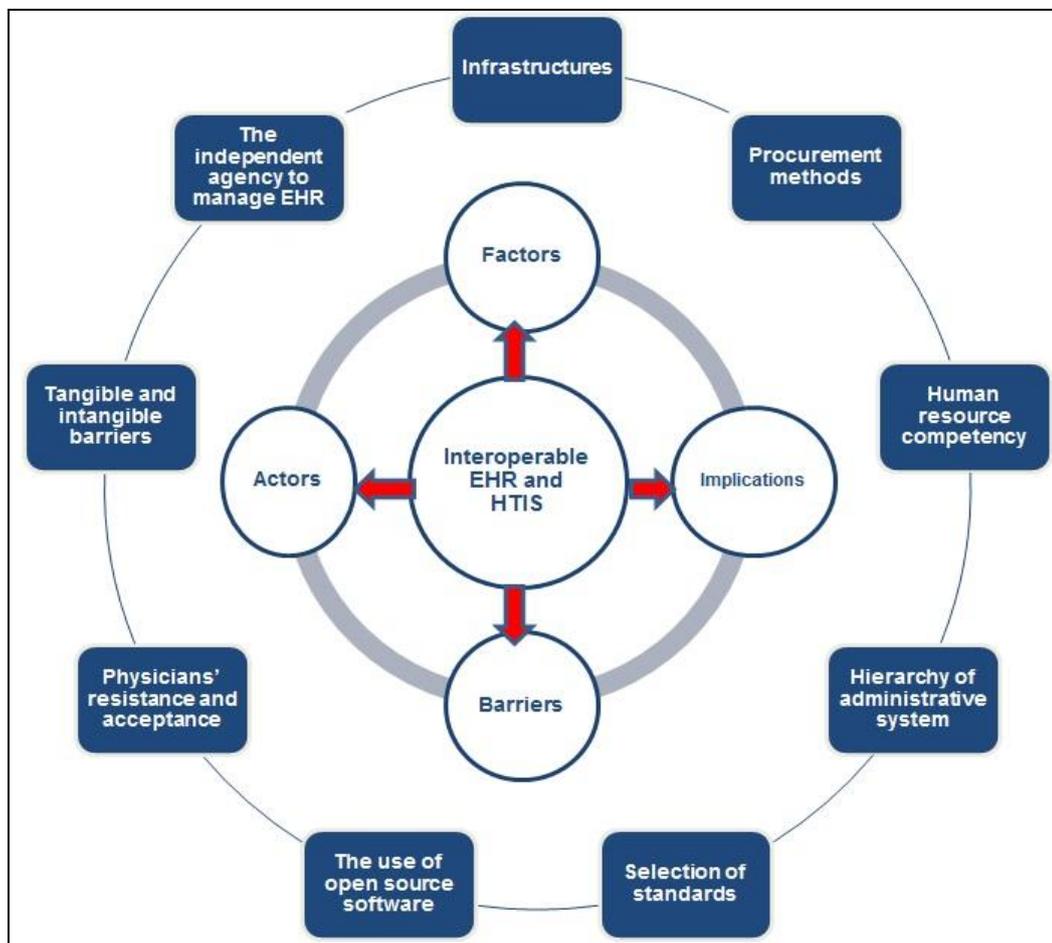


Figure 1.5 Conceptual framework.

Introduction

The conceptual framework requires details that shape the whole idea behind the research. The details include research questions, research objectives, methodological choice and the method of inquiry (Pickard 2007, p. 40). At this stage, instead of identifying a central issue, problem statements, the relevant theory and potential sites, the choice of methodology and method of inquiry are added into the context. Knowing the type of methodology and method of inquiry, research questions are then designed. As proposed by Creswell (2009) these research questions include the central research question and associated sub-questions. Subsequently, research objectives are formed that reflect the central issue, problem statements, methodology and method of inquiry.

1.5.1 Research questions

Creswell (2009, pp. 129-132) proposes two types of research questions to be used for qualitative research. The first type is a broad central question that highlights the central issues or phenomena of the investigation. The second type are associated sub-questions that narrow the focus of the study. According to him, the central research question and sub-questions can be set by forming one or two central questions followed by no more than five sub-questions.

Central research question:

Why can hospitals that use information systems not exchange their patients' health records electronically in Malaysia?

Sub-question 1:

How capable are elements of information systems in Malaysian hospitals of supporting interoperability of electronic health records?

Sub-question 2:

Why can hospital information systems that use the same standards not support interoperability of electronic health records in Malaysia?

Sub-question 3:

Why is open-source technology not widely used in Malaysian public hospitals despite of its notion of being open and free?

Sub-question 4:

How influential are managerial and administrative entities in affecting implementation of interoperable electronic health records and HTIS?

Research questions also have to be verified with the method of inquiry. In a case study, the questions should address the illustration of the case and the themes that emerge from studying it (Creswell, 2009, p. 130). The use of the words ‘why’ and ‘how’ are examples of questions that are normally used in the case study method (Yin, 2009, p. 9).

1.5.2 Research aim and objectives

In designing the research objectives, Pickard (2007, p. 45) proposes a checklist that includes reasons and purposes of the research, anticipated knowledge and outcomes, and potential tools to achieve the outcomes. The checklist contributes to the formation of the aim and objectives of this research. This research is being conducted because the researcher wants to know why Malaysian hospitals cannot exchange health information with each other. Since there are many possible answers to this question, the researcher needs to have a focus. Therefore, the intention is to establish the factors that influence the adoption of HTIS and electronic health records in Malaysia. From this investigation, it is hoped that the researcher might be able to identify possible important actors, plus discover the barriers and technological gaps that Malaysian public hospitals have experienced over the years. In an effort to understand all of this, the researcher identified, through the literature review, nine issues that act as the statement of the problem of the research. Section 1.3.1 described those issues in detail.

Thus, this research aims to do the following:

Aim: To establish factors and actors that influence the implementation of interoperable electronic health records in hospitals of Malaysia.

This aim will be supported by the following objectives:

Objective 1: To conduct a critical literature review of previous studies related to the implementation of interoperable hospital information systems and electronic health records, in order to understand the background problems and propose solutions for this research

Introduction

Objective 2: To form a model that highlights factors and actors in implementing interoperable electronic health records in Malaysia.

Objective 3: To identify the barriers faced by Malaysian hospitals when implementing electronic health records.

Objective 4: To understand the level of managerial and administrative influences in implementing interoperable electronic health records in Malaysia.

Objective 5: To establish the external and internal influences that affect the implementation of interoperable electronic health records and health information systems in Malaysia.

Objective 6: To present recommendations for implementing interoperable electronic health records to the Ministry of Health of Malaysia based on the findings of this research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews and examines the literature that discusses ICT and EHR adoption and is relevant to the research aim, objectives and questions. The chapter starts with a discussion of the relevant terms used in this research. The chapter continues by reviewing, comparing and contrasting the existing literature in terms of different approaches and implementation methods in other countries. This chapter also highlights the reflections of literature reviews in developing the nine propositions, which act as a framework of the problem statement, data collection and analysis and direction of this research.

2.2 Discussion of terms

Terms can assist the understanding of the proposed research project. In inductive qualitative research, terms are defined in discrete sections, in which every term needs to complement each other until all the research findings are developed. The terms are defined based on the existing literature, and the definitions must be consistent from the introduction to the conclusion of the research (Creswell 2009, pp. 39-42).

Five general terms define this research. They are health information systems, hospital information systems, electronic health records, interoperability and public hospitals. The discussion is based on the definitions given by previous literature and their applications to this research.

2.2.1 Health information systems

This technology is perceived by many studies as a transformation from simple hospital information systems that perform basic ICT solutions for hospitals into a wider functionality. Haux et al. (2004, p. 33) perceived the interconnectivity of a health information system (HTIS) as wider than a hospital information system

(HIS), interacting not only between departments but also with external organisations. Kuhn and Giuse (2001, p. 275) acknowledge this evolution as a transformation of a hospital information system into a networked and integrated environment, which upgrades the name to be more universal.

2.2.1.1 Hospital information systems

Haux et al. (2004, p. 30) define a hospital information system as the:

‘Socio-technical subsystem of a hospital, which comprises all information processing as well as the associated human or technical actors in information processing roles.’

This definition is developed based on the meaning of ‘system’ and the functionality of information systems. Haux, Winter & Brigl (2004, p. 26) view the word ‘system’ as including people, things, events and entities that are working together in clear relationships. An ‘information system’, according to them, refers to the:

‘Socio-technical subsystem of an enterprise, which comprises all information processing as well as the associated human or technical actors in their respective information processing roles.’

This actually forms the definition of ‘hospital information system’, where the relationship is based on four functionalities of any information systems: enterprise functions, business processes, application components and physical data processing. Haux et al. (2004, p. 30) regard these components as hospital functions. This view is supported by Winter et al. (2003, p. 544), who view the hospital as a system where humans and machines work together to accomplish specific tasks under established rules.

In recent years, there has been increasing interest in shifting from departmentalised hospital information systems (HIS) to the use of health information systems (HTIS). Haux et al. (2006, p. 33) support this view, and report the initial transformation in the United States under the flagship of *integrated health delivery systems*. In another study, Haux (2006, p. 797)

Literature Review

considers that a hospital information system is only an institutionalised health information system or HTIS that is attached to an institution.

However, this interest has still not changed the significant role played by HIS as an information-processing engine for hospitals. An HIS is a complex system that comprises various modules based on the functionalities of various departments (Winter & Wendth, 2003, p. 545; Haux et al 2006, p. 30).

These functionalities are further explained by Czekierda et al. (2006, p. 94), who define the main and sub-functions of HIS. Table 2.2.1.1 elaborates these functionalities.

Table 2.2.1.1: Functionalities of hospital information systems (Czekierda et al., 2006, p. 94).

| Functionalities | Activities |
|---|--|
| Storing patient data and monitoring their state | <ul style="list-style-type: none">• Electronic health records (storing and retrieving)• Alerting the medical professional of a new data discovery• Time management for scheduled tests or non-scheduled tests• Processing data for statistical purposes and for research |
| Data flow and staff management | <ul style="list-style-type: none">• Automatic transfer of patient data between outpatient and inpatient clinics• Graphical, digitised diagnostic images from hospital digital imaging storage and retrieval systems• Digital signatures for online orders and requests• Communication with laboratory information systems (LIS) |

Literature Review

| Functionalities | Activities |
|-------------------------------------|---|
| | <ul style="list-style-type: none">• Scheduling staff resources |
| Administration of financial aspects | <ul style="list-style-type: none">• Efficient administration of finance• Monitoring of drug usage and ordering effectiveness• Tracking and reporting expected and actual treatment costs• Automatically scheduling nursing staff requirements• Evaluating bed status and whole hospital performance |

Before the concept of total hospital information systems was introduced, many sub-functions of HIS were implemented as separate entities. Examples of this practice in the 1980s in the UK included the use of information systems by the NHS such as patient administrative systems and lab and radiology systems, GP systems, pathology laboratory systems, theatre systems and nursing and care planning systems (Brennan, 2005, pp. 39-47). When the Hospital Information Support System (HISS) was launched in 1988, there was an attempt to integrate these sub-functionalities into it, but this failed because they were departmental and stand-alone clinical specialty systems (Brennan, 2005, pp. 49-51). This view acknowledges the importance of the issues of technology and user attitudes when integrating various modules into a total hospital information system (Krabbel & Ratuski, 1995).

2.2.2 Electronic health records (EHR)

ISO/TR 20514 (2005, p. 2) defines electronic health as: ‘...a repository of information regarding the health status of a subject of care in computer processable form, stored and transmitted securely, and accessible by multiple authorised users.’

This definition is further elaborated by Urowitz et al. (2008, p. 2), who view EHR as:

Literature Review

‘...a computerised version of an individual’s health record that may contain a person’s full health and medical record or can be used for certain records, such as lab results, in conjunction with a more traditional, paper-based, patient chart.’

Under different information system frameworks, EHR is an integrated part of HTIS, in which its modules are processed by HTIS. In lamenting the issues of lack of interoperability of EHR, Kitsiou et al (2009, p. 375) also highlight EHR as an output of different HTIS in hospitals.

Abd Ghani et al. (2008b, p. 2) conducted a study of Lifetime Health Records and the integration of electronic health records in Malaysia. They reported that the reason for implementing LHR in Malaysia is to store and process the Malaysian patient’s health record over his lifetime, with the capability of integrating a discrete spectrum of health information systems and health care levels.

Concerning interoperability, the International Organisation for Standardisation (ISO) provides a lengthy definition of interoperable electronic health records, which it calls ‘The Integrated Care Electronic Health Records’ or ICEHR (ISO/TR 20514: 2005, p. 10). ISO defines ICEHR as:

‘...a repository of information regarding the health status of a subject’s care in computer processable form stored and transmitted securely and accessibly by multiple authorised users. It has a standardised or commonly agreed logical information model, which is independent of EHR systems. Its primary purpose is the support of continuing, efficient and quality integrated health care and it contains information, which is retrospective, concurrent, and prospective.’

According to ISO/TR 20514 (2005, p. 11), this common information model is influenced by four factors. First is the type of standards that are agreed at the national and international level to support interoperability, such as ISO, CEN and HL7. The second factor is the administrative process of formal or informal agreement at the level of a group of users, such as a local or regional health

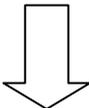
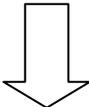
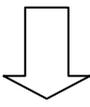
Literature Review

authority, to decide the selection of standards for interoperability. The third factor is the structure of the information that describes the type of relationships between the structures. The fourth factor is the design model or product model that describes the logical structure of the electronic health records information model. These four issues are the subjects that this research attempts to understand but in the more specific context of Malaysian public hospitals.

2.2.2.1 Electronic Patient Record and Electronic Medical Record

The definition of EHR in previous section shows a need to be explicit about other definitions of terms such as Electronic Patient Records (EPR) and Electronic Medical Records (EMR). It is because the broad use of the EHR is sometimes equated with other terms such as (EPR and EMR). Uslu and Stausberg (2008, p. 676) in their literature analysis study have concluded that the broad term EHR includes other narrow terms such as EPR and EMR. They consider the use of EHR in stages contributes to the evolvement of EPR definitions. To illustrate the evolvement, a modification is made to show the links between definitions, which is in Table 2.2.2.1.

Table 2.2.2.1: Evolvement of EHR and links with other terms of EPR and EMR (modified from Uslu & Stausberg 2008, p. 676)

| Terms | Definitions |
|--|--|
| Automated Medical Record (First stage)  | It is a paper-based record which has computer-generated documents as additional part of it. |
| Computerised Medical Record (Second stage)  | It is a medical record, which is transformed and available in electronic and digital formats via scanning of all not computer-generated documents with the same structure and contents as the first stage. |
| Electronic Medical Record (Third stage)  | It is a medical record, which is attained from the second stage by reconstructing and upgraded for computer processing with the same contents as the first two stages with the possibility for interoperability. |
| Electronic Patient Record (Fourth stage)  | It is an extended content of patient-centred record about different supplying facilities and health providers about the patient. |
| Electronic Health Record | It is patient extended record, which |

Literature Review

| Terms | Definitions |
|-------|--|
| | includes only the relevant data and is attained from the fourth stage. |

The evolvement of these medical records is also outlined by Rodriguez (2010) who defines these three according to the processes involved generating each of them. According to him, these three records refer to:

“Electronic medical record (EMR) is a medical record in digital format, whereas electronic health record (EHR) refers to an individual patient’s medical record in digital format. EHR systems coordinate the storage and retrieval of individual records with the aid of computers, which are usually accessed on a computer, often over a network. One of the important trends is the move towards a universal electronic patient record (EPR). EPR is defined as electronically stored health information about one individual uniquely identified by an identifier. Essentially, EPR technology entails capturing, storing, retrieving, transmitting, and manipulating patient-specific, healthcare related data singly and comprehensively, including clinical, administrative, and biographical data.

The categorisation of definitions of these three records is also acknowledged in a comparative study by Protti et al. (2009, p. 271). Their definitions indirectly illustrate the role of EHR as a broad term, and the other two (EMR and EPR) as narrower terms. They also consider the distinction between these three records is related to the processes that involved either during record creation or record storage. According to them, EMR is an individual’s health information that is created, gathered, managed and consulted by authorised clinicians and staff within one health organisation. In other words, EMR is more provider-centric such as physician’s office. EPR on the other hand, is more facility-centric, which refers to individual’s health information that is created, gathered, managed and disseminated within health facilities such as hospitals and its facilities. They also extend the meaning of EHR to refer to health-related information of individuals that is created, gathered, managed and consulted by authorised clinicians in health organisations and is compliant to the national interoperability standards for data exchange across different health agencies.

2.2.2.2 The reference model of EHR

This section explains the actual formation of electronic health records. According to BS EN 13606-1 (2007, p. 6), ‘The Reference Model’ describes the global characteristics of electronic health record components. The characteristics include the ways that the components are aggregated, alongside context information that defines the ethical and legal provision of health care. In addition, this model depicts the set of classes that form the generic building block of the EHR. This building block is called the Logical Building Block by Kalra, (2006, p. 141) and is also known as the RECORD_COMPONENT by BS EN 13606-1 (2007, p. 8). The Reference Model describes this hierarchy according to the contents and their relationships. Table 2.2.2.2 illustrates the components of the EHR Extract Reference Model.

Table 2.2.2.2: Hierarchy Components of the EHR Extract Reference Model (BS EN 13606-1: 2007, p. 8).

| EHR Hierarchy Components | Description | Examples |
|--------------------------|---|---|
| EHR EXTRACT | The top-level container of EHR It is used to represent all the components during the communication process between sender and receiver. | |
| FOLDER | The high-level organisation within an EHR. It is divided into compartments relating to care provided for a single condition, by a clinical team or institution, or over a fixed time period such as an episode of care. | Diabetes, paediatric, Leicestershire Royal Infirmary, Loughborough |
| COMPOSITION | The set of information committed to one EHR by one agent as a result of a single clinical encounter or record documentation session. | Discharge summary, progress note, laboratory test result, referral letter, diabetes |

Literature Review

| EHR Hierarchy Components | Description | Examples |
|--------------------------|---|---|
| | | review |
| SECTION | EHR data within the COMPOSITION that belongs under one clinical heading. It usually reflects the flow of information gathering during a clinical encounter. | Reason for encounter, past history, allergy information, treatment, abdominal examination |
| ENTRY | The information recorded in EHR as a result of one clinical action, one observation, one clinical interpretation or an intention. It is also called a clinical statement. | A symptom, an observation, a prescribed drug, blood pressure measurement |
| CLUSTER | The means of organising nested multi-part data structures such as time series and to represent the columns of a table. | Audiogram result, weighted-differential diagnosis |
| ELEMENT | A single data value | Heart rate, drug name, body weight |

BS EN 13606-1 (2007, p. 8) describes the hierarchical relationships of these entities with the following statements:

‘An EHR_EXTRACT contains EHR data as COMPOSITIONS, optionally organised by a FOLDER hierarchy.

COMPOSITIONS contain ENTRYs, optionally contained within a SECTION hierarchy

ENTRYs contain ELEMENTS, optionally contained within a CLUSTER hierarchy.’

Archetypes specify sub-classes of each RECORD_COMPONENT by defining names and other relevant attribute values that function as meta-data for the specific characteristics of RECORD_COMPONENT (BS EN 13606-2: 2008, p.

v). Archetypes are defined in the Data Archetype Definition Language (dADL), whose syntax provides a formal means of expressing instance data based on an underlying information model, which is readable by both humans and machines. For example, dADL specifies an identifier for PERSON together with its attribute names and values. BS EN 13606-2 (2008, p. 59) also specifies characters to be used in EHR systems under dADL, which are listed below:

- '<': open an object block;
- '>': close an object block;
- '=': indicate attribute value = object block;
- '(', ')': type name or plug-in syntax-type delimiters;
- '<#': open an object block expressed in a plug-in syntax;
- '#>': close an object block expressed in a plug-in syntax.

Within <> delimiters, the following characters are used to indicate primitive values:

Figure 2.2.2.2 illustrates an example of specifications set by dADL for PERSON identifier.

```
person = List<PERSON> <
  [01234] = <
    name = <                                -- persons name
    forenames =                               <"Sherlock">
    family_name =                             <"Holmes">
    salutation =                              <"Mr">
    >
    address = <                                -- persons address
    habitation_number =                       <"221B">
    street_name =                             <Baker St>
    city =                                    <London>
    country =                                 <England>
    >
  >
  [01235] = < -- etc
  >
>
```

Figure 2.2.2.2: Archetype specification in dADL (BS EN 13606-2: 2008, p. 59)

The purpose of Archetype specification is to assist interoperability of EHR systems. This is done by representing every conceivable kind of health record data structure in a consistent way. This is necessary because of the diversity of clinical data sets, value sets and templates as clinical practice and medical knowledge advance. Its development also is an acknowledgement of the challenges facing

EHR interoperability, which require universal specifications from respectable agencies (BS EN 13606-2: 2008, p. v).

2.2.3 Interoperability

While a variety of definitions of the term ‘interoperability’ have been suggested, the definition by the British Standards Institution (PD ISO/TR 16056-1:2004 p. 6) appears to be relevant to this research. According to them, interoperability refers to:

‘...the ability of two or more systems (computers, communication devices, networks, software, and other information technology components) to interact with one another and exchange information according to a prescribed method in order to achieve predictable results.’

This definition provides only one dimension of interoperability, which is the end-process of interoperating. In defining the implication of this definition, the standards committee (PD ISO/TR 16056-1:2004, pp. 13-14) has outlined two aspects that derive from this definition. The first aspect is the substance that is being delivered by the system. This first aspect attempts to identify two issues:

‘WHAT’ information is being exchanged? This is defined by means of information models, which model data entities, their attributes, and the relationships between the entities.

‘WHAT’ tasks actually exchange the information? This is defined by means of functional models, which model processes and activities performed by the system.

The second aspect that they would like to convey from this definition is the ways and means to achieve this interoperability. This aspect is defined by the tasks and entities that interact within the process.

To obtain interoperability, Raghupathi and Kesh (2009, pp. 69-72) propose the incorporation of EHR into total health information systems, or what they call a ‘Total Digital Health System’. This technical incorporation enables EHR to interoperate with external applications. Table 2.2.3 summarises the difference between traditional EHR and the incorporated/integrated version of EHR.

Literature Review

Table 2.2.3: Differences between traditional EHR and the incorporated version of EHR (Raghupathi and Kesh, 2009, p. 72).

| Concept | Traditional EHR | Integrated EHR |
|------------------------|--|---|
| Nature of Model | Closed Hard Inflexible Axiomatic Sequential | Open Soft Flexible Dynamic Holistic |
| Architecture | Entity relationship Relational model Record driven Centralised Monolithic Dependency Mostly vendor driven Limited functionality | Service oriented Web services Model driven Distributed Integrated Loosely coupled Platform independent Scalable |
| Focus Design | Intra-enterprise Stand-alone View based Physical Platform dependent Data oriented Table, files, DBMS Views, queries Reports | Inter-enterprise Interoperable Service based Higher level of abstraction Modular/components Process oriented Object oriented (UML) Classes Need for standards |
| Control | Mostly explicit Federated | Mostly explicit Federated |
| Domain Characteristics | Simple More structured | Complex Structure |

The differences assist the researcher to formulate the interview questions on the technical aspects.

2.2.4 Public hospitals

Central to this research is an understanding of the functions and roles of public hospitals, especially in Malaysian health care. In an attempt to classify hospitals in Malaysia, Noor Ghani and Yadav (2008, pp. 79-81) linked public hospitals with hospital management, locations and level of services offered by the hospitals. It implies that the Malaysian government, under different ministries, manages public hospitals. The details of the definition are illustrated in Table 3.3B.

2.3 The adoption of ICT in seven developed countries

The purpose of this section of the literature review is to compare the efforts to implement e-health by the Malaysian government with the initiatives of seven developed countries: the United Kingdom, Australia, Canada, New Zealand, Singapore, Taiwan and Hong Kong. The methods and mechanisms that these countries use to adopt ICT in their health care provide direction for this research.

2.3.1 United Kingdom

2.3.1.1 Overview of the United Kingdom's health care system

The health care system in the UK is formed under the notion of a welfare state in which health care is the responsibility of the government.

2.3.1.2 The adoption of ICT in United Kingdom health care

The adoption of ICT in the United Kingdom has been through various stages. There were stages of segregation and piecemeal implementation, and there was a stage of a holistic national plan aimed at integrating patient health records. The piecemeal implementation resulted in the segregated procurement of health information systems that were not interoperable, since they were developed by different vendors under different standards and technologies (Brennan, 2005). Having had segregated implementation of ICT adoption since the 1960s, the NHS realised the importance of having a national plan to rationalise the use of HTIS/HIS. Therefore, in 1998, one national strategy was launched that proposed the action plans to implement integrated patient health records all over the United Kingdom by 2005, followed up with various reports and White Papers concerning

Literature Review

the adoption of ICT in the UK (Burns, 1998). Two eras represent ICT adoption in United Kingdom health care: before 1998 and after 1998.

ICT adoption in the UK before 1998

Prior to 1988, the development of ICT in health care in the United Kingdom went through various stages. Brennan (2005) lists the information systems procured by the NHS from the 1960s to the 1990s, including the procurement of Patient Administration Systems in the 1960s, Lab and Radiology Systems in the 1970s, Hospital Information Support System (HISS) in the 1980s and Resource Management in the 1990s. The key indicator from this development shows that awareness of the importance of ICT adoption in health care started three decades ago in the UK, and has undergone various stages of improvement. Besides the positive indicator, the spectrum also depicts a non-strategic ICT programme by the NHS. Figure 2.3.1.2 illustrates this development.

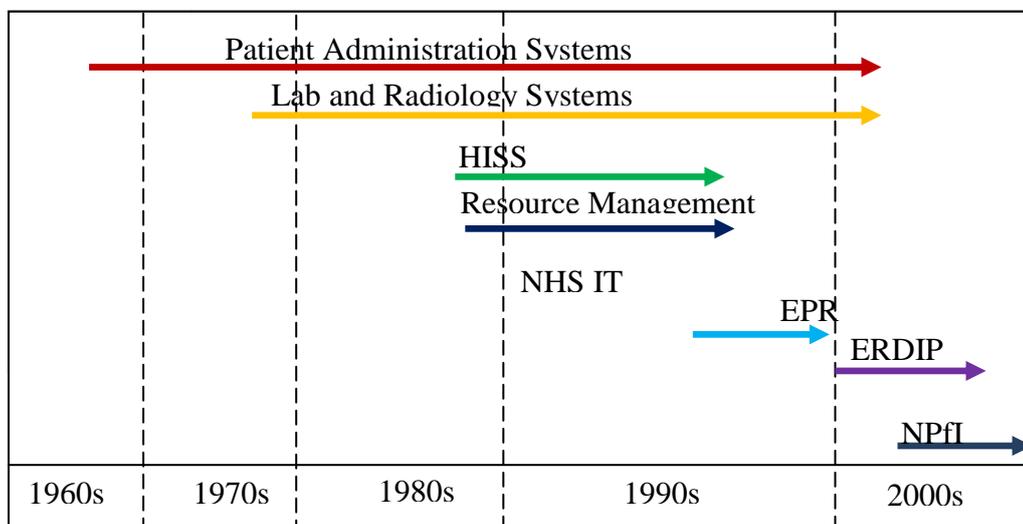


Figure 2.3.1.2: The spectrum of NHS health care information systems (Brennan, 2005, p. 25).

To overcome this, schemes and strategies were introduced to support the adoption of information technology inside the NHS. In 1987, for instance, the Computer Reimbursement Scheme was introduced with the intention of reducing bureaucracy in reimbursing the general practitioners who upgraded or purchased computer equipment or leased health information systems (Royal College of General Practitioners, 2005) so that physicians would be exposed to a variety of

Literature Review

ICT applications for health care. Since the scheme was not conducive enough to cover the strategic issues, in 1992, Information Management and Technology (IM&T) was published. This document highlighted the key principles and initiatives for IT adoption in UK health systems. This strategy was based on five key principles which focused on the person-based record system, integrated systems, information systems based on operational requirements, the security and confidentiality of information and information-sharing across the NHS (Smith & Preston, 2000; Wainwright & Waring, 2000; Brennan, 2005).

Even though the IM&T Strategy 1992 intended to formulate the key principles by which the health authority should abide, this did not happen in practice. Brennan (2005, p. 31) criticised the adoption of information technology in UK health care before 1998 by referring to it as a ‘fashion industry’, where the management of the NHS kept changing from one information system to another by merely following the technological hype. The drawback of this approach is explained in studies of health information technology evaluation. For example, a study by Yusof et al. (2008, p. 388), in which they evaluate the framework for health information systems, proposes three prerequisites for successful information technology adoption: the right user attitudes and skills, an organisational corporate strategy (business and IT) along with good leadership, and an information technology architecture or IT-friendly environment within the organisation. Another similar study by Jensen & Aanestad (2007, p. 31) also concluded that to succeed in adopting or applying new technology in a health care organisation, managers must try to identify all aspects related to the technology, the acceptability to the end users and the functionality of the systems.

ICT adoption after 1998

In 1998, the NHS introduced the White Paper *Information for Health*. This paper proposed that integrated electronic patient records be available for the NHS by 2005. The paper set out action plans that comprised items such as support for patient care, infrastructure and technological requirements, management of resources, fulfilment of the public’s expectations, key success factors, local and

Literature Review

national action plans and implementation methods. There were to be three implementation phases. The first phase was from 1998 to 2000, which covered the provision of added value to the existing NHS business plans and activities such as the NHS email project, local health informatics and the NHS Direct Service. The second phase was from 2000 to 2002, which was supposed to provide the infrastructure and resources leading up to the full implementation of electronic patient records by 2005. The final phase was in 2005, when it was expected that the full implementation of electronic patient records throughout the NHS for the betterment of service delivery would be in place (Burns, 1998). According to Wainwright & Waring (2000), this new plan changed many of the concerns of its 1992 predecessors from too much emphasis on clinical information needs to a managerial and resource-based emphasis.

However, two years after the White Paper was published, the research findings of Wainwright & Waring (2000) revealed that the NHS was still unready and too immature for the implementation of large-scale information systems. According to them, there were several factors that would hamper the smooth running of the National Programme for IT (NPFIT). First were the constant changes in government policies towards the adoption of information technology in the NHS. Second was political ideology. Third were health care reforms and, finally, the pace of technological progress. These findings were then endorsed by the national review in 2002, when Derek Wanless (Wanless, 2002, pp. 97-105) considered that the use of information technology in the NHS was still segregated and needed to be integrated on a national scale. Five years after the implementation, Bradshaw & Urquhart (2005) carried out a study of the smooth running of health information systems in the United Kingdom. They discovered that seven years after the implementation, the project had come across various experiences that included success stories and failures. According to them, the gap in implementation was due to unforeseen problems during the planning stage, which included unclear objectives and some overlooked, intangible elements like training and skills.

Literature Review

In the process of modernising the health care system through information technology, the authorities should not focus only on the technological aspects. There are many variables that contribute to the success of adopting information technology. They include the role of politics in ICT transformation, organisational culture, user and staff perceptions of ICT adoption, strategic management, fulfilment of user requirements and financial support. According to Kreps & Richardson (2007), health information systems are both technically and socially constructed. Health information systems are not merely the technical configurations or solutions, but rather they involve other elements, such as humans and other intangible factors (Littlejohns et al., 2003).

With support from the government, the adoption of ICT in health care has achieved some positive results. Fifteen online services are now offered to health service providers and clients. All are interrelated and can be shared across different primary carers and acute trusts. In particular, two technologies are related to this research: the NHS Care Record Services and the Spine (Connecting for Health, 2008).

The NHS Care Record Services (NHS CRS) is a technology that allows a summary of patient data to be stored in a central database (the Spine), and the details of patient clinical data to be stored in local hospitals, GPs' surgeries or acute trusts to be transmitted securely to all NHS agencies when needed for decision-making regarding health and well-being. The second online service application is the Spine, which refers to the national database that stores the summary of patients' demographic data taken from the local data of the NHS CRS.

The Spine is part of the NHS Care Record Services (NHS CRS). Each patient's electronic NHS CRS contains full details of clinical data and is stored on computers where the treatment is provided to the patient. A summary of that patient data, such as demographic information and summarised clinical information (allergies, medication, test results), will be stored on the Spine. NHS Connecting for Health (2009) describes the Spine as functioning like a:

Literature Review

‘...big electronic telephone exchange where it takes calls and puts them through to the right section of callers to get information they require.’

In other words, when the NHS CRS is fully implemented across England, whenever a physician wants to retrieve a patient’s health data, he will get a summary of that data from Spine, and then Spine will direct the physician to the location where the details of the clinical data are stored.

The status of the NPfIT project in 2011

Comparing two national audit reports for 2008 and 2011 it appears that NPfIT project has had successes and failures. Based on the report from the National Audit Office (2011, pp. 4-21), two illustrations are made by the auditors. They agree on the importance of this project for the NHS, and support some of the deliverables from some projects in the plan. However, there are many unresolved issues concerning undelivered ICT procurement under this project, especially on two core projects. According to the National Audit Office (2011, p. 4) these two central projects are the Detailed Care Records, and Summary Care Records. The problems with these two projects were related to three issues. The first problem was the failure to deliver the projects by the vendors according to the plan, which continued from 2006 until 2009. The second problem was difficulty to provide standardised systems across the NHS because multiple vendors were involved. The final problem was due to the contractual issues that caused from the withdrawal of vendors from the projects and termination of the contracts.

Despite some problems, nine projects were deployed successfully across health agencies. Those projects are N3 Networks, Spine, NHS Mail, Choose and Book, Electronic Prescription Service Release 1, and Electronic Prescription Service Release 2, GP to GP Transfer, Picture Archiving and Communication System (PACS), and Quality Management and Analysis System (National Audit Office 2011, p. 17). These projects however, are not core projects for NPfIT. They are categorised as infrastructural projects and national application projects.

Literature Review

The delay in delivering the two core projects (Detailed Care Records and Summary Care Records) is caused by two obvious factors. The first factor is vendor management. The vendors have failed to give the Department of Health the best deal from the contracts despite having been paid some £1.8 billion since 2002. One supplier, Computer Sciences Corporation (CSC), has yet to deliver the bulk of the systems it is contracted to supply and has instead implemented a large number of interim systems as a temporary solution. The approach used by the Department of Health to resolve this issue was through negotiation and according to the Committee of Public Accounts, the negotiation lead to a dead end. (Committee of Public Accounts 2011, p. 3).

The second factor is slow response to the assessment. In 2008, the National Audit Office had reported problems in these NPfIT projects. The auditors also alerted the authority about the possibility of the delay and non-delivery of some of the systems. To respond to this report, in 2009 the Department of Health and NHS Connecting for Health changed the direction from national-based projects into local-based projects that emphasised the systems that were already in use by the health agencies. The problem with this approach was that the cost remained unchanged because it was still under the contract, which needed to be honoured.

The Department of Health (2011) on 22nd September 2011 proclaimed the Detailed Care Records and Summary Care Records projects did not achieve the targeted outcomes in enabling the exchange of patient medical records across the NHS agencies. However, the department acknowledged the ability of other projects to create infrastructures for record sharing, for example N3 Network, Spine, NHSmail, Choose and Book, Secondary Uses Service and Picture Archiving and Communications Service. For that reason, the national-based project of NPfIT was dismantled and is being replaced with local-based projects.

2.3.2 Canada

2.3.2.1 Overview of the Canadian health care system

Health care in Canada is similar to that in the United Kingdom and is formed under the notion of the government's responsibility to provide health services to the public.

2.3.2.2 The adoption of ICT in Canadian health care

A series of discussions, projects and strategic plans have been organised by the Canadian government since 1994 to study the adoption of health information systems by their health care system. The end result of these efforts was the establishment of Canada Health Infoway Inc. in 2001. Infoway is a non-profit organisation which has been assigned by the Canadian government to make the implementation of electronic health records a reality. Its aim is to put in place the basic elements of a Canada-wide system of interoperable electronic health records for 50% of Canadians by the end of 2009 (Canada Health, 2008). According to Assadi (2003), between 1999 and 2002, 15 federal funding projects were approved with an incurred cost of around \$112,500,000. From these 15 initiatives, 153 projects were conducted in seven different categories. The categories were: 51 projects in Telehealth; 36 in electronic health records; one in health informatics; 34 in e-learning; 34 in health information; four in privacy; plus 12 other types of project. Based on the latest report for 2007–2008, since 2001, 254 projects have been developed. From that figure, 157 projects are still in progress and 97, 35% of the total, have been completed (Canada Health Infoway, 2008a, p. 3).

Electronic health records are the major element in the implementation of health information technology in Canada. This is supported by the two official Canadian government reports. The first report was by the Senate Standing Committee on Social Affairs, Science and Technology, who proclaimed:

‘An EHR system is the first step in gathering health-related information that will allow for evidence-based decision-making throughout the whole health care system. An EHR system also offers tremendous opportunities to integrate the

Literature Review

various components of Canada's health care system that currently work in silos' (Kirby et al., 2002, p. 175).

The benefits of EHR, as proposed by this report, cover not only the patients' welfare but also the health care administrator. Decision-making pertaining to health will be improved by the existence of EHR. The report states that a centralised repository will help physicians to retrieve the right information at the right time with accurate data and facts. The second official report was by Romanow (2002, p. 111), who considered EHR as one of the key players in the modernisation of Canadian health care. In Recommendation 8, Romanow emphasises the importance of having an interoperable electronic health record framework in all health information systems in Canada. He advocated:

‘...a personal electronic health record for each Canadian that builds upon the work currently underway in provinces and territories’ (Romanow, 2002, p. 111).

In defining the meaning of EHR, the Office of Health and the Information Highway Health Canada (2001, p. 9) propose five components that define the direction of EHR. The first component is Person Identifier. It refers to a universal code that uniquely identifies each individual within the health system. The second component is Facility Identifier, which refers to a universal code that uniquely identifies each institution or centre that provides services within the health system. The third component is Provider Identifier, which refers to a universal code uniquely identifies each health care provider within the health system. The fourth component is Health Information. It refers to Health data in a standardized format (e.g. diagnosis, x-rays, prescriptions) that are the result of interactions between individuals and their health care providers. The fifth component is Administrative Information, which is Standardized data that support administrative functions, such as billing.

In the national survey of the readiness of Canadians to accept the online electronic health records, Urowitz et al. (2008, pp. 3-5) made some important findings by surveying the CEOs of Canadian public and acute care hospitals. Two hundred

Literature Review

and thirteen CEOs were contacted via email with a response rate of 39%. From the survey, it was found that 54.2% of hospitals in Canada had already implemented EHR; 97.6% of respondents perceived that EHR is not the sole method of recording information about patients; 39% of hospitals only maintained around 11–50% of electronic records in addition to paper-based records; 44.6% of respondents believed that their organisations were still on track in the implementation of EHR. The findings seem to be parallel with the survey findings by HarrisInteractive (2007, p. 1-2), which show the low use of ICT by primary care physicians in Canada. The survey reports that only 23% of primary care doctors in Canada use electronic medical records. This percentage can be subdivided into three categories. The first category is the sharing of electronic records with other clinicians outside the practice, which only 6% of the sample did. The second category is the effort to access the electronic records outside the office, which only 11% reported they did. The third category is the provision to patients of easy access to their records, which only 6% reported that they provided. By using the same data as the HarrisInteractive poll, Jha et al. (2008, pp. 3-4) identify two reasons behind the low use of EHR in primary care: the absence of large-scale funding from the government and the lack of incentives for physicians in Canada to use health information technology.

In 2007, Canada Infoway and the Office of the Privacy Commissioner of Canada commissioned EKOS research associates to conduct a public survey. The survey discovered a strong indicator of the acceptance of electronic health records by the public. The results show that 87% of doctors, 86% of pharmacists and 81% of nurses/patients agreed that EHR will improve the effectiveness of health systems. On another occasion, Urowitz et al. (2008) conducted a survey to determine the readiness of hospitals in Canada to fully utilise EHR. The result of the survey highlights the slow adoption of EHR instead of paper-based health records. This slow adoption occurs despite the implementation of EHR in 54% of Canadian hospitals.

One strategy used by Infoway Canada in implementing the interoperable electronic health records is to divide the project into phases. Under the flagship of

the EHR project, there are nine phases of projects that are implemented as supporting technologies to achieve interoperable EHR: Diagnostic Imaging Systems, Drug Information Systems, Laboratory Information Systems, Registries, Telehealth, Public Health Surveillance, Interoperable EHR, Infostructure and Innovation and Adoption. By dividing the project into phases, it is much easier for Infoway to identify standards and technological frameworks that can be integrated to achieve interoperable electronic health records. (Arnold et al. 2007, p. 4).

The strategy of dividing a big project into several phases has been adopted by Malaysia through the Lifetime Health Plan (LHP) since 1997. Three phases of projects were identified to support LHP. However, the latest progress has not been published except in two presentations by Dr Amiruddin Hisan in (2006) and (2007) which mentioned unresolved issues related to standards, interoperability, infrastructure and technological barriers of LHP.

2.3.3 Australia

2.3.3.1 Overview of the Australian health care system

Unlike Canada, where the government is the sole provider of health care, the health system in Australia is more diverse. Besides the government, there are other independent agencies that provide health services to the population. The flexibility of the Australian health system is exhibited not only in terms of service provision, but also in the range of locations and settings. Health services are delivered in public and private hospitals, community health centres and private clinics, Aboriginal Community Controlled Health Services, community pharmacies and people's homes (Australian Health Information Council, 2007, p. 4). This flexibility is also an indicator of the need to have a proper infrastructure that can link various health service providers in terms of sharing the resources and patient data.

2.3.3.2 The adoption of ICT in Australian health care

In a study of computerisation in Australian general practices, Western et al. (2003, p. 1) identify three drivers that have encouraged computerisation in Australian general practices. The first driver is the promotion of computerisation by the

Literature Review

General Practice Strategy Review Group. The second is funding by the government of the General Practice Computing Group (GPCG). Finally, there is the inclusion of computerisation as a factor in the Practice Incentive Programme (PIP). This study also indicates that Australian general practices are highly computerised with over 85% of GPs using computers in their work. This finding shows an increase of more than 50% over the data obtained by a study conducted in 1998 by A. C. Nielsen (1998, p. 26). Nielsen conducted a national survey on the use of computers by GPs and, according to them, 31% of practices had computers.

Other results of the Western et al. (2006, p. 3) study demonstrated that computers were widely utilised in the Australian health care system. Another study by Henderson et al. (2006) discovered a high increase in computer use by GPs, with 94% of practices having computers present. Another interesting point from this study is the sceptical perception of certain GPs towards the reliability of computers to store data. All of these results are supported by the latest study by Jha et al. (2008, p. 3), who report that, currently, 98% of Australian GPs use computers in their daily work.

The organisation responsible for the management of e-health in Australia is NEHTA (the National E-health Transition Authority). It is a not-for-profit company established by the Australian State and Territory governments to develop better ways of electronically collecting and securely exchanging health information. Their core businesses and domains in e-health include e-health interoperability, clinical communication, unique health care identification, identity management, secure messaging, individual health records and supply chains (NEHTA, 2008).

The adoption of ICT in Australia's health care aims to provide secured accessibility and a wide range of data sharing across continents by health service providers, regardless of time and location, through the implementation of interoperable electronic health information (e-health) systems. To accomplish that, NEHTA undertook several projects to establish the standards, specifications

Literature Review

and infrastructure requirements. These requirements will then be adopted by the health sector in their own e-health systems. This common national approach will set the necessary foundations for the widespread and rapid adoption of e-health across the Australian health sector.

With regards to interoperability of e-health, Australia already has the framework that highlights three directions. First, this framework will establish uniform e-health concepts, standards and principles for any e-health systems in Australia. Second, it will ensure that any e-health systems in future will be able to be adopted within the current interoperability framework even if there are changes in technologies and personnel. Third, it will provide compliance of e-health systems with NEHTA's interoperability framework by providing testing and certification for e-health systems that claim to be interoperable.

The former CEO of NEHTA, Dr Ian Reinecke (Reinecke, 2007), in his presentation to the Healthcare Information and Management Systems Society of Asia Pacific 2007, listed five key elements to accelerate e-health implementation. The first element is the identifier, which refers to the unique identification of all individuals and health care providers across Australia. The second element is the terminology, which aims to support clinical information exchange by using a common language with consistent terms, descriptions and formats. The third element is the benefits, which refers to the outcomes of e-health in providing benefits with the least costs. The fourth element is the shared electronic health records (EHR), which refers to the national programme to design shareable electronic health records. Fifth is public sector supply chain reform. This refers to the building of a national product catalogue and e-procurement to enhance efficiency across the public health sector supply chain. These five elements are manifested by the Standard Catalogue V5, which refers to the standards and specifications that are the main reference for those who want to develop, sell, support, buy and implement e-health software in Australia. It provides a recommended list of specifications and standards supported by NEHTA. Under the Standard Catalogue, NEHTA has specified two categories to explain the flow of implementation. First is the domain, which refers to the direction to define the

Literature Review

standards and specifications for the eight e-health projects. The second category is the interoperability framework. This defines the blueprints for interoperability in Australian health information systems.

The eight projects under domain specifications are listed below:

- e-Health Interoperability
- Clinical Communications
- Unique Health Care Identification
- Identity Management
- Secure Messaging
- Shared Electronic Health Records
- Supply Chain
- Engagement & Adoption.

NEHTA defines interoperability with reference to the capability of an organisation as doing three things:

‘...use business or technical services of another organisation or system...’

‘...offer business or technical services to another organisation or system...’

‘...exchange information with other organisations or systems...’

There are ten programmes directly related to e-health interoperability. These ten programmes can be categorised under six modules:

- Open Distributed Processing-Reference Model
- Interoperability framework v2.0
- Specifications for corporate governance of ICT
- Unified Modelling Language v2.0
- Development of The Open Group Architecture Framework (TOGAF)
- Definitions of services in health care messaging.

Exchanging information in the interoperability framework permits different types of data to be transmitted and understood by other systems. To realise the notion of interoperability, NEHTA has come out with an example of how clinical

Literature Review

information will be interoperated. Four components are essential in that process. The first component is the Data Group Specification, which contains information about medical procedures and diagnosis. The second component is the terminology, which defines the information specifications and avoids duplication. An example of terminology is the SNOMED CT, with the Australian version of its contents known as Australian SNOMED Extensions. The third component is Structure Documents, which contain templates of certain hospital processes such as discharge summary, referral, prescription, registry, diagnostic testing etc. The final component is the Exchange Format, which consists of HL7 v2 under the configuration HL7 CDA. This format will determine the methods of data transfer and sharing in the secure messaging platform (Reinecke, 2008). Figure 2.3.3.2 demonstrates the flow of information in the NEHTA interoperability framework.

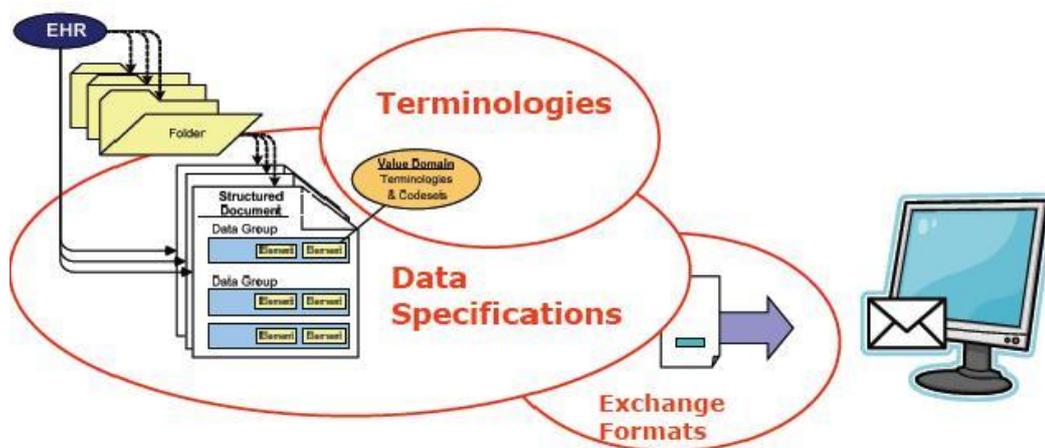


Figure 2.3.3.2: NEHTA interoperability framework (Reinecke, NEHTA 2008, slide 11)

This model shows an example of the flow of clinical information or electronic health records. The exchange occurs using a common language that supports uniform clinical terms, descriptions and formats. Three elements are essential in the exchange: terminology, data specifications and exchange formats or standards.

2.3.4 New Zealand

The purpose of this section is to highlight the adoption of ICT in New Zealand health care. This section contains two sections. The first discusses New Zealand's health care system in general and the second, the adoption of HTIS and EHR in its health care.

2.3.4.1 Overview of New Zealand's health care system

New Zealand classifies its health service delivery into three categories: public, private and voluntary, with the management of health care in New Zealand being undertaken at two levels: policy makers and health operation administrators. The policy makers include the Minister of Health, who is supported by the Ministry of Health and its business entities. The minister is also counselled by the National Health Board, Health Workforce of New Zealand and the National Health Committee. The daily health administrators are 20 District Health Boards (DBH) that are responsible for planning, managing, providing and purchasing health services for their respective districts' populations. The boards are also accountable for funding health service providers such as primary care, hospital services, public health services, aged care services, and non-governmental health providers (Ministry of Health of New Zealand, 2011a).

The reform of health care in New Zealand started in 1992, when the government restructured the provision of health services and payment (Hadorn and Holmes, 1997, p. 131). The adoption of ICT in health care is also another form of reformation that occurred in New Zealand health care. With this effort, the ministry aimed to create an environment that would enable electronic information sharing among clinicians and patients to improve health care delivery (Ministry of Health of New Zealand, 2011b).

2.3.4.2 The adoption of ICT in New Zealand health care

There have been a number of studies conducted by the New Zealand government to identify factors and challenges in adopting ICT in its health care. All New Zealand health practitioners have adopted five ICT technologies (UMR, 2008, p. 92): the Internet, email, teleconferencing, Patient Management System, and secure

Literature Review

network providers. In addition to these five, some practitioners use videoconferencing, the Health Network, texting and digital imaging.

An incompatible ICT system also affects ICT adoption in New Zealand health care. The recent situation of ICT adoption in New Zealand health care suggests three factors that cause incompatible ICT solutions in New Zealand. The first factor is different versions of the Patient Management System (PMS) across different health agencies. The other causes are the availability of technology and the issues of standards (UMR Research, 2008, pp. 68-69).

The issue of security and privacy is a challenge that needs to be resolved. The uncertainty about public consent, capacity, security and the amount of data transmission are the main challenges for ICT adoption in New Zealand (UMR Research, 2008, p. 70). The concern over security was tackled by adopting AS/NZCS 4444 in 1996. AS/NZCS 4444 is a standard to monitor the security of HTIS in New Zealand. A mixed-method study by Janczewski and Shi (2002, pp. 176-189) to analyse the use of this standard suggests ten factors that are important to maintain the security of HTIS in New Zealand health care: security policy and organization, asset classification and control, personnel security, physical and environmental security, computer and network management, system access control, system development and maintenance, business continuity planning and compliance.

The problem of cost for new ICT projects affects ICT adoption in New Zealand health care. The qualitative report by UMR (2008, pp. 72-73) identified four reasons that contributed to this challenge. The sceptical perception of the need to invest in ICT projects by stakeholders and practitioners is the first reason. The second reason is a lack of resources in the form of financial allocation, technology and human resources (training). The third reason is unclear benefits from investment in ICT; many health agencies run by GPs are already equipped with a Patient Management System (PMS) and new ICT procurement appears to be unnecessary for them. The final reason is related to the physical location of health agencies. The condition of health care buildings means that it is not feasible to

Literature Review

install ICT equipment. Installation in those buildings incurs a greater cost compared to modern buildings.

Access to training is also a factor that is relevant to the success of ICT adoption in health care. According to UMR (2008, pp. 73-74), time and skill competency are two determinants that contribute to this challenge. With many requirements on their time, especially clinical work, most physicians are not keen to attend additional ICT training.

Staff ICT literacy also determines the level of acceptance of ICT adoption. Four factors contribute to this challenge according to UMR (2008, pp. 74-75). The first factor relates to resistance to change in the working style using ICT. Most resisters are senior staff who are already comfortable without ICT. The second factor is a lack of interest in ICT among medical practitioners. Many GPs believe that ICT does not contribute much to the doctor-patient relationship. The third factor involves the unclear benefits of using ICT among medical practitioners that implies a refusal to learn about them. The final reason relates to demographic factors such as age and seniority. The UMR's findings suggest that the more senior staff are less interested in ICT.

Information overload is also an issue in ICT adoption for New Zealand health care. There is a concern from GPs that too much information generated from ICT might not be useful in delivering services to patients. Too much information generated from ICT may sometimes not reach the right person at the right time (UMR, 2008, pp. 75-76).

The isolation of a few health segments of ICT programmes by the government has discouraged their members to get involved in ICT adoption programmes. Those segments are ambulance units, central agencies for health care and non-profit organisations. Isolation happens because there are too many administrative layers in New Zealand health care (UMR, 2008, p. 76).

Literature Review

Leadership is identified as contributing to the success of ICT adoption in New Zealand health care (UMR, 2008, p. 77). Two hindrances in leadership affect ICT implementation: lack of direction and an idea-centric attitude. The lack of direction is apparent when there is a disagreement and difference between ICT planning and actions to execute the plan. An idea-centric attitude appears when officials representing each administrative layer try to convince others that their ideas about how to manage ICT are the best, which implies that no action can be undertaken.

Problems in vendor management also appear to be important in managing ICT for New Zealand health care. It has been suggested that vendors are not reliable and responsive to the demand of the government (UMR, 2008, p. 78).

2.3.5 Singapore

The purpose of this section is to highlight the adoption of ICT in Singapore's health care.

2.3.5.1 Overview of the Singaporean health care system

Public and private health providers form the Singaporean health care system. Health services are subsidised by the government with a contribution from each citizen. The individual's contribution is generated from three sources. The first source is from individual income and earnings. Secondly, under the retirement and health expenses scheme, individuals have 20% of their income deducted every month and 13% comes from their employer. Thirdly, a variety of health planning schemes are developed to encourage people to save for their health care. They are MediSave, MediShield, ElderShield and MediFund (Ministry of Health of Singapore, 2011a; Miller, 2010).

The health agencies are grouped under four services: primary, hospital and dental services, and intermediate and long-term care. Table 2.3.5.1 describes these services and the agencies under them. Information about those services is scattered in the Ministry of Health of Singapore's official document. By tabulating that information, it assists the researcher to understand the type of

Literature Review

health service providers in Singapore. It also directs the researcher to compare with Malaysian health service providers.

Table 2.3.5.1: The type of health service providers in Singapore (adapted from the Ministry of Health of Singapore, 2011a, 2011b).

| Health groups | Health agencies |
|--|---|
| Primary services | There are 18 polyclinics and 2,000 private medical clinics. |
| Hospital services | There are 13 public hospitals with number of beds ranging from 185 to 2,064 and 16 private hospitals with number of beds ranging from 20 to 505. Out of 13 public hospitals, five are acute general hospitals, and six are specialty centres for cancer, cardiac, eyes etc. The remaining two are general hospitals that provide multi-disciplinary and psychiatric care. |
| Dental Services | National Dental Care provides services in some polyclinics and hospitals. |
| Intermediate and long-term care (ILTC) | Residential and community ILTC centres. |

In 1999, acute care hospitals, specialty centres and polyclinics under primary care were restructured. As a result, two organisations merged, namely the National Health Group (NHG) and Singapore Health Services (SingHealth). These two organisations belong to the government and are funded through subsidies. Singapore Health Services or SingHealth was established in 2000 under the restructuring process of public health care in Singapore (Lee 2007, p. 65). According to the Ministry of Health of Singapore (2011b), these two agencies are able to act independently and react to patients' needs promptly. They are managed like non-profit organisations and not like private health service providers, because they receive financial support from the government. SingHealth, for example, offers a complete range of multi-disciplinary and integrated medical care. The

group consists of two tertiary-level hospitals, five National Specialty Centres and a network of nine polyclinics (Singapore Health Services, 2011).

2.3.5.2 The adoption of ICT in Singaporean health care

A report by Chew et al. (1998, p. 301) suggests that Singaporean health care has adopted an integrated ICT solution since 1998 with the development of OphthWeb. The solution aims to provide access to medical records locally and globally through Internet technology at a low cost, because browser and hardware are available on all computers (Chew et al. 1998, p. 302). However, according to Wei et al. (2008), the system is asynchronous and cannot support real-time interaction. In a new modified version of OphthWeb, known as TeleOph, Wei et al (2008) improved the system to provide two means of real-time interaction and is now feasible for online consultation. Two hospitals currently use TeleOph, namely Tan Tock Seng Hospital and Ang Mo Kio hospital of Singapore.

The *Singapore One Infrastructure* in 2001 was another initiative to widen ICT adoption in health care by embedding it under the e-citizen initiative. This effort enabled a Singaporean to search for relevant information and administer his own health affairs. Examples of administration are rescheduling appointments, providing admission information and informing hospitals of a change in address. It also enabled the patient to seek information about services offered by other government agencies (ESCAP, 2007; Tay-Yap and Hawamdeh, 2001). Under *Singapore One Infrastructure*, there were two health-related ICT solutions: CyberCure and Health ONE. CyberCure was an interactive multimedia application for children. Health ONE was an information resource in three different languages (English, Chinese and Tamil), which was dedicated to public and health professionals (Tay-Yap and Hawamdeh, 2001).

According to Lee (2007, p. 66), the Singapore government launched one committee in 2003 known as the *Exploit IT Maximally Workgroup* (ITWG). This committee was established to propose solutions for issues like law, culture, ethics, change management, publicity and IT architecture. Three challenges affect the implementation of interoperable Electronic Medical Records (EMR) across

different health clusters: privacy, data standardisation and ownership of EMR (Lee, 2007, pp. 67-68).

The implications of those challenges can be seen from two organisations under the Singapore Ministry of Health. SingHealth and NGH already use an EMR system across their health agencies. Inter-departmental relations are only successful across institutions under SingHealth, as all its institutions are able to share data among them. However, institutions under NGH cannot share data among them even if all their EMR systems are attached to one cluster, namely the Cluster Patient Record Sharing system. As a solution, the Singapore government has implemented the Electronic Medical Record Exchange (EMRX), which enables all data across public hospitals to be shared, including institutions under both SingHealth and NGH (Lee, 2007, 65).

There has been active deployment of the ICT solution in Singaporean health care. However, the users do not fully utilise the systems. This generalisation is made based on a quantitative study by Luo et al. (2009, pp. 532-534) of SingHealth polyclinics. Their research aimed to identify the prevalence of Internet and SMS usage by polyclinic visitors. According to them, age, socio-economic status, educational level, reason for visiting and race are predictors that influence the level of usage of the Internet and SMS in health care.

2.3.6 Hong Kong

The purpose of this section is to highlight the adoption of ICT in Hong Kong health care.

2.3.6.1 Overview of Hong Kong's health care system

Both the public and private sectors provide health services in Hong Kong. Two bodies manage health care: the Department of Health and the Hospital Authority. The Department of Health is responsible for delivering primary care to the public, including outpatient and preventive services. The Hospital Authority provides hospital services to the Hong Kong population (Taylor, 2002).

Literature Review

Taylor (2002) proposes five problems that require Hong Kong health care to reform: financial sustainability, quality of service, compartmentalisation, shortage of doctors and an aging population. Of these, financial sustainability (which incorporates a burden on the government to subsidise the public health care system), compartmentalisation and service quality may all have an influence on this study...

Despite Taylor's view from the life expectancy of Hong Kong, its health care can be categorised as one of the best in Asia. The life expectancy of Hong Kong people is 79.3 years, which is similar to the Japanese but higher than Singaporeans, whose life expectancy is 78.4 years (Department of Health of Hong Kong, 2011a). Fitzner et al. (2000, p. 151) reports that people in Hong Kong frequently visit health agencies compared to citizens of mainland China. In 2010, the Department of Health and the Hospital Authority received a high number of attendees for their health services. Table 2.3.6.1 illustrates the categories of attendees. Information about those attendees is scattered in the Department of Health's official document. By tabulating that information, it assists the researcher to apprehend the possibility of high data transactions by HTIS in Hong Kong's health providers.

Table 2.3.6.1: The number of Hong Kong attendees for health services in 2010 (adapted from Department of Health, 2011b)

| Department of Health | Hospital Authority |
|--|--|
| 657,716 General outpatient attendances | 2,224,220 Accident and emergency attendances |
| 6,273,797 Other outpatient service attendances | 4,836,015 General outpatient attendances |
| | 8,445,575 Specialist outpatient attendances |
| | 280,326 Family medicine specialty clinic attendances |

2.3.6.2 The adoption of ICT in Hong Kong health care

The case study finding of Chau and Hu (2004, p. 88) shows the occurrence of data sharing between regional general hospitals and acute tertiary hospitals. This is an example of successful telemedicine practice in Hong Kong. The effort to widen the use of ICT in health care started years before this study. According to Tse (1997), a plan was introduced in September 1994 that aimed to enable health information to be accessed through the use of ICT. The outcome of this initiative was the installation of a Content Management System at 14 Hong Kong public hospitals (Tse, 1997). Ko (2002) regards the good track record of ICT adoption in Hong Kong health care as an outcome of the efforts of the Hospital Authority. The need to reduce expenses in health care motivated the Hospital Authority to be persistent in their efforts to harness ICT in health care.

Three development plans are shaping the EHR roadmap. The first plan is to build a core infrastructure to share patient records across different organisations. This includes building data storage and system infrastructures to support health data sharing. To create a digital link between public and private hospitals through the deployment of a Hospital Authority Content Management System (HA CMS), a second plan is to build a system extension and component in private hospitals. The third plan is to establish technical standards and interfacing components that can be used by different health care providers (e-Health Record Office, 2011b). This project started in 2009 and is expected to be delivered in 2014 (e-Health Record Office, 2011a). Table 2.3.6.2 illustrates the programmes under this timeframe.

Table 2.3.6.2: Programmes under the first phase of EHR implementation in Hong Kong (e-Health Record Office, 2011a)

| Year | Hospitals | Clinics | Ancillaries |
|------|---|-------------------------------------|--------------------|
| 2009 | Radiological image sharing with private hospitals | | |
| 2010 | Pilot use of Smart ID for patient authentication | | Laboratory sharing |
| 2011 | Clinical Management | Community Person Master Index (PMI) | |

Literature Review

| Year | Hospitals | Clinics | Ancillaries |
|------|--|-------------------------------------|----------------------|
| | System (CMS) adaptation of basic modules | | |
| 2012 | Begin patient enrolment | Clinical Management System (CMS) | Hong Kong drug table |
| 2013 | Shared record in Doctor portal | | |

2.3.7 Taiwan

The purpose of this section is to highlight the adoption of ICT in Taiwanese health care.

2.3.7.1 Overview of the Taiwanese health care system

The health care system in Taiwan is based on universal health care, which aims to provide health services to the Taiwanese population under an insurance scheme subsidised by the government (Chang, 2011). The health scheme is called National Health Insurance (NHI). In 2010, the Taiwan government allocated NT\$ 96,170 million to the fund together with NT\$ 321,153 million from the insured groups (Department of Health, Executive Yuan of ROC, 2011a).

This health care model entitles all Taiwanese, regardless of their wealth status, to choose hospitals and doctors without a gatekeeper and waiting lists. It also includes medical benefits and packages such as prescription drugs, dental services, Chinese medicine, preventive medical services and others (Reid, 2008). Gunde (2004) raises a concern about the physicians' ability to cope with the burden of providing health services to patients under this scheme. Gunde states that diagnosis is not done thoroughly, as doctors need to attend to a large number of patients each day because of the openness of the system.

Five institutions provide health services to the Taiwanese under NHI; hospitals, Chinese medicine hospitals, clinics, Chinese medicine clinics and dental clinics. According to the latest statistics from the Department of Health for 2008, there are 20,174 health institutions in Taiwan. Table 2.3.7.1 illustrates the categories.

Literature Review

Table 2.3.7.1: Categories of health institutions

| | Hospitals | Chinese medicine hospitals | Clinics | Chinese medicine clinics | Dental clinics | |
|----------------|-----------|----------------------------------|---------|--------------------------------|-------------------|--------------|
| Public | 414 | 1 | 460 | 1 | - | |
| Non- public | 79 | 22 | 9,866 | 3,159 | 6,173 | Total |
| Total | 493 | 22 | 10,326 | 3,160 | 6,173 | 20,174 |

According to Lu and Chiang (2011, p. 100), the NHI is a reform in health care based on four external forces, namely knowledge, socio-cultural factors, economic resources and the political system. These four external factors influenced the formation of a new health policy in Taiwan. The outcome of the NHI scheme is evidenced by life expectancy in Taiwan. The life expectancy of the Taiwanese based on 2008 health statistics is 78.9 years.

2.3.7.2 The adoption of ICT in Taiwanese health care

ICT adoption in Taiwanese health care incorporates telemedicine, with the ability to exchange data across different health agencies (Hu et al., 2002; Li et al., 2001, p. 241; Liu et al., 2000; Chen et al., 2001, p. 119). The entities are the National Health Information Network (NIHN), National Information Infrastructure (NII) and Smart Card. The government initiative to establish the National Health Information Network (NIHN) started in 1989. In conjunction with that plan, a series of extended projects was proposed across Taiwanese regions, including smart cards in 2001 (Li, 2008, p. 71). The infrastructure to support these projects was developed five years after the NIHN was proposed, with the development of the National Information Infrastructure (NII) in 1994. The NII proliferated ICT penetration in Taiwan, and by 1999, four million Taiwanese had Internet access. This project also promoted Taiwan to being one of the highest Internet users in the world (Chen et al., 2001, p. 119).

According to Liu et al (2000), NIHN performance improved with the deployment of NII. The new version, NIHN 2.0, to replace version 1.0 appears to work very

well under NII, overcoming some problems faced by NIHN 1.0 (Li et al., 2001, p. 242). Liu et al., (2000) identified three problems in NIHN 1.0 including supporting data exchange: insufficient bandwidth for multimedia application and obsolete legacy systems and medical applications.

In addition to the above problems, Hu et al., (2002) identify the implications that might occur from the deployment of telemedicine in Taiwan. The first implication is related to physicians' acceptance of telemedicine. To avoid resistance by physicians, training and maintaining their professional autonomy accelerates their acceptance. The second implication is effective technology management. Managing the acquisition of telemedicine should consider interoperability and integration. Acquisition should be done on the basis of being able to integrate legacy systems into telemedicine by acquiring technology that shares the same standards. The third implication is the ability to expand telemedicine into other external HTIS beyond dedicated terminals through new service configuration. The expansion includes both clinical and non-clinical purposes, such as communication and administration of health.

NIHN 2.0 uses smart cards to gather Taiwanese health information. Specifically, three items of information are maintained: the cardholder's status, medical service information and public health administration information. This will assist service providers to gain accurate information about the patient's medical history, as it is accessible from the card (Li, 2008, p. 72). However, a study by Hsu et al. (2009, p. 558) suggests that inaccurate data storage does occur with smart cards – for example in recording allergic reactions.

2.3.8 Lessons learned from ICT adoption in developed countries

The seven countries discussed within this section were selected as all of these countries have recently attempted to digitise aspects of their health service by implementing electronic health or patient records. These were chosen for discussion as they include a range of both private and public healthcare initiative

Literature Review

from a range of geographical regions. These countries are all discussed widely in the literature and it seems likely that their experiences may influence the behaviour of developing countries that plan to implement electronic health records. The rationale for selecting these seven countries is also to get different perspectives on how ICT is adopted and implemented in those countries. To compare differences between these seven countries in relation to the healthcare, two studies are used to identify the subject areas. First is study by Brown (2003) and the latter is by Abd Ghani (2008). Table 2.3.8 illustrates the differences between those seven countries.

Table 2.3.8: Differences of healthcare systems between seven countries (United Kingdom, Canada, Australia, New Zealand, Singapore, Hong Kong, Taiwan) – Malaysia is included for comparison purposes

| Countries | Cost GDP per capita | Providers | Leadership | National ICT project for health | Electronic health record initiatives |
|------------------|----------------------------|--------------------------------------|---------------------------------|--|---|
| United Kingdom | 9.6% | Government | National Health Services (NHS) | NPfIT | NPfIT |
| Canada | 10.8% | Government | | Canada Infoway | Canada Infoway |
| Australia | 8.9% | | | NEHTA | NEHTA |
| New Zealand | 10.1% | | | | |
| Singapore | 4.4% | | Ministry of Health of Singapore | Health One Telemedicine | EMR Exchange (EMRX) |
| Hong Kong | 3.8% | | | Telemedicine | Patient card |
| Taiwan | 6.2% | | Department of Health | NHI-IC Cards | NHI-IC Cards |
| Malaysia | 4.4% | Government and private practitioners | Ministry of Health of Malaysia | Integrated tele-health, teleprimary care | Lifetime Health Record (LHR) |

Sources: Bloomberg Visual Data (<http://www.bloomberg.com/visual-data>)

The Guardian:

<http://www.theguardian.com/news/datablog/2012/jun/30/healthcare-spending-world-country>

To sum up, by reviewing the adoption of health information systems in the seven developed countries outlined above, an insight has been gained which can direct this research project. Important issues that can be learned from the implementation of health information systems in developed countries can be categorised into six categories that are discussed in the next sections.

2.3.8.1 Government initiatives and commitment

The previous sections suggested that governments were the main players and supporters. The commitment and initiatives from the government was the mechanism that drove those seven countries to actively adopt ICT initiatives into their health care. The United Kingdom for example, embarked the NPfIT project after the government agreed to allocate a handsome budget to have integrated HTIS across health agencies under NHS. This commitment was reinforced with additional budget increases until it reached £12.7 billion and the project was re-evaluated (Martin, 2011; National Audit Office, 2011, p. 19). Another example of government commitment was through establishment of national ICT procurement plans that include development of relevant infrastructures to support HTIS adoption in health care. The Taiwanese government for example, after establishment of National Health Information Network (NIHN), supported the NIN by building National Information Infrastructures (Chen et al., 2001, p. 119).

Nevertheless, despite all of these commitments, the interoperability of EHR and HTIS are still not fully attainable. The explanation for this situation is best illustrated by Jha et al., (2008, p. 852) who outline other factors such as resistance from users and inefficiency to manage the vendors.

2.3.8.2 Independent research into project assessment

The previous sections suggested that there were plentiful research and audits by independent researchers and agencies to evaluate the success of HTIS and EHR adoption in those countries. New Zealand for example, received assessments from one agency known as UMR to evaluate the HTIS in its health care (UMR, 2008). The National Audit Office in United Kingdom had been auditing the NPfIT

programme since 2006 until the recent report in 2011 (National Audit Office, 2011).

The implication from these efforts is they assist decision-makers and stakeholders to realise the mistakes, wrong approaches, and miscalculation in the execution of the projects. However, there is a possibility for decision makers to ignore the findings (especially if they are already too late to correct the situation). For example, prior to the final reports from the National Audit Office, Greenhalgh and her team (2004; 2008; 2010) conducted at least three studies on NPfIT programme. Their findings identified a number of weaknesses and mistakes from the NPfIT, and suggested recommendations on how to resolve them.

2.3.8.3 Infrastructural readiness

Infrastructural readiness was another aspect that appears important from the previous sections. Singapore for example, launched Singapore One Infrastructures in 2001, in its effort to provide complete support for all ICT activities across the island, including the health care (Tay-Yap and Hawamdeh, 2011). United Kingdom also acknowledged the importance of having sufficient networking infrastructures to support mass patient data by establishing N3, which was a specialised network for NHS (NHS Connecting for Health 2011).

However, to build these infrastructures (especially the ICT infrastructures) is time consuming and expensive. Most of the budget for ICT under MoHM from the Treasury is for supplies and services, which includes everything from hardware and software purchasing (Ministry of Finance of Malaysia 2011). It has been suggested that the progress of ICT programmes in health care in developing countries depends on the financial constraints (Edirippulige et al. 2009).

2.3.8.4 The priority of standards and technical specifications

The previous sections suggested that standards and technological specifications are the priorities to enable interoperability of EHR and HTIS. Canada Infoway for example, improved its health data structures and standards to cope with its nine phases of EHR implementation (Infoway Canada 2011). NEHTA Australia also gave more emphasis to develop standards and technical specifications that enabled

procured HTIS to be compatible with future technologies and platforms (NEHTA 2011).

However, based on findings by Jha et al. (2008), it appears that technical and standard specifications is only one part of implementing interoperable EHR and HTIS. They only provide a framework for interoperability but do not guarantee interoperability will happen.

2.3.8.5 Implementation methods

The previous sections suggested that all of the countries implemented interoperable EHR projects in phases under the national programme. United Kingdom for example, embarked on phases of projects for all counties in Britain (NHS Connecting for Health 2011). Canada divided the implementation into nine phases as supporting technologies for interoperable EHR (Canada Infoway 2011). Taiwan and Hong Kong also used the same methods (Chen et al. 2001, p, 119; e-Health Record Office, 2011a).

The problems that occurred under NPfIT projects in United Kingdom, however showed this method may not be a good approach if the vendors cannot deliver the results within the timeframe of the phases (National Audit Office 2011, p. 5). In 1997, MoHM also divided Telemedicine project into phases (Ministry of Health of Malaysia 1997, p. 16) as described in section 3.4.2.1. However, all the phases were not delivered and the project was discontinued.

2.3.8.6 Managing the vendors

The seven countries mentioned above outsourced EHR and HTIS projects to vendors, and some of them used various vendors to deliver the project. The United Kingdom for example, outsourced the Summary Care Record (SCR) to four vendors based on the regions. The vendors were Accenture, BT, Computer Sciences Corporation (CSC), and Fujitsu. The projects were considered as individual projects by those vendors and the products were delivered in different settings which caused problems for integration (National Audit Office 2011, pp. 4-6). The problem of managing the vendors also occurred in New Zealand ICT

adoption projects. The unreliable and irresponsive vendors were identified as a source of problems in New Zealand's ICT adoption (UMR, 2008, p. 78).

The problem of outsourcing ICT projects through vendors is that each project is treated as a separate project with its own priorities, which may cause some conflicts in the settings and deliverables (Guah and Currie 2007, p. 2158).

2.4 Barriers to ICT adoption: EHR implementation

Many factors hamper the adoption of electronic health records in hospitals, as suggested by the literature. Lobach and Detmer (2007, p. 106) view the problem of EHR implementation as not a totally information technology-based problem but rather a change management issue. However, this view contradicts the study by Ragupathi and Kesh (2009, p. 77), who suggest that the urgent problem in current electronic health record systems is their technological design. Vishwanath and Scamurra (2007, p. 129) have another concern; they mention the need for end users to have control over the issue of usability of the EHR information system.

The problem in transferability and data security is another factor that affects implementation. Lobach and Detmer (2007, p. 109) suggest three policies to curb this barrier: policies to protect personal health information and the patient's unique identifier, and a policy to control accessibility to personal records.

Apart from that, universal standards have become another barrier and have become a challenge for research into electronic health records. The standards include nomenclature, terminology, vocabulary and data representations (Lobach & Detmer 2007, p. 110). A major problem with this issue is having the full support of the authorities and government. The qualitative study by Walker et al. (2005, p. 17) suggests that the achievement of fully integrated electronic health records requires strong policy incentives, central leadership and legislation to ensure that universal standards are applied at all levels of health care. A study by Sfakianakis et al. (2007, pp. 51-52) suggests the exploration of open-source software to support the development of open standards in electronic health records. Open-source software with the availability of source codes and the nature

of its licence should allow standards like HL7 and DICOM to be incorporated into health applications.

A recent study by Deutsch et al (2011, p. 219) into the barriers to EHR implementation in five countries (England, Germany, Canada, Denmark and Australia) suggest eight barriers, namely acceptance, change management, demonstration of benefits, funding, project management, health-policy related goals and implementation strategy, and basic legal conditions and data protection. They also lament the heavy focus on technological barriers at the expense of these eight non-technological barriers. Another qualitative study by Jahanbakhsh et al. (2011, p. 1200) in an Asian country (Iran) also identifies similar barriers to those mentioned in the previous study. They classify the barriers into two main categories: infrastructural and structural barriers.

To successfully implement EHR Lobach and Detmer (2007, p. 110) suggest that the development of a national infrastructural programme is essential to support the implementation. This remark supports the recent study by Jahanbakhsh et al. (2011, p. 1200).

2.5 The governance and political issues in EHR and ICT adoption

This section aims to discuss issues related to politics in ICT implementation in health care. The involvement of politics in ICT adoption or Health Information Technology (HIT) has been discussed in various directions. For example, a study by Irestig and Timpka (2008, p. 92) analyses the political conflicts during HTIS development. They report the political conflict that occurs between users and stakeholders in reaching consensus on HTIS, which in the end causes the escalation of cost and maintenance.

Issues related to legislative and regulatory consideration appear to be related to this subject. Gerber (2007, p. 44), for example, examines the issues behind the funding and investment policy for HTIS for universal political systems. Apart

from the legislative issue, the success of ICT adoption, especially interoperable EHR depends on political and national commitment (Hovenga & Garde 2010). Glaser (2009, pp. 50-54) recommends ten factors that determine EHR in health agencies. All of those factors are related to good governance and effective management.

The governance of ICT in health care consists of many issues. Suomi and Tähkäpää (2004, p. 371) outline outsourcing as a crucial component in ICT governance in health care.

2.5.1 The outsourcing of ICT procurement

Outsourcing in ICT procurement is widely used by the Malaysian government in all sectors. A study by Arshad et al. (2008, p. 121) of outsourcing activities in Malaysia suggests that outsourcing could mostly not meet the expectation of the Malaysian government. They identify five reasons that contribute to the limitation: inappropriate outsourcing activities, problems in the transfer of technology, poor documentation, vendor management and problems producing a Request for Proposal (Arshad et al., 2008, pp. 122-123).

To minimise all those problems in ICT outsourcing, especially in health care, MAMPU (2006b, pp. 8-19) proposed detailed guidelines for outsourcing management. The guidelines include nine components, namely preparation of a Request of Proposal, criteria of service providers, contractual terms and agreement, Service Level Agreements (SLA), project management, project team criteria, change management, transitional management and progress management.

In response to the above guidelines, an empirical study by Aris et al. (2008) outlines issues in the risk management of outsourcing practice in Malaysia. The study suggests that the awareness of risk management of ICT outsourcing in Malaysia is still low, even with guidelines from MAMPU. It also recommends four phases to be emphasised in managing ICT outsourcing. They include on-going monitoring from the beginning of the project, selection of service providers, contract management and decisions for outsourcing.

2.5.2 The issue of human resource competency to manage ICT adoption in health care

The issue of human resource competency is highlighted by the World Health Organisation (2006, p. 29) as a contributing problem in ICT adoption, especially EHR in developing countries. Ludwick and Doucette (2009, p.27), in their literature analysis, suggest that human resource issues such as training and staff unfamiliarity with HTIS contribute to the failure of ICT adoption in health care. This suggestion is parallel with the findings by Abd. Ghani et al. (2008a, p. 90), who also suggest limitations in human resource competency in using ICT as part of their working tools in health care.

Two decades ago, a study by Detmer and Friedman (1994, p. 562) reported a finding that showed that the incompetency of medical staff to adopt ICT in health care was an unresolved problem. A recent study by Morton and Wiedenbeck (2010, p. 4) suggests an increase in exposure and computer skills among physicians, which shows an improvement from what was suggested by Detmer and Friedman (1994). The study also proposes an increase in the level of physicians' acceptance of using ICT in their work.

There are studies that link human resource competency to knowledge barrier in ICT adoption to health care. Paré and Trudel (2007, p. 24) for example in their conceptual model to explain knowledge barriers in Picture Archiving and Communication System (PACS) implementation, identify

2.6 Physicians' resistance to ICT adoption

The World Health Organisation (2006, p. 29) acknowledges the possible resistance by physicians to adopt ICT in their working environment. Nevertheless, WHO incorporates good strategy as a contributing factor to convince them to get involved in the adoption programme. In an effort to identify a strategy to convince the physicians, Holden and Karsh (2010, p. 164) tested four theoretical models that explain physicians' acceptance of ICT. They conclude that internal and external factors such as technical infrastructure and support are facilitating

conditions that influence physicians to accept ICT in their work. Schaper and Pervan (2007, p. S216) discovered similar findings for different health professionals, i.e. Australian occupational therapists. The findings of Yarbrough and Smith (2007, p. 668) also highlight the fact that internal factors such as personal characteristics and level of competency in IT influence physicians' acceptance.

There are number of causes for resistance among physicians. Crisóstomo-Acevedo and Medina-Garrido (2010, p. 384) identify reasons why physicians refuse to accept EHR and HTIS in their working routines. Most of them are based on physicians perceptions and assumptions. The first reason is the perception that EHR and HTIS are developed without consideration of their interests and needs. The second reason is a fear of losing their status as service providers by adopting EHR and HTIS. The third reason is uncertainty about what can be offered by the EHR and how this affects their jobs. The fourth reason is resistance to attend new training and gain new information about the system. The final reason for physicians' resistance to EHR/HTIS be that it is difficult to break working routines.

2.7 The role of standards in ICT adoption

This section discusses the application of the standards used for electronic health records. There are a number of standards available that support interoperability for health care information systems. These standards need to be selected based on whether they are specifically developed for particular technologies or whether they are general domain standards that can be used in various applications (Mykkänen & Tuomainen, 2008, pp. 176-177). According to the Ministry of Health of Malaysia, HL7 and DICOM are two standards that have been endorsed for use in all health information systems procured by agencies under the ministry (Ministry of Health, 2009). With regard to this endorsement, this section attempts to discuss the application of HL7 and DICOM for electronic health records. Understanding the flexibility and openness of these standards will help understanding of the reasons behind the inability of Malaysian hospitals to

exchange patient health data, even though the information systems they use are HL7 and DICOM compliant.

2.7.1 Standards for interoperable electronic health records

The discussion starts with ISO/TR 20514: Health Informatics-electronic health records: Definition, Scope and Context. This standard is a general blueprint for electronic health records. HL7 and DICOM will be discussed in the next sections.

2.7.1.1 ISO/TR 20514: Health Informatics-electronic Health Record: Definition, Scope and Context

This standard was developed to define the general scope and context of where interoperability of EHR can take place. ISO/TR 20514 (2005, p. 8) proposes four conditions that need to be met to implement interoperable electronic health records. The first condition is a standardised EHR reference model, which includes information architecture for EHR between the sender and receiver of EHR outputs. The second condition is standardised service interface models. These interfaces enable interoperability between the EHR service and other services within the clinical information systems. Examples are demographic data, terminology, access control and security services. The third prerequisite is a standardised set of domain-specific concept models. These include archetype and templates for clinical, demographic and other domain-specific concepts. The fourth prerequisite is standardised terminology which supports the archetype. The British Standards Institute (BS EN 13606-1: 2007, p. 6) defines ‘archetype’ as the formal definition of prescribed combinations of the building-block classes that are defined in the Reference Model. It also specifies the particular subsets within the reference model by constraining their names and other relevant attributes, values, options and multiplicity at any point within the hierarchy (BS EN 13606-2: 2007, p. v).

The implementation of interoperable electronic health records in Malaysian hospitals needs to fulfil these four requirements. The issue of information architecture between the senders and receivers of health service providers in

Malaysia is another gap that needs to be highlighted. The list of information systems in the MoHM ICT blog (Ministry of Health of Malaysia 2009) indicates that a segregated information architecture is being used. The result of this segregated architecture is the inability of each application to communicate and exchange data (Abd Ghani et al., 2008a, p. 90). The second issue, that of service interface models that include demographic data, terminology, access control and security services, is being only partially resolved. According to Ibrahim (2003, pp. 18-19), all Malaysian hospitals use ICD-10 (International Classification of Disease Tenth Edition) for morbidity and mortality coding for either manual or electronic record creation. The problem with this coding process is that there is no standardised procedure being developed among the hospitals under MoHM. The coding was used only to support the decision support system developed by the Information and Documentation System Unit of the MoHM to acquire the data from the agencies that apply the coding. In other words, there are still gaps that need to be highlighted before interoperable EHR can be achieved.

2.7.2 HL7 and DICOM in electronic health records

2.7.2.1 HL7

HL7, or Health Level 7, is a standard that defines the structures and mechanisms used for the description and communication of administrative and clinical data in the health information system without any preference for specific domains or applications (Blozana & Koncar, 2007, p. 426). It was developed in 1987 under the initiatives of international medical communities including medical professionals and scientists. Prior to the development of HL7, the data exchange among HTIS required customisation and extensive configuration at both sending and receiving applications (Liu & Wang 2011, p. 129).

The types of message protocols that HL7 supports for data integration are HL7 v2 and HL7 v3. According to Eichelberg et al. (2005, p. 9), HL7 v2 is the protocol that is widely used in most health information systems. However, being compatible with HL7 v2 is not an automatic enabler for interoperability. The limitation of this version, according to Eichelberg et al. (2005, p. 9), is its unclear structure for underlying data fields, which aim to provide flexibility but fail to

create agreement between different health information systems. To overcome this drawback, a new version of HL7, v3, was developed. HL7 v3 focuses on the methodology of aligning the final data set between discrete health information systems. This alignment is achieved through its foundation, which is the Reference Information Model (Blozana & Koncar, 2007, p. 426; Eichelberg et al., 2005, p. 9). The Reference Information Model (RIM) is a framework that represents all related health data generated from various domains (Kitsiou et al., 2006, p. 1).

To sum up, HL7 suggests the framework to enable clinical applications to exchange data. It does not provide instructions on how to develop clinical application programmes and not develop any software. It compiles message formats and clinical standards to provide framework for information exchange, integration, and retrieving (Liu & Wang 2011, p. 129).

2.7.2.2 DICOM

DICOM, or Digital Imaging and Communications in Medicine, is a standard for medical image communication. It is used to define data structures and services for medical images in the exchange process (Eichelberg et al., 2005, p. 12). Liu and Wang (2011 p.138) stated that international medical communities and manufacturers developed DICOM to resolve the barriers for medical image interoperability as a result of proprietary applications in medical image equipment.

Some research has been done to adapt DICOM in an interoperable environment. Blozana and Koncar (2007) attempted to integrate radiological images between hospital departments in Croatia by integrating DICOM with Clinical Document Architecture (CDA). Its flexibility and openness to support interoperability is the reason that Magni et al. (2007) selected DICOM and HL7 as the main standards for their research into integration. Their research aims to resolve the incompatibility of orthodontic electronic records. Through modification of HL7 and DICOM and incorporating both of these standards into Ortho-EPR, integration in this field can now be achieved (Magni et al. 2007).

To facilitate medical image transmission through web technologies, as well as to meet clinical needs, two supplementary DICOM standards were developed. They are Web Access to DICOM Persistent Objects (WADO) and DICOM Structured Reporting (Kitsiou et al. 2010, pp. 384-385). In WADO, several functions enable Internet-related technologies for DICOM information exchange. WADO provides a means for accessing DICOM images and reports from Web pages or XML documents. Data may be retrieved in either JPEG or GIF as specified by the requester, or in a native DICOM format from a DICOM Web server. A DICOM Web server is a system that manages DICOM persistent objects and is able to transmit them on request to a Web client system. A Web client is a system that uses Internet technologies such as Web and e-mail in retrieving DICOM images or reports from a Web-enabled DICOM server. (Liu & Wang 2011, p. 143).

DICOM Structured Reporting (DICOM SR) is a standard for structured documents in medical images. This standard was developed not to compete with HL7 (which is an existing standard for exchange of clinical data). DICOM SR was developed to support documents that incorporate references to images and associated data such as waveforms. The advantage of SR is that it allows very effective linking to other DICOM objects such as images, waveforms, measurements, and parts of images or presentations of images (Liu & Wang 2011, p. 143). Examples of DICOM SR as described by Liu and Wang (2011, p. 140) are basic text for text description referencing to images, comprehensive text for numerical measurements and region-of-interest references, and radiation dose report.

2.8 The relevancy of open-source software (OSS) in ICT and EHR adoption

Historically, open-source applications have contributed to the development of electronic health records for three decades. Two projects pioneered health information systems using open-source applications. The first project was

Literature Review

COSTAR, which was developed by Octo Barnett for Costar ambulatory medical records in the late 1970s. The second project was by an institution known as The Veterans Administration, which developed a system known as DHCP/VISTA (McDonald et al., 2003, p. 179). The drive behind this initiative, as suggested by Yellowlees et al. (2007, p. 284), was the limitation of the current proprietary health information systems, which were inflexible, expensive and difficult to interoperate with other systems.

Valdes et al. (2004, p. 7), in a quantitative analysis, suggest that the solution to the barriers to standardisation in electronic health record systems is through free and open-source software electronic health records. The reliability of open-source software is recognised by Waring and Maddock (2005, p. 414), who believe that the reliability of OSS is down to the perpetual support from programmers if any problems are identified. Despite all the benefits of OSS, there are a few concerns regarding its drawbacks and limitations. Warring and Maddock (2005, pp. 416-417) identify the drawbacks of OSS. They indicate that the major limitation is the implementation issue, where there is a great worry about the availability of experts to support OSS in an organisation.

Another issue concerning OSS adoption in HTIS is related to financial and licensing implications. Warring and Maddocks (2005, p. 421) for example are sceptical about the ability of OSS to provide economic feasibility to the government projects. This view is supported by Ven et al. (2008, p. 55) who suggest a hidden cost of open-source software adoption arises from dual licensing of OSS. Dual licensing of OSS refers to the business model where software is offered under OSS and proprietary licenses (Fitzgerald 2006, p. 592). For example, MySQL is released under the GNU public license (GPL) but when other organisation develops its software that uses MySQL as its database, that organisation must publish the source codes and licenses it under the GPL; otherwise, it needs to pay to MySQL to keep its intellectual property and avoid publishing the source code (Ven 2008, p. 55).

Literature Review

Carnall (2000) on the other hand thinks open-source software is feasible financially by referring to one case study of Walton NHS Trust in 1995. The stand of the Malaysian government on open-source software financial feasibility is obvious from recommendations made by MAMPU (2009) in its guidelines on how to adopt OSS to Malaysian government ICT projects. Comparing to all these views, the hidden cost of OSS adoption may result from human incompetency to administer OSS projects. This view is supported by Young (2004) who suggests that the scarcity of OSS specialists, leads to high costs to hire them.

The establishment of government policy also affects the adoption of OSS in health care. Paré et al. (2010, p. 7) suggest seven barriers to OSS adoption in health care. Their research was to identify hindrances to adopt OSS in Canadian health care. The barriers are lack of IT expertise and resource, internal and external political structure, lack of reliable information about OSS products, conservative nature of chief information officers, lack of responsible third parties, individualistic and competitive culture, and hidden cost of OSS. According to them, all of these derive from two key factors, which are the policy of the ministry of health and the lack of information at the operational level of IT managers concerning OSS (Paré et al. 2010, p. 1). Technological and cultural barriers have also been identified as determinant factors that affect the success of OSS adoption in health care. (Janamanchi et al. 2009, p. 470).

Apart of the limitations and barriers, the feasibility of OSS attracts researchers to recommend it as a solution for problematic national ICT projects such as NPfIT. Syeikh et al. (2011) in their evaluation on the NHS Care Record Services, recommend in-house development using OSS for the project. Another success story for OSS adoption is Online Receipt Computer Advance (ORCA) in Japanese health care. The commitment from the government by reducing bureaucracy and amending the policy facilitated the implementation of ORCA to almost all health agencies across Japan (Kobayashi et al. 2009, p. 98).

Concerning the standards for interoperability, there are already OSS tools to configure DICOM and HL7 into OSS HTIS. For example, Langer et al. (2010, pp.

684-685) conducted an experiment to mitigate the installation of various OSS health solutions using the Virtual Machine configuration under various operating systems including Linux and Debian under OSS. However, for the commercial laboratory information system (LIMS), HL7 requires complicated configuration and modification before it can be used (Cheng et al. 2010, p. 427). In order to solve that, Cheng et al. (2010, p. 428) developed open-source LIMS and used a new modified version of HL7 known as LL7 or laboratory level 7.

2.9 The model for the integration of applications in general organisations

One of the most recognised studies into enterprise application integration is by Themistocleous (2004). He studied the factors that assist the integration of discrete applications in organisations by using Enterprise Application Integration (EAI). Khoumbati et al. (2006, p. 5) regard Themistocleous's study as the main reference for EAI. EAI is an approach that aims to provide a solution to the integration of heterogeneous and incompatible applications in an industry (Linthicum, 1999, p. 3). Using a case study, Themistocleous (2004, pp. 101-102) suggests ten main factors and 13 sub-factors that are relevant in forming the conceptual model for application integration in organisations. This model has been used by most of the recent studies to propose the blueprints for ICT adoption in health care. Figure 2.9 illustrates the conceptual model proposed by Themistocleous.

Literature Review

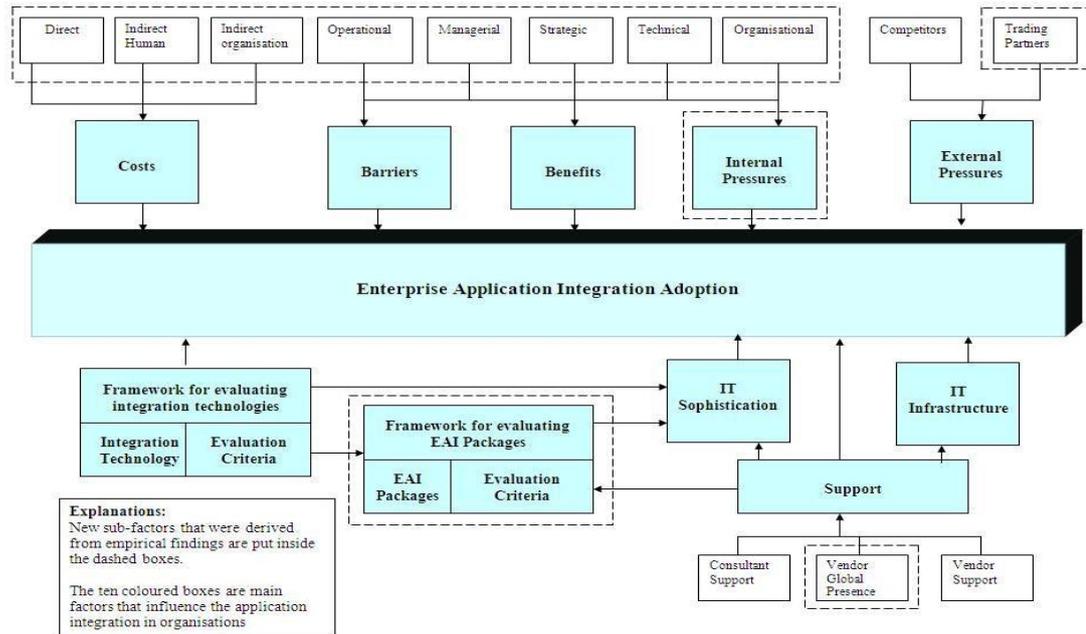


Figure 2.9: EAI framework for application integration in organisations (Themistocleous, 2004, p. 102).

This model is a tool for making decisions with regards to inter-organisational information system relationships (Themistocleous, 2004, p. 101). There are three types of factors which form this model. The first category includes key factors derived from the literature that study the integration of discrete information systems in organisations. These factors include cost, barriers, benefits, external pressure, IT infrastructure and sophistication, support and the framework for evaluating integration technologies. In Figure 2.9, they are presented in the blue boxes without the dashed lines. The internal pressure and framework for evaluating EAI packages are new factors proposed by Themistocleous (2004). The second category involves new factors suggested by Themistocleous (2004) resulting from his case study of two companies using the EAI model to integrate discrete information systems. These factors are presented within the dashed lines in Figure 2.9 and include internal pressure, the framework for evaluating EAI packages and one sub-factor, which is vendor global presence. The third category involves sub-factors that are additional factors which Themistocleous discovered in his study of two companies. These factors support the key factors and offer a new perspective on the EAI model. They are presented in non-coloured boxes in Figure 2.4 (Themistocleous, 2004, pp. 100-101).

Concern has been raised about the limitations of this framework. Mantzana and Themistocleous (2005) hold the view that the emphasis on organisational and technical aspects excludes human-related factors from being included in this model. This remark is based on the recommendation of McGrath and More (2001, p. 3), who consider that people-related issues also influence application integration in health care. The next section discusses application integration models in health care.

2.9.1 The model for the integration of applications in health care

Even though the framework proposed by Themistocleous (2004) considers Enterprise Application Integration (EAI) in general, it represents the whole idea behind the adoption of ICT in health care including electronic health records (Mantzana & Themistocleous, 2005). The flexibility of the model of application integration allows modifications to be made. Khoubati et al. (2006, p. 74) have modified the framework proposed by Themistocleous (2004, p. 102), based on either current literature or empirical findings. The modification includes adding five new main factors into the existing framework; telemedicine, organisation size, patient satisfaction, compatibility and the physician and administrator relationship. Figure 2.9.1A illustrates all factors in Khoubati et al.'s (2006) framework. Khoubati's model therefore, represents examples of thinking concerning the integration within the health care domain.

Literature Review

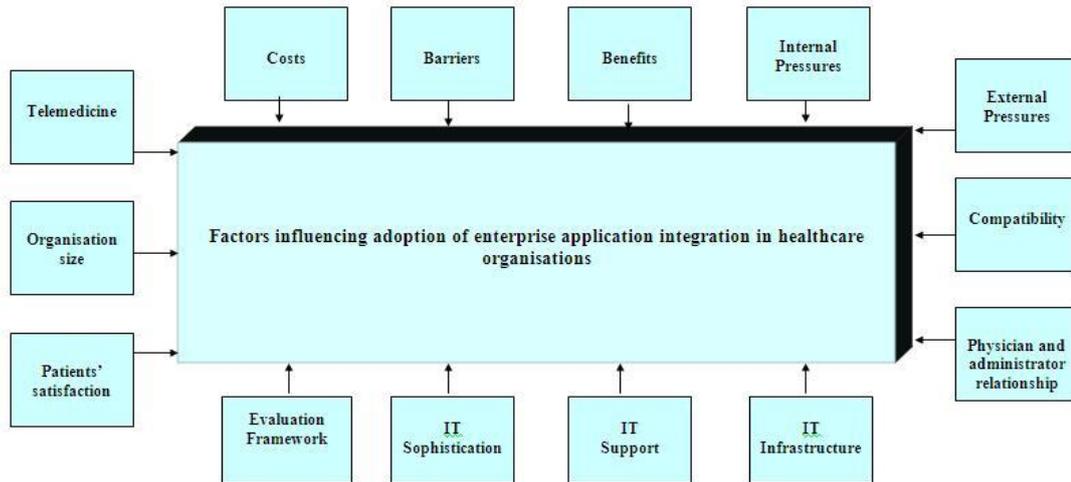


Figure 2.9.1A: Factors that influence the adoption of EAI in health care (Khoumbati et al. 2006)

Another study also has attempted to explain the factors that contribute to the success and failures of information systems in health organisations. Brender (2010, pp. 610-619) for example, suggests seven factors that determine the success and failures of HTIS adoption. Those factors are functional, organisational, behavioural, cultural, management, technical, and strategic factors. These factors are derived from his literature analysis on the subject. Figure 2.9.1B illustrates all these factors according to Brender’s frameworks. All these factors are formulated to represent the external and internal determinants in HTIS implementation. They also represent reactions from those involved in managing the HTIS implementation such as users, stakeholders and managers (Brender 2010, pp. 610-619).

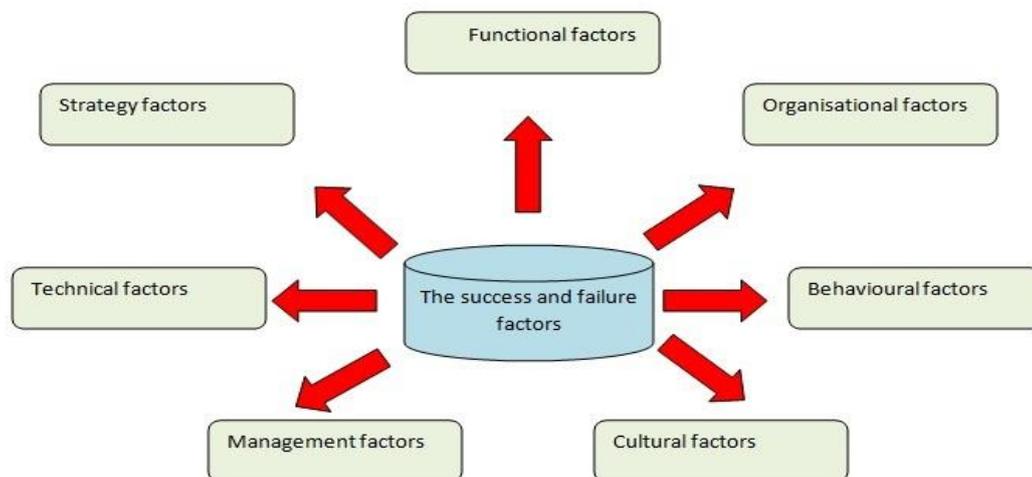


Figure 2.9.1B: Factors for success and failure in HTIS implementation

Literature Review

The above two figures are representation of technical and non-technical factors that influence the success and failure of interoperable HTIS as suggested by the literature (Jha et al. 2008; Egyedi 2007, p. 611).

2.10 Direction of the research and literature review

As highlighted in chapter one (section 1.1.1) the literature has influenced the researcher in uncovering nine issues that acted as a blueprint for this study. Links between the literature and those nine issues are portrayed in Figure 2.10 below:

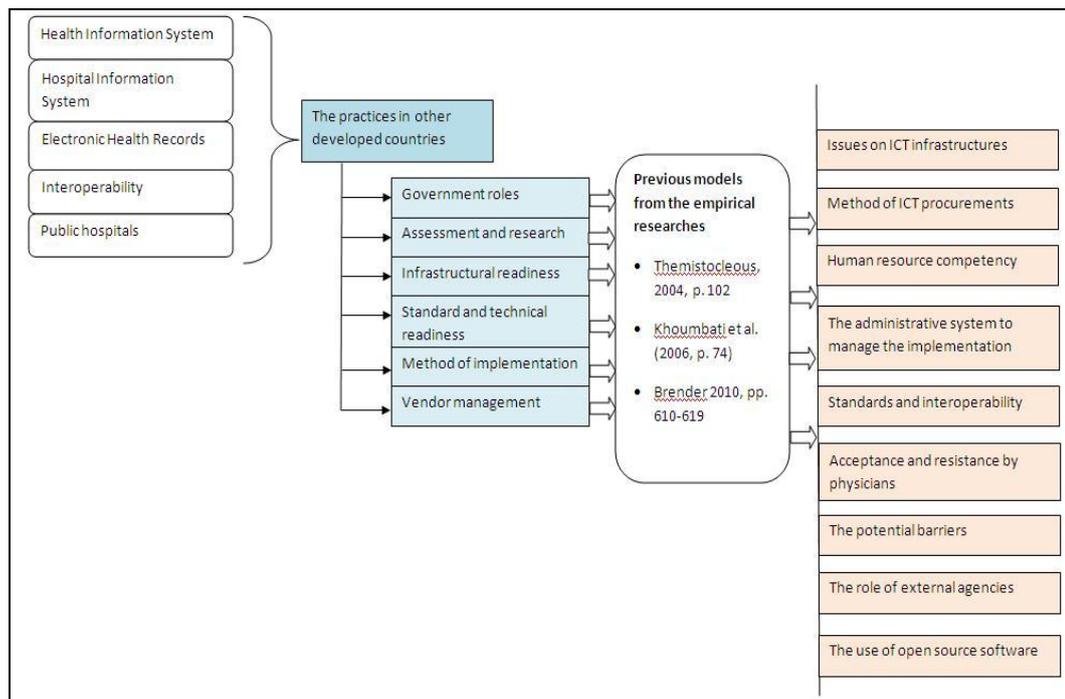


Figure 2.10: Literature and nine issues of this research

The five terms defined in section 2.2 focussed the discussion on issues related to their portfolios. Therefore, the researcher was able to focus on specific issues surrounding those five terms. To identify the experiences in other countries, seven developed countries were selected. It was beneficial to identify the issues and challenges of interoperable EHR in those countries as those issues and challenges provided lessons to be learned, as discussed in section 2.3.8. Those lessons guided the researcher to consider three different models from the previous empirical studies. After considering those models, and reviewing relevant articles and

Literature Review

research papers, the nine issues were extracted and proposed in the conceptual framework of section 1.5.

CHAPTER THREE

AN OVERVIEW OF THE MALAYSIAN HEALTH CARE SYSTEM

3.1 Introduction

This chapter describes the management of health care in Malaysia. The discussion starts with a description of the administrative systems in Malaysia.

3.2 The administrative systems in Malaysia

This section explains the structure of administrative systems in Malaysia and how management decisions are channelled from the top to the bottom. Since this research is related to an evaluation of how interoperable EHR and HTIS should be implemented in Malaysia, knowing the administrative structure and flow of command is important. It is important because it explains the mechanisms involved in any decision related to health care, displays the working procedures in government administration and illustrates the challenges and barriers that occur in the administration.

Malaysia is a parliamentary democratic country based on a federal system. The chief of state is Yang di-Pertuan Agong or Paramount Ruler, who is elected from hereditary rulers from nine states every five years. The governance of the Malaysian government is represented by three governing powers: executive, legislative and judiciary. All of them have their judiciary, in which no command can interfere with others.

The head executive is the Prime Minister, who leads the cabinet of ministries. There are 25 ministries in the Malaysian government, as listed below:

- | | |
|--|--|
| 1. Ministry of Agriculture and Agro-Based Industry | 14. Ministry of Information, Communication and Culture |
| 2. Ministry of Defence | 15. Ministry of International |

An Overview of the Malaysian Health Care System

3. Ministry of Domestic Trade, Trade and Industry (MITI),
Cooperative And Consumerism Malaysia
4. Ministry of Education
5. Ministry of Energy, Green 16. Ministry of Natural
Technology and Water Resources and Environment
6. Ministry of Federal Territories 17. Ministry of Plantation
and Urban Wellbeing Industries and Commodities
7. Ministry of Finance, Malaysia 18. Ministry of Rural and
Regional Development ,
Malaysia
8. Ministry of Foreign Affairs
9. Ministry of Health, Malaysia 19. Ministry of Science,
Technology and Innovations,
Malaysia
10. Ministry of Higher Education
11. Ministry of Home Affairs
12. Ministry of Housing and Local 20. Ministry of Tourism
Government
13. Ministry of Human Resources 21. Ministry of Transport,
Malaysia
22. Ministry of Women, Family
and Community
Development
23. Ministry of Works, Malaysia
24. Ministry of Youth and Sports,
Malaysia
25. Prime Minister's Department

Each ministry has respective departments, divisions and statutory bodies that specialise in certain core businesses and assignments. The Secretary General is a Chief Executive Officer (CEO) for the ministry. The Deputy of Secretary Generals and Director General, who act as Chief Operation Officers for their respective portfolios, assist the Secretary General. Each portfolio has divisions led by an Under Secretary. The establishment of portfolios varies according to the ministry. The MoHM, for example, uses ‘administration’ and ‘finance’ as its major portfolios. The Ministry of Defence uses ‘development’ and ‘management’ as its portfolio. Some ministries have respective departments to execute special tasks or assignments. These departments are be led by Director Generals.

An Overview of the Malaysian Health Care System

Another type of Malaysian government agency are the central agencies. The role of central agencies is to formulate policies and circulars for public administration. The policies and circulars are developed to support decisions, bills and enactments issued by the cabinet. They also make sure that there is standardisation in administration, resource management and chain of command.

The central agencies are listed below:

1. The Public Service Department
2. The Ministry of Finance
3. The Malaysian Administrative Modernisation and Management Planning Unit (MAMPU)
4. The Economic Planning Unit (EPU)
5. The Implementation Coordination Unit (ICU)

There are also independent commissions to monitor, advise, enforce and regulate the operations of those government agencies (ministries, departments and statutory bodies). These commissions are accountable to the Office of the Prime Minister. The commissions are listed below:

1. The Public Service Commission
2. The Bribery Preventive Commission
3. The Election Commission
4. The Human Rights Commission

The chain of command in Malaysian administration starts in Parliament. The bill and enactment are transformed into action plans by the ministries after approval by Parliament. The ministries propose policies, strategies and implementation plans to support the enactment. The Prime Minister chairs cabinet meetings to discuss relevant matters from time to time and makes decisions and policies in alignment with those enactments (The Malaysian Government Portal, 2011)

3.3 Overview of the Malaysian health delivery system

The Ministry of Health is the primary provider and supervisor of health services in Malaysia. Its jurisdiction on health is secured under the Ninth (9th) Schedule of the Malaysian Federal Constitution (Article 74, 77), which refers to the lists

An Overview of the Malaysian Health Care System

containing the subjects on which the Federal and State Governments can legislate. The clause within Articles 74 and 77 gives the MoHM the total right to provide health services in various categories to the public, and to collaborate with various government agencies (Noor Ghani & Yadav, 2008, p. 55; Malaysian Constitution, 1963, pp. 70-72). However, there are other ministries such as the Ministries of Higher Education, Local Government and Housing, Defence and National Unity and Social Development which are also responsible for the management of hospitals and health institutions. For example, the Ministry of Defence monitors health service delivery to the armed forces by military hospitals.

According to the 2010 health facts (The Ministry of Health, 2011), the mission of MoHM can be categorised into three missions. Firstly, the MoHM aims to facilitate and support the people to do three things:

- To attain fully their potential in health
- To appreciate health as valuable health
- To take individual responsibility and positive action for their health

The second mission is to ensure a high quality health system and is based on seven bases:

- Customer centred
- Equitable
- Affordable
- Efficient
- Technologically appropriate
- Environmentally adaptable
- Innovative

The third mission is to emphasise three values: professionalism, caring and teamwork; respect for human dignity; and community participation.

Thrust Four of the 10th Malaysian plan (2011–2015) highlights the core business of the MoHM. The thrust is ‘to improve the standard and sustainability of quality of life’. The transformation that the Malaysian government aims to achieve under this national plan can be classified into four strategies:

An Overview of the Malaysian Health Care System

- Transforming delivery of health care systems
- Increasing quality, capacity and coverage of the health care infrastructure
- Shifting towards wellness and disease prevention, rather than treatment
- Increasing the quality of human resource for health

The first strategy is relevant to this research because interoperable EHR and HTIS is a tool to optimise health delivery systems. Identification of the factors and actors that influence its implementation will assist the MoHM to have good direction when the Malaysian government wants to implement it. Interoperable EHR would also affect the second strategy and may also enable healthcare workers to focus on prevention rather than cure, as highlighted in the third strategy.

Three groups deliver health services in Malaysia: public, private and traditional or alternative. On top of that, these three providers are classified into two categories: Western and traditional. Figure 3.3A describes the categories of health service providers in Malaysia.

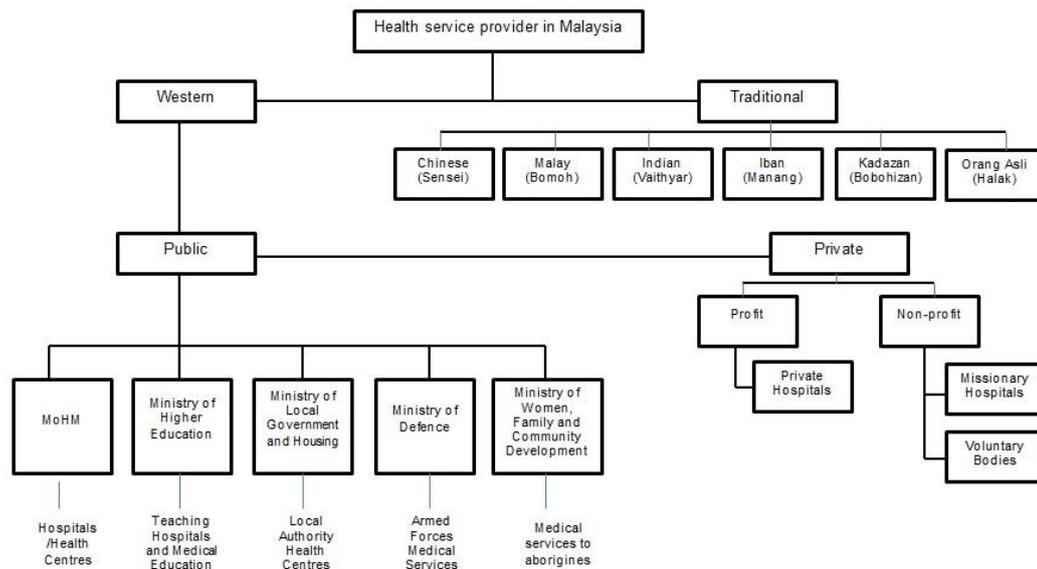


Figure 3.3A: Health service providers in Malaysia (Noor Ghani & Yadav, 2008, p. 38)

This figure illustrates the segregation of Malaysian health services. This segregation happens because there are some portions of tasks within certain ministries that involve health care. Therefore, they need to collaborate with the

An Overview of the Malaysian Health Care System

MoHM in terms of central administration, human resources and financial allocation. For example, there are universities that offer medical degree programmes and thus require hospitals for training purposes. Therefore, the Ministry of Higher Education in collaboration with the MoHM is accountable for the management of public hospitals that function as teaching hospitals. Currently, ten public universities and twelve private higher learning institutions offer medical degree programmes. Therefore, it is a great challenge for the MoHM to monitor health service delivery, particularly when it involves the core business of other ministries.

Based on the latest statistical data for 2010, 131 public hospitals are under the MoHM (The Ministry of Health, 2011). Table 3.3A displays the latest statistical facts about health service delivery in Malaysia.

Table 3.3A: Health statistics for Malaysian health care (Ministry of Health of Malaysia, 2011)

| The health agencies under the Ministry of Health of Malaysia | |
|--|--------|
| | Number |
| Hospitals | 131 |
| Special medical institutions | 6 |
| Special institutions | 15 |
| National institute of health | 6 |
| Dental clinics | 34 |
| Mobile dental clinics | 25 |
| Health clinics | 2,833 |
| Health clinics (1 Malaysia) | 53 |
| Mobile health clinics and teams | 165 |
| Mobile health clinics and teams (1 Malaysia) | 3 |
| Flying doctor stations | 13 |
| The health agencies not under the Ministry of Health of Malaysia | |
| Hospitals | 8 |

An Overview of the Malaysian Health Care System

This research focuses on public hospitals. These hospitals are classified into five types: district hospitals, district hospitals with specialist services, general hospitals, national referral centres and teaching hospitals (Noor Ghani & Yadav, 2008, pp. 79-84). Table 3.3B summarises the functions and specialties of these hospitals.

An Overview of the Malaysian Health Care System

1 Table 3.3B: The types of hospitals and their functions (adapted from Noor Ghani & Yadav, 2008, pp. 79-84).

| The types of hospitals | Summary of functions |
|---|--|
| District hospitals | <ul style="list-style-type: none"> • They are located in the districts of a state • The range of beds is around 24–150 • The offered medical services include outpatient care, inpatient care, accident and emergency services • The specialist services are on a ‘visiting basis’ • They are equipped with basic laboratory and radiology services • They are base community hospitals for simple clinical problems |
| District hospitals with specialist services | <ul style="list-style-type: none"> • They are located in bigger districts of the state – each state may have at least two • The range of beds is around 150–500 • The specialist services include general medicine, general surgery, paediatrics, obstetrics and gynaecology, anaesthesia, pathology and radiology • They also provide similar services to small district hospitals, for example inpatient services • They are equipped with better laboratory and radiology equipment • The specialists provide consultancy and visiting services to small district hospitals |
| General hospitals | <ul style="list-style-type: none"> • Each state has its own general hospital that acts as a final referral from all hospitals in the state • The range of beds is from 400–1000 • It offers tertiary services such as neurosurgery, neurology, urology, neonatology, cardiology, etc. |

An Overview of the Malaysian Health Care System

| The types of hospitals | Summary of functions |
|---------------------------|---|
| | <ul style="list-style-type: none">• For complex cases, the patient will be referred to national referral centres, or teaching hospitals |
| National referral centres | <ul style="list-style-type: none">• These centres are established to cater for complex cases from all public hospitals across the states• They are located in central locations, e.g. in Kuala Lumpur, the capital of Malaysia• Kuala Lumpur hospital is an example of a national referral centre• The other examples are paediatric Institute, maternity hospitals, the Institute of Urology and Nephrology, the Institute of Neurological Sciences, and the Institute of Orthopaedics• The other centres that cater for specific disease conditions are psychiatry, respiratory, psychiatric illness and the National Heart Institute |
| Teaching hospitals | <ul style="list-style-type: none">• These hospitals are attached to universities that offer medical degrees, and they are under the Ministry of Higher Education and partly funded by the MoHM• Besides teaching the medical programme to the undergraduates and postgraduates, they also provide services and referral centres for specific regions |

3.4 ICT adoption in Malaysian health care

This section discusses the application of ICT in Malaysian health care. The discussion starts with ICT initiatives in the Malaysian public sector. It is an overview of how ICT penetrates into the public sector and the current progress of the adoption.

3.4.1 ICT initiatives in the Malaysian public sector

The past decade has seen rapid developments in the adoption of ICT by the Malaysian government. The adoption of ICT into Malaysian governance started in the 1970s when data processing was introduced to facilitate information storage. Then, in the 1980s, the Malaysian government adopted management information systems (MIS). In 1997, with the growth of Internet technology and for the purpose of facilitating the delivery process, the concept of e-government was introduced. By 2005, realising the importance of having integrated systems for government agencies, system applications were able to be accessed through government webpages. All of these efforts were the building blocks for the achievement of maximum government service delivery through ICT in 2010 (Mohd Zahri, 2008).

3.4.2 ICT initiatives in health care

The Ministry of Health of Malaysia (MoHM) is responsible for the coordination, regulation, advocacy and supervision of all activities related to health in Malaysia. There are a number of departments and organisations under the MoHM whose functions are discrete and specialised. The use of information technology in Malaysian health care is not something new; over several decades, implementation has occurred in line with ICT adoption by the Malaysian government. At the ministerial level, two divisions are accountable for the management of anything related to ICT adoption in Malaysian health care; the Division of Information Management and the Division of Telehealth. There are also committees from these divisions to approve or disapprove any procurement of ICT projects for Malaysian health care agencies.

An Overview of the Malaysian Health Care System

ICT has formed part of Malaysian health care for almost a decade (Mohd Zahri, 2008). According to the ICT weblog of the MoHM, there are various information systems and applications being used by health agencies under the MoHM. However, the information does not represent all health agencies under MoHM, because only 13 agencies report their health information systems to the weblog (Ministry of Health of Malaysia, 2009a). Table 3.4.2A provides a list of the information systems being used in Malaysian health care agencies. Information about these agencies is scattered in the MoHM's online document. By tabulating that information, it assists the researcher to understand the level of disintegration of various HTIS used in Malaysian public hospitals.

Table 3.4.2A: List of information systems used in Malaysian health care institutions (generated from the ICT weblog and Newsletter of Ministry of Health of Malaysia, 2009a)

| Health care Institutions | Health Information systems |
|--|--|
| 1. Ministry of Health of Malaysia | <ul style="list-style-type: none"> • Helpdesk system for managing the budget and accounts • Information system for staff training • Information system for procurement contracts • Competency management system • e-Pengamal (traditional and complementary medicine) |
| 2. Banting District Hospital, Selangor | <ul style="list-style-type: none"> • Hospital Inventory System (HIS) |
| 3. Besut District Hospital, Terengganu | <ul style="list-style-type: none"> • Patient admission systems • Remuneration system • Computerised dispensing system |
| 4. Duchess of Kent Hospital, Sarawak | <ul style="list-style-type: none"> • Unit of use system • Pathology system |
| 5. Kuala Kubu Bharu District Hospital | <ul style="list-style-type: none"> • Hospital Inventory System (HIS) |

An Overview of the Malaysian Health Care System

| Health care Institutions | Health Information systems |
|---|---|
| 6. Kuala Lumpur General Hospital | <ul style="list-style-type: none"> • Supplier system • Patient record management system • Housemen system |
| 7. Penang General Hospital | <ul style="list-style-type: none"> • Endoscopy patient registration system |
| 8. Raja Permaisuri Bainun Hospital | <ul style="list-style-type: none"> • National Suicide Registry, Malaysia • Pharmaniaga system (pharmacy system) • E-latihan (staff training) • Virtual library • Inventory system • Computerised operating theatre documentation system • Remuneration and salary system • Neurophysiology database system • Record management system |
| 9. Institute for Medical Research (IMR) | <ul style="list-style-type: none"> • Lab-based surveillance system for infectious diseases • BiomicXLData Sorter • Antibiotic sensitivity verification • Salmonella typhi phagotyping system • Salmonella serotyping system • Microscopic Electron Service system • Budgeting and financial assessment system • National Quality Control Programme in Microbiology • Malaysian Marrow Donor Registry |
| 10. Kelantan Health Department | <ul style="list-style-type: none"> • Advanced Clinic Management (ACM) for whole health clinic in Kota Bharu • Food conductor registration system |
| 11. Perak Health Department | <ul style="list-style-type: none"> • Property record management system • Service management information system |

An Overview of the Malaysian Health Care System

| Health care Institutions | Health Information systems |
|--|--|
| | <ul style="list-style-type: none"> • Pharmaceutical information system |
| 12. Sabah Health Department | <ul style="list-style-type: none"> • Tibi (Tubercle Bacilli) database system |
| 13. Selangor Health Department | <ul style="list-style-type: none"> • Human resource development information system • E-fail system • E-aduan (online complaint) |
| <ul style="list-style-type: none"> • Selayang Hospital • Serdang Hospital • Pandan Hospital • Putrajaya Hospital | <ul style="list-style-type: none"> • Total Hospital Information Systems (THIS) that will cater for three modules: <ul style="list-style-type: none"> • Hospital information systems • Clinical sub-system • Non-clinical system |
| <ul style="list-style-type: none"> • Penang Hospital • Seremban Hospital • Tengku Ampuan Afzan Hospital • Queen Elizabeth Hospital • Kota Kinabalu Hospital • Ipoh Hospital • Tengku Ampuan Rahimah Hospital • Kuala Terengganu Hospital • Sultanah Aminah Hospital • Alor Setar Hospital • Seberang Jaya Hospital • Kajang Hospital • Kota Bharu Hospital • Melaka Hospital | <ul style="list-style-type: none"> • Inpatient management information systems • The information system developed to cater for functionalities that involve nursing, paramedic services, patient records and resource management |

An Overview of the Malaysian Health Care System

| Health care Institutions | Health Information systems |
|--|---|
| <ul style="list-style-type: none"> • Kuala Lumpur Hospital • Batu Pahat Hospital • Slim River Hospital | |
| <p>There are three districts in Johor, four divisions in Sarawak and one district in Perlis that actively run TPC applications, and they are linked to MoH headquarters in Putrajaya</p> <p>40 rural clinics, three district hospitals and seven health district offices</p> | <p><u>Teleprimary Care (TPC)</u></p> <p>TPC comprises 16 modules that intend generally to enable delivery of health care services and data from primary and secondary care (general hospitals with rural clinics), regardless of distance</p> |

At least two questions, relevant to this research, can be posed: are those information systems able to interoperate; and are data from those information systems exchangeable?

An email communication between the researcher and the Under Secretary of the Division of Information Technology and Communication for the MoHM, Dr Mokhtar Mohd Yusof (March 14, 2008), proposed that interoperability in Malaysian health information systems could be achieved by using third party applications, if they comply with the agreed standards. Dr Ahmad Tawfik (March 31, 2008), who is head of the Information Technology Unit at the Malaysian National University Hospital, also stressed the importance of the current effort by Malaysian health care to adopt the Integrated Health Enterprise (IHE) framework and standards. This view is supported by a series of Connectathon events organised by the Multimedia Development Corporation (MDEC) to test interoperability among the health care solutions developed by Malaysian companies by using IHE profiles (MDEC, 2009).

An Overview of the Malaysian Health Care System

To widen the use of HTIS across public hospitals, MoHM developed an in-house information system known as the Patient Management System (PMS). It was developed to cater for basic modules for hospital operations. The ICT Steering Committee of the MoHM and Central Committee of MAMPU decided to expand the PMS into those hospitals that did not currently have a health information system (referred to throughout this thesis as non-HTIS hospitals). The committee members also agreed to allocate some budget for expanding the PMS's to reach an acceptable level of information provision that equates to the basic features of an HTIS (MAMPU, 2010b, pp. 25–26; Ministry of Health, 2008). The original PMS generally had nine existing modules – these are listed below:

- | | |
|----------------------------------|--------------------------|
| 1. Outpatient Management | 5. Billing and Payment |
| 2. Medical Record Management | 6. Nurse Administration |
| 3. Discharge Summary | 7. Inquiries and Reports |
| 4. Ward and Inpatient Management | 8. Diet and Catering |
| | 9. Order Management |

Upgrading PMS into HTIS requires the installation of another eleven modules for clinical and non-clinical modules. The Putrajaya Hospital, for example, combines both clinical and administrative modules that form HIS modules. Table 3.4.2B describes the modules in Putrajaya Hospitals.

Table 3.4.2B: The HIS and non-clinical modules for HTIS-hospitals (generated from technical documents of Putrajaya Hospital)

| HIS modules (administrative and clinical modules) | Non-clinical modules |
|---|--|
| <ol style="list-style-type: none"> 1. Patient management – outpatient and inpatient 2. Patient accounting 3. Appointment management 4. Order management 5. Queue management 6. Bed management 7. Electronic medical record | <ol style="list-style-type: none"> 1. Central sterilisation and supply department (CSSD) 2. Dietary order management system 3. Material management system |

An Overview of the Malaysian Health Care System

| HIS modules (administrative and clinical modules) | Non-clinical modules |
|--|----------------------|
| <p style="text-align: center;">(EMR)</p> <ol style="list-style-type: none"> 8. Haemodialysis system 9. Labour and delivery monitoring system 10. Operation theatre management 11. Critical care information system (CCIS) 12. Laboratory information system 13. Radiology information system 14. Picture archiving and communication system (PACS) 15. Pharmacy information system 16. Clinical report 17. Medical social service system | |

Comparing two Malaysian hospitals in their case study, Abdul Karim and Ahmad (2010, p. 86) suggest a different classification of the modules. Figure 3.4.2 describes the differences. In their study, they identify two modules of HTIS are used in the two hospitals. The modules are I-SOFT Clinical Manager, and Total Hospital Information System.

As described in Figure 3.4.2, the iSOFT Clinical Manager or iCM comprises of three main modules such as Clinical System, Clinical Support System and the Non-clinical System. The clinical system functions for patient administration. The clinical support provides modules like PACS, Radiology Information System (RIS), Lab Centre, Blood Bank System, Cysto-Cyto, and Neurosurgery ICU system. The Non-clinical System comprises of the engineering system, biomedical system, Finance and the Queue Management System (Abdul Karim & Ahmad, 2010, p. 86).

An Overview of the Malaysian Health Care System

As illustrated in Figure 3.4.2, the modules for Total Hospital Information System (THIS) contain three major components. They are image, clinical and administrative-finance components. The image component comprises of PACS, whereas clinical component contains modules for clinical functions. The modules are laboratory information system, pharmacy information system, critical care system, haemodialysis system, and labour and delivery system. The administrative and finance functions are the components in admin-finance components (Abdul Karim & Ahmad, 2010, pp. 86-87).

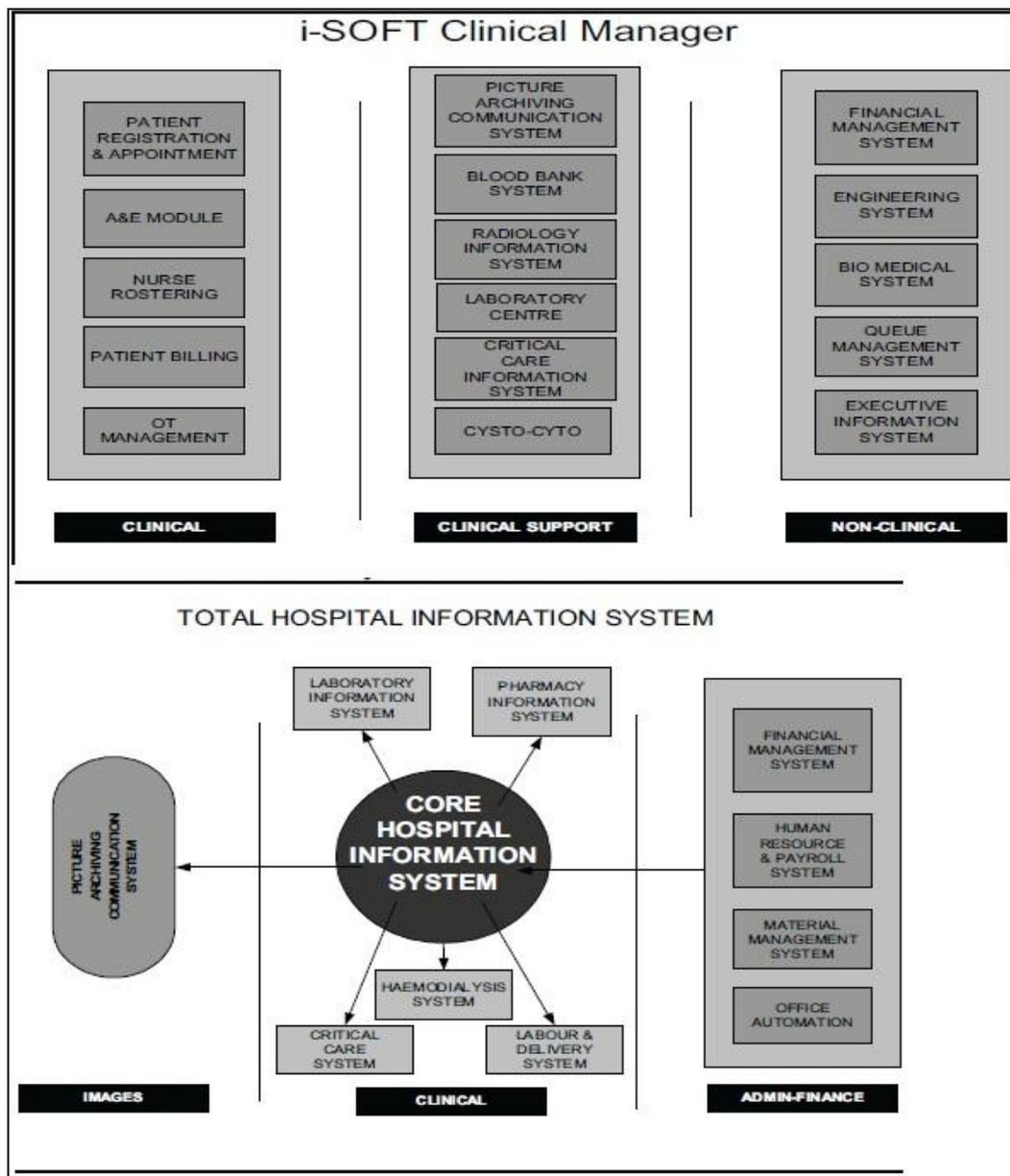


Figure 3.4.2: Different classification of HTIS modules between two hospitals (Abdul Karim & Ahmad, 2010, p. 86)

3.4.2.1 Implementing interoperable EHR in Malaysia

In 1997, under the flagship of the Multimedia Super Corridor, Malaysia formulated a notion to establish a national Telemedicine project, which aimed to improve health service delivery to the Malaysian public. The MoHM defined telemedicine as referring to *'the provision of health care and health related services using telecommunications, information and multimedia technologies to link the participants in the health care'* (Ministry of Health, 1997, p. 12).

The scope of telemedicine under this project was extensive and covered three areas: health care services; multimedia networks and applications, tools and technologies. In brief, the first area covered four specialisations: information and education services; consultation, diagnostic and treatment services; support services; and governance. The second area emphasised the telecommunication network between urban and rural areas in Malaysia. Its core business was to ensure sufficient bandwidth to support the telemedicine programme. The third area covered two major programmes: Lifetime Health Plans (LHP) and Teleconsultation (Ministry of Health, 1997, p. 16).

Four pilot projects were used to initiate this project:

1. Mass customised personalised health information and education
2. Continuing Medical Education
3. Teleconsultation
4. Lifetime Health Plan

The first pilot project was mass-customised personalised health information and education. It aimed to create and deliver high quality health information and educational content to patients using multimedia technology via telecommunication. In contrast to the first, the focus of the second project was to provide continuing medical education for health care professionals via multimedia technology. Realising the gap between rural and urban areas, Teleconsultation was a method to provide health care consultation services from a distance also using multimedia technology. The last pilot project was to design, develop and implement a personalised, proactive and prospective lifetime health plan to

An Overview of the Malaysian Health Care System

achieve continuity in a person's health care (Ministry of Health, 1997, pp. 25–26; Mohan & Yaacob, 2004, p. 218; Abd. Ghani et al., 2009, p. 3; Sarlan et al., 2009).

The second pilot project was Continuing Medical Education (CME), which aimed to provide medical education for health professionals through distance learning methods using ICT. Four scopes of CME were based on content development, maintenance and updating of content, provision of CME through multiple delivery channels and marketing the CME programmes to health care professionals (Ministry of Health, 1997, pp. 26–27; Lee, Ramayah & Zakaria, 2011).

The third pilot project was Teleconsultation, this aimed to provide interactive consultation between medical specialists in tertiary hospitals with patients who live in remote areas. Teleconsultation is not limited to video conferencing between the specialist and patient, but includes transmission of the patient medical records between a variety of medical specialists (Ministry of Health, 1997, pp.28; Lee, Ramayah & Zakaria, 2011).

The fourth pilot project was the Lifetime Health Plan (LHP). The objective of this project was to develop and implement a personalised lifetime health plan for each individual who lived in Malaysia. The outcome of this project was to ensure the continuity of medical records for individuals so that their range of care can be sustained. It was supported by three ICT solutions. These three applications contain sub-systems that specialise in the respective functionalities (Ministry of Health, 1997, pp. 28–29; Lee, Ramayah & Zakaria, 2011). Table 3.4.2.1 illustrates the sub-systems that support these three applications.

Table 3.4.2.1: The Lifetime Health Plan and its sub-systems

| The LHP Sub-Solutions | |
|--------------------------------|--|
| Clinical Support Systems (CSS) | <ul style="list-style-type: none">• Hospital Information System (HIS)• Clinical Information System (CIS)• Laboratory Information System (LIS)• Radiology Information System (RIS) |

An Overview of the Malaysian Health Care System

| The LHP Sub-Solutions | |
|---|--|
| | <ul style="list-style-type: none"> • Picture Archiving and Communication System (PACS) • Pharmacy Information System (PhIS) • Critical Care System (CSS) • Decision Support System (DSS) |
| Health care Information Management and Support Services (HIMSS) | Information Management System (IMS) contains: <ul style="list-style-type: none"> • Lifetime Health Records (LHR) • Lifetime Health Plan (LHP) |
| Personalised Lifetime Health Plan (PLHP) | <ul style="list-style-type: none"> • PLHP information systems |

One of the sub-applications under HIMSS is Lifetime Health Records. The Lifetime Health Records (LHR) is a repository that aims to store the integrated medical records of individuals. This national repository will function together with another repository – Lifetime Health Plans (LHP) – whose function is to store the generated data of complete past medical records together with sets of prospective health plans for individuals (Ministry of Health of Malaysia, 1997, pp. 19–20). The LHR project is referred to again in chapter Four and Five, as the LHP project was used during the data collection phase of this project as an important example when discussing EHR implementation in Malaysia.

After a failure to proceed with these four Telemedicine projects, the Malaysian government once again, after nine years, included LHR as a prioritised project under the Ninth Malaysian Plan of 2006–2010. The project aimed to improve health service delivery by using ICT (Economic Planning Unit, 2006). This effort was initiated with a pilot project known as MyHIX, which intends to integrate the discharge summaries of six health care agencies (Ministry of Health, 2009).

3.5 Conclusion

This research attempts to identify factors that influence the successful implement interoperable EHR in Malaysian healthcare. In the Telemedicine proposal of 1997, the MoHM had identified five barriers that required instant solutions for telemedicine project (Ministry of Health of Malaysia 1997, p. 38). Those barriers included healthcare organizations, people, process reengineering, financing, and regulations. However, those barriers were proposed according to the political and technological surroundings at that time. After reviewing the literature and communicating with officials from the MoHM, there are new barriers that require solutions by the MoHM. All of the old and new barriers discussed in Chapters 2 and 3 were considered when developing the nine issues that framed this research as outlined in section 1.3.1.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

This section is about the method of inquiry used in this research. The discussion starts with the research paradigm and elaborates upon the reasons that a qualitative methodology is used and why a case study is suitable for this research. Interviews and document analysis as data collection techniques are then discussed to explain the relevancy of these techniques to this research.

4.2 Research Paradigm

4.2.1 Types of research paradigm

This philosophical view will provide an indication of how the research problems will be handled. According to Seale (1998, p. 12), research paradigms ‘provide the concrete puzzle solution or exemplar of how to solve a scientific problem’. There are three schools of thought regarding research paradigm. The first school of thought is Positivism, which believes that the end result of the research is to predict, control and explain the phenomena. This school prefers quantitative methodology. The second school is Postpositivism, which is similar to positivism in the end result of the research, with the difference being only in the methods of perceiving the reality. Consequently, either quantitative methodology or a combination of both qualitative and quantitative methodology can be employed. The last school is Interpretivism. This school believes that there are multiple constructed realities in research and that realities vary in nature. The purpose of this school concerns the understanding, reconstruction and transference of the findings (Pickard, 2007, pp. 5–12). Table 4.2.1 illustrates the comparison of these three schools in terms of the methodological stances used in the research.

Research Methodology

In presenting the differences between these three philosophical thinking paradigms, Pickard (2007) uses examples and descriptions to support her arguments. As a summary, the researcher has extracted various explanations and examples from her arguments and presented them in tabular presentation as in Table 4.2.1. The summary assists the researcher to identify the right thinking approach for this research.

Table 4.2.1: Comparison of three research paradigms with respect to their methodological stances (generated from Pickard, 2007, p. 7)

| | Positivism | Postpositivism | Interpretivism |
|--|--|---|--|
| Ontological stance (What is the nature of reality?) | Realism Belief in a tangible and social reality. A social reality exists as natural reality. For example, leadership exists in social reality in a similar way as water in natural reality | Critical realism Belief in a social reality but acceptance that this reality will always be inhibited by imperfections in detecting its nature | Relativist Belief in multiple and constructed realities cannot exist outside the social contexts that create them. Realities vary in nature and are time and context bound |
| Epistemological stance (What is the nature of knowledge?) | Objectivist/dualist Investigator and investigated are independent of each other | Modified dualist/objectivist Acceptance that independence is not possible but objectivity is seen as the goal and demonstrated by external verification | Transactional/subjectivist The results of the investigation are a product of interaction between the subject and the investigator. The result is interaction Knowledge is not objective but rather subjective. Reality is based on diverse interpretation, which no one ultimate or correct way of knowing |

Research Methodology

| | Positivism | Postpositivism | Interpretivism |
|--|---|--|---|
| Methodological stance (What is the nature of approach to research?) | Hypothesis testing. Variables identified before the investigation. Empirical testing is conducted to establish the truth of the proposition | Hypothesis testing | Investigator interacts with the object of the investigation. Each construction of reality is investigated in its own way and interpreted by the researcher Focus on understanding Uses inductive reasoning. Meaning is constructed in the researcher–participant interaction in the natural environment Gathers diverse interpretations (e.g. grounded theory, ethnography) |
| | Quantitative methodology Analysis by variables | Quantitative and qualitative methodology Analysis by variables | Qualitative methodology Analysis by case |
| Purpose | Prediction, control, explanation. Framing of general laws | Prediction, control, explanation and generalisation | Understanding, reconstruction. Transfer of findings |
| Methods: (What techniques can be used to gather this information?) | Tends to use quantitative methods, often including statistical testing of hypotheses (e.g. randomised controlled trials, questionnaires) | Quantitative and qualitative methods: systematically gathered and analysed data from representative samples (e.g. surveys, interviews, focus groups) | Tends to use qualitative methods to capture various interpretations of a phenomenon (e.g. naturalistic observation, interviews, use of narrative) |

4.2.2 The interpretivist paradigm and this research

This research requires an enquiry into multiple realities of the subject matter, which is the issue of interoperability of electronic health records in Malaysian hospitals, so that understanding, reconstruction and findings can be transferred, depended upon and confirmed. Examples of potential multiple realities for this research are listed below:

- The directives and strategic planning by the Ministry of Health of Malaysia on electronic health records, with regards to the concept of interoperability
- The readiness and availability of technology used by public hospitals in Malaysia to support the interoperability of electronic health records
- The role of standards in interoperability of electronic health records in Malaysia
- The relevancy of open-source technology in supporting interoperability of electronic health records in Malaysia

This research is more related to Interpretivism because it is about interaction with the practice of electronic health record projects and the people who handle them either in the Ministry of Health or in the respective hospitals. All of these entities will be investigated and interpreted as cases.

In devising any form of research, axiology is important. Axiology is the study of values and in any research project and the researcher's approach and values are important in devising a research approach (Hart 1971, p.29; Carter & Little 2007, p. 1322). In this context it is important to the research that the attitudes and opinions of stakeholders are surfaced as an important aspect of the research and *Jennings (2004)* believes that these views can be most clearly investigated by a set of in depth face to face interviews that provide researchers with valuable inputs about the reality. Furthermore, two perspectives according to *Bunnis and Kelly (2010, p. 360)* entitle a research to be interpretivism. These two perspectives are compared with the nature of this research in Table 4.2.2.

Table 4.2.2: The interpretivism and this research

| Two perspectives by Bunnis and Kelly (2010, p. 360) | How this research is conducted? |
|--|---|
| <i>“It uses a subjective epistemology which anticipates multiple, diverse interpretations of reality rather than seeking to reveal an overarching ‘truth’”,</i> | The epistemology of this research is built up on the foundations, which are based on different interpretations of those officials who handle the procurement processes of EHR and HTIS in MoHM and physicians who are currently using the EHR and HTIS. |
| <i>“It is associated with an interpretive effort to gather a range of in-depth accounts with the aim of building a detailed picture of how a particular phenomenon is understood by those who have personal experience of it”.</i> | The detailed picture of how EHR and HTIS is implemented in MoHM is understood by interviewing the relevant officials (IT personnel, Medical Record officials, and physicians) who have direct experiencing either managing the EHR or using the system. |

Based on the above justifications, the use of interpretivist’s research approach is viable for this research.

4.3 Research Approach

4.3.1 Qualitative and quantitative research

This research uses a qualitative research methodology to analyse the interactions between the entities involved. According to Creswell (2009, p. 4), qualitative research is:

‘A means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. The process of research involves emerging questions and procedures, data typically collected in the participant’s setting, data analysis inductively building from particulars to general themes, and the researcher making interpretations of the meaning of the data. The final written report has a flexible structure. Those who

Research Methodology

engage in this form of inquiry support a way of looking at research that honours an inductive style, a focus on individual meaning, and the importance of rendering the complexity of situation.’

Therefore, this approach is justifiable for this research, because ICT adoption in Malaysian hospitals is not something new. Almost all hospitals in Malaysia use ICT as a tool for administrative purposes and decision-making. However, the question arises of why hospitals that already have hospital information systems still cannot exchange their electronic health records with other public hospitals, even though they are under one management body, the MoHM. This inability has caused problems to society, particularly in the case of referral, where it takes a long time for a referred hospital to obtain a patient’s health record. The area which this research intends to study concerns the interoperability of electronic health records. Therefore, there is a need to examine current ICT adoption in depth in order to identify the factors or variables that support interoperable electronic health records. This information will be obtained by interviewing key people from the MoHM and the respective hospitals, which are the natural settings of this problem. Furthermore, examples of where a similar research design has been used can be found in the literature. Table 4.3.1 provides examples of relevant studies that use a qualitative research approach.

Table 4.3.1: Other similar research and their approach

| Authors | Study overview | Research approach | Research method |
|--------------------------|---|--------------------------|------------------------|
| Hendy et al., 2007 | Describes progress and perceived challenges in implementing the NHS information and technology (IT) programme in England. Design case studies and in-depth interviews, with themes identified using a framework developed from grounded theory. | Qualitative research | Case study |
| Abd. Ghani et al., 2008a | The challenges in the integration process of Life Health Records in | Qualitative research | Case study |

Research Methodology

| Authors | Study overview | Research approach | Research method |
|-----------------------|--|----------------------|-----------------|
| | Malaysia, focusing on five issues: integration efforts, process reengineering, funding, people and laws. Uses interviews and literature. | | |
| Khoubati et al., 2006 | A study about the integration of discrete information systems in health care organisations. They use EAI as a foundation for their framework, and a qualitative approach to understand the problem behind the integration, and a case study method of inquiry. | Qualitative research | Case study |
| Mantzana et al., 2007 | Identifies the health care actors that play significant roles in ICT adoption of information systems in health care. A qualitative approach is used to delve into the problem. They use a case study as their method of inquiry. | Qualitative research | Case study |

4.3.2 Justification of the qualitative research approach for this research

This approach is widely used in evaluation studies of computer and information systems in health care. The aim of qualitative research is to understand issues or situations by examining the perspective and behaviour of the people in those situations and the context within which they interact. Data are gathered primarily from observations, interviews and documents in the natural settings. In contrast to quantitative research, whose data are numerical, qualitative research data are formed in words (Kaplan & Maxwell, 2005, p. 30). A study by Mantzana et al. (2007, p. 93) of health care actors applies qualitative research, because this approach is able to investigate little-known phenomena and complex processes in a natural setting. This is supported by Flick (2006, pp. 15), who holds the view

that qualitative research is able to tackle complex research problems because it handles research objects in their entirety and contexts within their own natural settings. The implementation of interoperable electronic health records in Malaysia is quite a complicated field of study, because it involves various research objects such as managerial and technical issues. To reduce the objects into variables and represent them in numerical forms may overlook some important entities of the objects. Thus, it is appropriate to tackle this research by using qualitative research, since it handles the research objects within their own natural settings. Under the qualitative research approach, there are several methods that can be used to conduct the inquiry: ethnography, grounded theory, phenomenological study, action research and case studies.

Quantitative research is not used as an approach for one reason. It is because of the nature of the study that the researcher is required to understand the reasons and context behind the inability of Malaysian hospitals to exchange electronic health records. Quantifying the population samples through questions or experimentation to see the relationship between dependent and independent variables will not assist in the understanding of the problem faced by Malaysian hospitals. The non-parametric or parametric data techniques of inquiry will only provide numerical data that requires correct interpretation and analysis. Misinterpretation of those data will affect the validity of the research findings.

4.4 Research Design

This section discusses the overall research design of this study. Creswell (2009, p.5) defines research design:

‘Research design is a plan or proposal to conduct research and involves the intersection of philosophy, strategies of inquiry, and specific methods.’

To structure the research design as a systematic flow, Ulin et al. (2005, p. 33) list 12 design questions that should form the research design:

- What is the general area of inquiry?
- What is the purpose of the research?
- How is the research problem defined?

Research Methodology

- What is the larger conceptual framework?
- What questions will address the research problem?
- What methods will best address the research questions?
- Who should participate?
- What ethical standards will assure the protection of study participants?
- How should the data be collected?
- How will data collectors be trained and monitored?
- How will the data be analysed?
- How will the results be disseminated?

The general area of inquiry is the implementation of interoperable electronic health records in Malaysian public hospitals. The purpose of this research is to investigate the capability of Malaysian hospital information systems to support the interoperability of electronic health records by focusing on nine issues, as discussed in section 1.3.1. The way to define the research problems is through identification of those issues that form the core of the research, as proposed by Ulin et al. (2005, pp. 34-35). The expected outcome of the researches problem statement is the identification of the factors that influence the implementation of interoperable electronic health records in hospitals of Malaysia. The literature also contributes to the formation of the research problems. Several previous studies form this research problem: Kimberly and Evanisko (1981); Kim and Michelman (1990); Themistocleous (2004); Khoubati et al. (2006); Khoubati and Themistocleous (2007); Montzana et al. (2007).

Defining a conceptual framework will determine the key concepts behind the research design. Besides outlining the research questions, a conceptual framework also assists the researcher to understand the related facets of the problems and associations between them, thus helping to identify the correct method of inquiry, either within qualitative or quantitative research approaches (Ulin et al., 2005, pp. 37–38). Figure 1.6 comprises many of the elements mentioned by Ulin (2005), such as concepts, issues, the facets of problems, theories, research questions and objectives.

Research Methodology

The research design will determine the research approach to be used, whether qualitative, quantitative or a mixture of both. In designing the research, the researcher needs to consider two issues. The first is the research philosophy or research paradigm, and the second is the strategies of inquiry. The research paradigm will justify the use of the correct research approach, and in conjunction with that, the selection of the correct method of inquiry also needs to be justifiable (Cresewell, 2009, pp. 4–14; Pickard, 2007, pp. xv–xvii). Figure 4.4 illustrates the entire research design for this study. In their study, Kaplan and Maxwell (2005, p. 38) suggest that a qualitative research design should be flexible and iterative due to its basis of induction.

Research Methodology

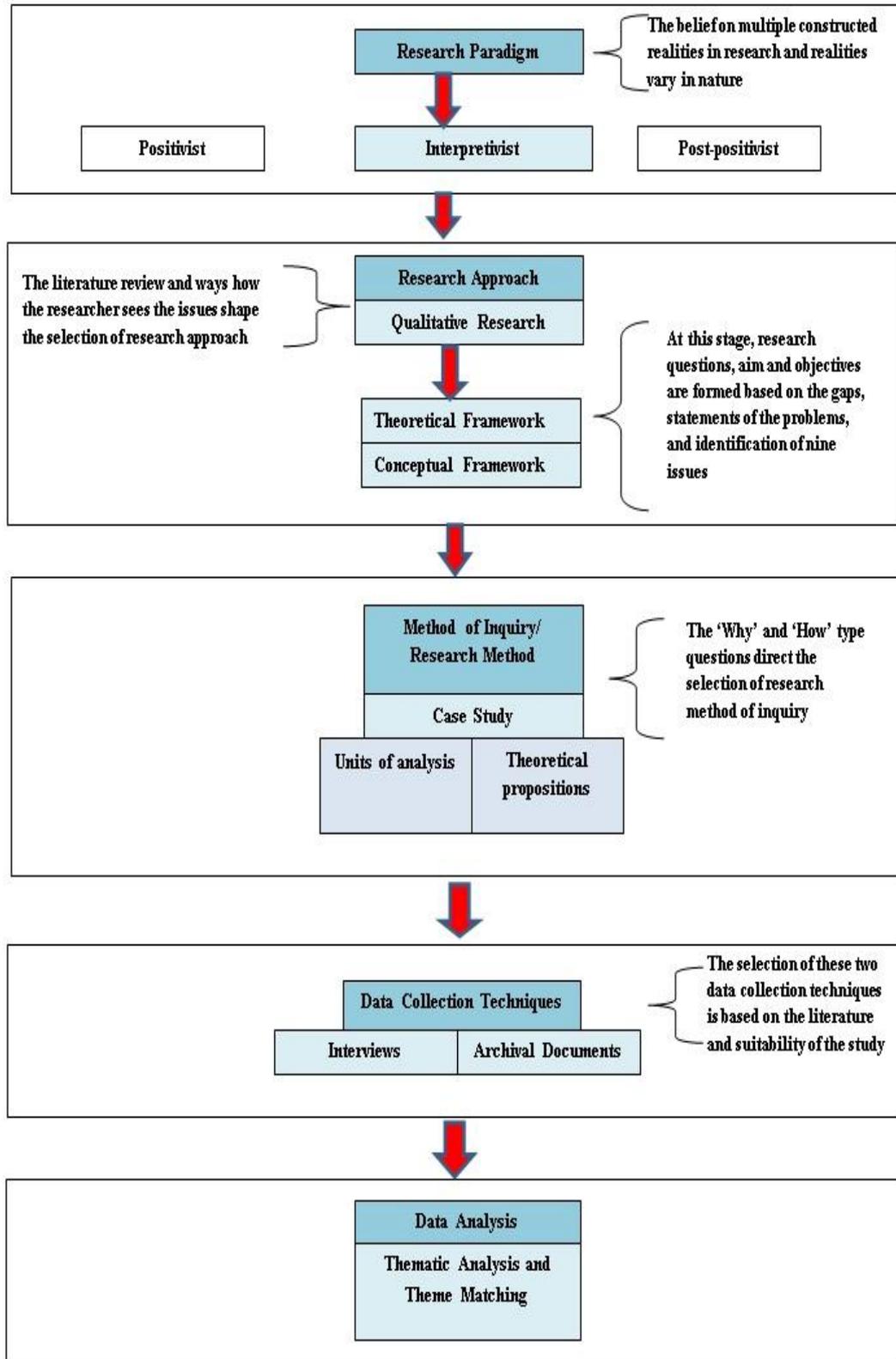


Figure 4.4: Research design

4.4.1 The case study research design

To ensure collected data was compliant with the research questions, five components were included in designing this case study (Creswell, 2009; Yin (2009, p. 27). They are listed below:

- Questions
- Propositions
- Unit(s) of analysis
- The logic linking the data to the propositions
- The criteria for interpreting the findings

4.4.1.1 Questions

According to Yin (2009, p. 131), questions such as ‘why’ and ‘how’ are suitable for an exploratory case study. The research questions are formalised under ‘why’ and ‘how’ questions.

4.4.1.2 Propositions

The proposition guides the researcher to examine the relevant scope and type of evidence for this research (Yin, 2009, p. 28). A study by MacKinnon and Wasserman (2009) is an example of a study’s propositions being used in a case study. In their study, they list six propositions that define their scope and the issues that need to be addressed.

In a recent study by MacKinnon and Wasserman (2009, p. 5) of critical factors that influence the implementation of integrated electronic medical record systems in the United States, they proposed six theoretical propositions. They then developed from these propositions the theoretical model of the research. Sarker and Lee (2003, p. 815) formulated their study’s propositions based on the following form:

<outcome> can occur only if <condition> occurs

The propositions for this research are based on the nine issues mentioned in section 1.3.1, and are derived from the failure of MoH initiatives, a review of pertinent literature and the current Malaysian context. The outcomes from those

Research Methodology

propositions assist this research to identify factors and guidelines that influence the implementation of interoperable electronic health records in Malaysian public hospitals. The propositions are listed below:

Proposition 1: The implementation of interoperable EHR in Malaysian public hospitals is hampered because of limitations in ICT infrastructure to support the complexity of health information systems.

Proposition 2: The procurement of ICT hardware and software based on departmental needs will cause segregation of health information systems and hamper the interoperability process.

Proposition 3: The competency of people involved in ICT projects in the MoHM contribute highly to the success of implementing interoperable EHR

Proposition 4: The hierarchical system in ICT procurements has permitted external influences to interfere in the decision-making.

Proposition 5: The selection of certain standards by the MoHM for all health information systems procurement does not guarantee interoperability of their digital outputs and EHR across different hospitals.

Proposition 6: Open-source technology requires supporting variables before it can be used in Malaysian public hospitals despite the notion of it being open and free.

Proposition 7: The willingness of physicians to use hospital information systems contributes to successful interoperable EHR implementation.

Proposition 8: Successful interoperable EHR implementation in Malaysian public hospitals will depend on the ability to accommodate the current barriers faced by the hospitals into a manageable ICT procurement plan.

Proposition 9: The management of interoperable HTIS and EHR implementation requires leadership by an external agency that is independent and authoritative in its decision-making.

According to Yin (2009, p. 131), the theoretical propositions will explain the whole process of the case study, including alternative explanations.

4.4.1.3 Units of analysis

The units of analysis in qualitative research include individuals, groups, documents, artefacts, interactions, dialogues, incidents or settings (Giacomini & Cook, 2000, p. 357). The formation of units of analysis also reflects the research questions and study propositions (Yin, 2009, pp. 29–30). They are the boundaries of this research, and are geared towards achieving the research aim and objectives. They are also the summaries of the statements of the problem and main subjects that represent the focus of this research, as highlighted in section 1.3.1. Five units of analysis are used in this research:

- ICT strategic planning and infrastructure
- The selection of standards to support interoperability
- The use of electronic health records
- Organisational and administrative issues in ICT adoption
- The potential of using open-source applications in Malaysian public hospitals

The validity of units of analysis is obtained when they are able to provide answers to the research aim and objectives (Yin, 2009, 32). The units of analysis in this research are geared to identify factors and actors that influence the implementation of interoperable EHR in Malaysian public hospitals. The identification of potential findings is an example of valid units of analysis (Patton, 2002, p. 229).

4.4.1.4 The logic linking the data to the propositions

The interviews produced quotations that were filtered into codes. Those codes were interpreted to form a series of themes. Those themes were matched with the

nine propositions of this research. This method enabled the linking of data to the propositions (Yin, 2009, p. 34).

4.4.1.5 The criteria for interpreting the findings

This criteria is about understanding ways of interpreting and analysing case study data, since this method does not use a statistical tool for data analysis. The interpretation is based on thematic analysis and theme matching. Figure 4.8 describes theme matching in detail.

4.5 Case study method of inquiry

4.5.1 Methods of inquiry in the qualitative research approach

The case study method of inquiry is one that can be used in qualitative research as well as ethnography, grounded theory and action research (Pickard, 2007, p. 15). This method is suitable for small-scale research where resources are limited. It allows the researcher to concentrate only on one example or type of institution (Blaxter et al., 2006, p. 72). This view is supported by Bell (1999, p. 10), who considers the case study as a suitable method to tackle an instance in a limited period of time. Despite this, there is a complexity that the researcher may face, particularly during the data analysis (Blaxter et al., 2006, p. 74). Thus, the researcher must start this method prudently by analysing the right instance and the right natural setting and sites before data analysis. Among the advantages, as proposed by Blaxter et al. (2006, p. 74), is the reliability of the data, since they are obtained from people's experiences and practices. There are health care solutions that claim to support interoperability of electronic health records, but only those who use them really know the truth.

4.5.2 Justification of the case study method for this research

The first justification is the nature of this research. According to Yin (2009, p. 2), there are three conditions that entitle the researcher to use the case study method. The first condition is by looking at the research questions. The research questions must be based on 'why' and 'how' inquiry. The second situation is when the researcher has little control over the events or subjects. No manipulation

of the samples or control group should happen if the researcher attempts to conduct this method of inquiry. The final requirement is that the subject must be a contemporary phenomenon within its real-life context. This condition differentiates the case study from the history method of inquiry (Yin, 2009, p. 8). This research aims to investigate the contemporary subject of the interoperability of electronic health records within its real-life context, which is in Malaysian public hospitals. The questions are formed based on 'why' and 'how' connotations. The researcher has no control over the subject, because it is governed by the Ministry of Health of Malaysia and managed by the respective hospitals.

The second justification is the context of this research. Yin (2009, p. 18) indicates that the scope of the study and the techniques of data collection and analysis should be appropriate if the case study method is to be used. He states that a case study is:

‘...an empirical inquiry that investigates a contemporary phenomenon in depth and within its real life context, especially when the boundaries between the phenomenon and context are not clearly evident.’

The technical entities such as data collection techniques and analysis have formed the definition of this method. He then defines the case study as:

‘...an inquiry that copes with the technically distinctive situation in which there will be many more variables of interest than data points and, as one result, relies on multiple sources of evidence, with data needing to converge in a triangulating fashion and, as another result, benefits from the prior development of theoretical propositions to guide data collection and analysis.’

With regard to this research, interoperability is a technically distinctive situation where electronic health records, which are produced by heterogeneous information systems under the same standards, are expected to interoperate. The interoperability, as mentioned by Mykkänen and Tuomainen (2008, p. 176), involves more than a single interrelationship, since other variables, sources or standards are likely to be involved:

‘A given standard only specifies some aspects of interoperability. It must usually be complemented with additional standards or project-specific conventions. The interoperability standards and standard families are, however, overlapping and incompatible, and often have effects beyond their main scope.’

The third justification for the case study approach comes from studies that have the same direction as this research. In recent years, there has been an increasing amount of literature published that discusses the model of ICT adoption in health care. Most use a qualitative approach with a case study as their method of inquiry. Table 4.5.2 provides examples of previous research that use case studies as the research method.

Table 4.5.2: Examples of similar research that use case studies

| Authors | Research method | Data collection techniques |
|------------------------|------------------------|---|
| Hendy et al., 2007 | Multiple case study | In-depth interviews |
| Khoumbati et al., 2006 | Multiple case study | In-depth interviews, observations and documentation |
| Themistocleous, 2004 | Multiple case study | Structured and semi-structure interviews |

4.5.3 The selection of single case study

This research used a single case study approach, however it did this within different settings. Two different organisations (MoHM and hospitals) were used as settings for data collection. Details about the setting are described in section 4.6.2. Using a variety of data sources assisted the researcher to understand the phenomena within the case timeframe (Ridder et al. 2009, p. 138). A single case study with different settings for data collection permitted the researcher to gather

heterogeneity of views on the research subject. This type of case study is also referred to in the literature as ‘*multiple levels of analysis within the single case*’ (Eisenhardt 1989, p. 534 or single case study with multiple embedded design (Yin 2009). This research is about adoption of ICT in Malaysian public hospitals, where a main focus is to investigate the implementation of interoperable EHR and HTIS. In order to do that, various data sources were selected, as mentioned in section 4.6.2.

The cross case analysis or multiple case studies is also applicable for this research. Three cases are applicable to delve into this subject matter, which include software companies that develop software for Malaysian public hospitals, hospitals that use the software and divisions in MoHM that manage the procurement processes. However, due to constraints such as permission factors and access to these cases, single case study with multiple embedded designs is used for this research.

4.6 Data Collection

4.6.1 The formation of case study data

In case study research, there are six data collection techniques that can be used: documents, archival records, interviews, observations (direct and participant observations) and physical artefacts. A summary of these techniques is given in Table 4.6.1

Table 4.6.1: Type of data collection techniques used for the case study method of inquiry (Yin, 1994, pp. 80–90)

| Data collection techniques | Strengths | Examples |
|-----------------------------------|---|---|
| Documentation | Stable – can be reviewed perpetually Unobtrusive – not created as a result of a case study Exact – contains exact | <ul style="list-style-type: none">• Letters, memoranda and other communiqués• Agendas, announcements and |

Research Methodology

| Data collection techniques | Strengths | Examples |
|----------------------------|---|---|
| | <p>names, references and details of an event</p> <p>Broad coverage – long span of time, many events and many settings</p> | <p>minutes of meetings, and other written reports of events</p> <ul style="list-style-type: none"> • Administrative documents – proposals, progress and other internal documents • Formal studies or evaluations of the same ‘site’ under study • Newspaper clippings and other articles appearing in the mass media |
| Archival records | <p><i>Same as above for documentation</i></p> <p>Precise and quantitative</p> | <ul style="list-style-type: none"> • Service records • Organisational records • Maps and charts • Lists of names • Survey data • Personal records |
| Interviews | <p>Targeted – focuses directly on case study topic</p> <p>Insightful – provides perceived causal inferences</p> | <ul style="list-style-type: none"> • Open-ended nature • Focused interview • Structured questions – like a formal survey |
| Observations | <p>Direct Observation</p> <p>Reality – covers events in real time</p> <p>Contextual – covers context of event</p> | <p>Direct Observation</p> <ul style="list-style-type: none"> • Observation as a formal data collection activity, a part of case study protocol |

Research Methodology

| Data collection techniques | Strengths | Examples |
|----------------------------|---|--|
| | <p>Participant Observation</p> <p>Same as above for direct observation</p> <p>Insightful into interpersonal behaviour and motives</p> | <ul style="list-style-type: none"> • Observations of meetings, sidewalk activities, factory work, classroom etc. • Observation as an informal data collection activity, for example during a field visit for interview. <p>Participant Observations</p> <ul style="list-style-type: none"> • Same as above for direct observation • Being an active observer by participating in the subject |
| Physical artefacts | <p>Insightful into cultural features</p> <p>Insightful into technical operations</p> | <ul style="list-style-type: none"> • A technological device, a tool or instrument, a work of art and physical evidence |

This research requires an in-depth understanding of what is actually happening in reality from targeted individuals who can provide insights based on their experiences and practice of using electronic health records. Therefore, two data collection techniques (interviews and archival documents) are used. These two techniques were also selected due to time and bureaucracy factors. Physicians are too busy, particularly in a country where the ratio of physicians to patients is around 1:1,105 (Ministry of Health, 2009). The selection of two sources of data collection under the case study is justifiable as long as they are able to converge

on the same set of findings (Yin, 1994, pp. 78). They are also suitable for an inquiry to answer questions of ‘why’ and ‘how’, particularly in a complex environment such as hospitals (Niazkhani et al., 2009, p. 179).

4.6.2 Settings and participants

Data was collected from 1st October 2009 until 30th November 2009, almost two months. The actual data collection took two forms. The first form involved interviews with members of relevant divisions of the MoHM, the second form involved case studies of three hospitals using interview techniques. Prior to that, a pilot study was done in one company that handles health information for public and private organisations.

The pilot study aimed to ensure the relevancy of the data and questions to be asked. Seven senior officials from the company who are involved directly with the management of patient data were interviewed. According to them, the questions that the researcher intended to ask the interviewees from the MoHM and hospitals were relevant because, to their knowledge, Malaysian public hospitals are still not achieving full interoperability in terms of electronic health records. There were some suggestion for changes, these are listed below:

- The questions should give more focus to the reasons why there is no holistic plan to implement interoperable electronic health records.
- The questions should give more focus to the opinions of officials on what barriers are faced by the Malaysian government to achieve integrated health information systems.
- The questions should give more emphasis on the attitude of physicians about the feasibility of EHR and HTIS in their work.
- The questions should give more foci on managerial and administrative aspects of EHR and HTIS.
- The questions should give more foci on the reasons for the current ability of infrastructures to support EHR and HTIS.

Once the pilot study had been conducted, the final interviewees were selected. To get a macro view about the reality of electronic health record adoption in

Research Methodology

Malaysia, four high-ranking officials at the MoHM were selected. They are involved directly in the procurement of ICT for health care agencies as members of ICT strategic planning meetings. Plus, they are attached to two divisions that manage ICT for health care agencies. Every session took around 45 minutes to one hour. Their views were recorded using a digital voice recorder. For the report, names and ranks are not disclosed due to confidentiality issues.

To get the micro view about the reality of EHR implementation in Malaysian public hospitals, three hospitals were selected. Two of these hospitals have already adopted hospital information systems and one is still using a paper-based record system. The paper-based hospital was selected because the researcher wanted to understand the following issues:

- Why is it still using a paper-based record system and not an electronic health record system?
- How effective is the paper-based record system in comparison with an electronic health record system?
- How true is the notion of open-source applications that offer less financial commitment with regard to this hospital?
- Is there any planning for this hospital to procure an electronic health record system that can be shared across the hospital's departments?

Due to confidentiality, at the request of the directors of the three hospitals, their locations and hospital names will not be disclosed in this thesis. The two computerised hospitals will be known as hospital HIS A and hospital HIS B, and the paper-based hospital will be known as HSP C. From these three hospitals, ten interviews were arranged and successfully conducted. The interviews were conducted with two heads of information technology departments, two heads of medical record departments and six medical doctors. The variety of the interviewees' specialisations will provide a range of different perspectives in analysing the qualitative data. Table 4.6.2A describes the details of this setting.

Research Methodology

Table 4.6.2A: Details of the participants and data collection settings

| Type of Site | Nature of involvement with EHR and HTIS | Respondent Position in EHR and HTIS projects | Type of Interviews |
|--|---|---|--|
| Division A of MoHM | Project managers for MoHM | High-ranking officer for management (F54) | Semi-structured interview |
| | Evaluation team Inspection team | High-ranking officer for technical issues (F54) | Semi-structured interview |
| Division B of MoHM | Project managers for MoHM | High-ranking officer for management (U54) | Semi-structured interview |
| | Evaluation team Inspection team | High-ranking officer for technical issues (F54) | Semi-structured interview |
| Hospital A that uses HIS | Users of EHR and HTIS | Head of IT (F44) | Semi-structured interview |
| | Project manager for the hospital Evaluator of EHR and HTIS | Four Physicians (U41) | Semi-structured interview |
| Hospital B that uses HIS | Users of EHR and HTIS | Head of IT (F48) | Semi-structured interview |
| | Project manager for the hospital Evaluator of EHR and HTIS | Head of Record Department (N41) | Semi-structured interview |
| Hospital that uses paper-based records | Non-users of EHR Comparative evaluation | Head of Record Department Two Physicians | Semi-structured interview Semi-structured interview |

Research Methodology

From October 2009 until July 2013, there were five meetings with research participants. Table 4.6.2B outlines all the interview details for all participants who participated in this stage of the research

Table 4.6.2B: Meetings with the research participants

| Date of Meetings | Participants | Outputs |
|---|---|--|
| 1 st October – 30 th November 2009 | Details in Table 4.6.2 | Research data The participants were informed via letters and phone after getting approval from the MoHM |
| February 2012 (Phone conversations with all interviewees) | All participants as mentioned in Table 4.6.2 | Arrangement of the future meetings Verifications of data analysis and preliminary findings |
| June 2012 (Meetings) | All participants as mentioned in Table 4.6.2 | Verifications of findings and presentations of research outputs for chapter six (discussion) |
| 27 th September - 5 th October 2012 | All participants as mentioned in Table 4.6.2 | Validation of actors |
| July 2013 | All participants as mentioned in Table 4.6.2A (with additional of two high ranking officials who are interested with the research findings) | Presentations of research findings and recommendations for MoHM on how to implement interoperable EHT and HTIS Verbal agreement by two high ranking officials on their willingness to assist the researcher for his future research in this area. |

4.6.3 Interviews

According to Pickard (2007, p. 172), an interview is used to clarify the questions that require qualitative, descriptive and in-depth data. She also adds that interviews can be used to obtain data that indicate the future development of certain issues. This research is about delving into the factors that are essential to the implementation of interoperable electronic health records in Malaysian hospital information systems. These factors will be studied based on three

statements of the problems: the interoperability model, electronic health records and the adoption of open-source technology in the development of hospital information systems. In other words, first-hand information needs to be obtained from the respective officers who are involved directly in handling the patient records. Hendy et al. (2005 and 2007), for example, also used the same data-collection technique to obtain first-hand information from NHS officers who used the systems of NPfIT.

According to Kvale (1996, pp. 81–87) and Pickard (2007, pp. 172–179), there are five stages involved in the interview sessions: thematising, designing, analysing, verifying and reporting. The theme of the interview questions will be based on the theme of this research, which is the interoperability of Malaysian hospital information systems in public health care.

Designing the interview requires the researcher to understand the purpose of the interview and to decide the type of interview to be used. Checklists based on the literature were created to direct the flow of the interview. Hence, the researcher designed the interview questions based on the following themes:

- Problems in the adoption of ICT in Malaysian health care organisations. This theme explored the significant problems in defining the adoption of health information technology in Malaysian health care. It covered all the issues highlighted in the statement of the problems, which are the interoperability model and standards, electronic health records and the use of open-source technology.
- Approaches to solving the problems. This theme explores the following issues:
 - The administration of EHR and HTIS by MoHM for Malaysian public hospitals
 - The non-technical factors that affect the implementation of interoperable EHR and HTIS
 - Types of solutions, relevant interoperability model and standards
 - User agreement about the benefits of EHR and HTIS
 - Open-source technology

Research Methodology

The researcher used semi-structured interviews in this research. This technique is also known as the guided interview, where checklists are prepared to help direct the interview but with more flexibility to explore, probe and question things that are relevant but outside the checklist (Pickard, 2007, p. 176).

The research sites included two divisions of the Ministry of Health of Malaysia and three hospitals under the Ministry. Approval was obtained from the Office of Deputy Director General of Health (Medical) and certain procedures have been followed during data collection. The interview templates are attached in Appendix A.

4.6.4 Documents and archives

The second data collection technique was document and archival analysis. The types of documents used in this research were circulars, letters, guidelines, policies, newsletters, directives and acts. These documents highlight the issues of ICT adoption in health care. Fifty government documents were reviewed, though only 39 of these proved relevant to this research. Nine document types were identified. They include a speech in the House of Common, Circulars and Letters, Circulars, Reports, Newsletters, Laws and Enactments, National Strategic Planning, Webpage, and Contractual Agreement. These documents are analysed for triangulation purposes. Table 4.6.4 describes the details of documents and their relevancy to this research.

Table 4.6.4: The document details (ordered by date)

| Document Types | Organisations and years | Relevancy to this research |
|--|--------------------------------|--|
| Laws and enactment: Federal Constitution of Malaysia | Malaysian Parliament 1963 | It guides the researcher on the allocation of laws with regard to role of MoHM in managing the healthcare. |
| Laws and enactment: The Malaysian Copyright Act 1987 | Malaysian Parliament 1987 | It assists the researcher to understand the issue of software ownership and copyright. |
| National Strategic Planning: Seventh Malaysian Plan 1996-2000 | Economic Planning Unit 1996 | It provides information about initial planning by the Malaysian |

Research Methodology

| Document Types | Organisations and years | Relevancy to this research |
|---|-------------------------------------|--|
| | | government to modernise health care using ICT under the 7 th plan. |
| Report: Telemedicine Flagship Application: Lifetime Health Plan (LHP) | Ministry of Health of Malaysia 1997 | It exposes the researcher on previous efforts by the Malaysian government to create interoperable HTIS among Malaysian health agencies. |
| Circular: Standards, Policies and Guidelines - Malaysian Government Interoperability Framework (MyGIF) | MAMPU 2003 | It provides comparative information on standards, policies, and guidelines on how create interoperability among different information systems in the public sectors. |
| Circular: The guidelines for electronic records and archive management | Malaysian National Archive 2003 | It guides the researcher to understand the process and policies in managing the records in the public sectors. |
| Circular: Malaysian government interoperability framework for open source software (MyGIFOSS) | MAMPU 2006a | It guides the technical components that public agencies should do to support interoperability. |
| Circular: The guideline for ICT outsourcing in public sectors | MAMPU 2006b | It provides comparative information about mechanisms to outsource ICT in the public sectors. |
| National Strategic Planning: Ninth Malaysian Plan 2006-2010 | Economic Planning Unit 2006 | It provides comparative information about the Malaysian government's plans and initiatives to modernise health care under 9 th Malaysian plan. |
| Report: Information technology instruction | MAMPU 2007 | It gives instruction in administering technical and non-technical components of ICT in public sector. |
| Newsletter: Information division's newsletter 2007 | Ministry of Health of Malaysia 2007 | It informs about the latest progress and updates about ICT in Malaysian health care in 2007 |
| Report: National ICT roadmap | Ministry of Science Technology and | It reports the roadmap and phases to improve |

Research Methodology

| Document Types | Organisations and years | Relevancy to this research |
|---|---|--|
| | Innovation 2007 | ICT infrastructures across Malaysia. |
| Newsletter: Information division's newsletter 2008 | Ministry of Health of Malaysia 2008 | It informs about the latest progress and updates about ICT in Malaysian health care in 2008 |
| MoHM ICT Blog: List of HTIS | Ministry of Health of Malaysia 2009a | It demonstrates the variety of HTIS in the public hospitals and health agencies. |
| Health facts: Web page 2010 | Ministry of Health of Malaysia 2009b | It informs about the health facts in Malaysia for 2010. |
| Circular and letter: The guidelines on procedures to apply the technical endorsement for ICT projects in government agencies. KKM/BPM/190/4/6/ Jld 2 | Ministry of Health of Malaysia 2009c | It provides guideline on procedure that need to be followed by health agencies under MoHM concerning technical endorsement for new ICT procurements. |
| Circular and letter: The guidelines for referral cases and movement of patient among public hospitals. MOH/P/PAK/165/08.GU | Ministry of Health of Malaysia 2009d | It provides guideline for managing referral cases among the public hospitals. |
| Contractual agreement: An agreement between Kersuma Nyata Sdn Bhd and Malaysian government (Ministry of Energy, Green Technology and Water) | Kersuma Nyata Sdn Bhd and Ministry of Energy, Green Technology and Water 2009 | It informs about the elements that involved in the agreement for ICT procurement between the vendor and the government. |
| Circular and letter: The guidelines on procedures to apply the technical endorsement for ICT projects in government agencies. UPTM(S) 159/267/2 Klt 26 (8) | The Office of Prime Minister of Malaysia 2009 | It guides the government agencies on how to procure ICT projects, which also includes MoHM. |
| Newsletter: OSCC Quarterly Newsletter | MAMPU 2009 | It informs about the latest news, information, and achievements of OSS for 2009. |
| Speech: Prime Minister Speech in Malaysian House of Common of tenth Malaysian plan 2011-2015 | The Office of Prime Minister of Malaysia (2010) | It provides information about visions of Malaysian government to improve ICT in health care under tenth |

Research Methodology

| Document Types | Organisations and years | Relevancy to this research |
|--|--------------------------------------|---|
| | | Malaysian plan. |
| Circular: Open source software (OSS) implementation guidelines | MAMPU 2010a | It guides how to implement OSS for government agencies. |
| Circular and letter: The guideline of ICT projects in Malaysian public sector. MAMPU.BDPICT.700-2/25. | MAMPU 2010c | It informs about elements that need to be included in managing the ICT projects in the public sector. |
| Report: The steering committee for ICT procurements in public sector | MAMPU 2010b | It informs about the roles and achievements of steering committee in ICT procurements. |
| Report: Open-source software implementation in Malaysian public sector | MAMPU 2010d | It shows the latest achievements of OSS implementation in Malaysian public sectors. |
| Report: Estimated Budget 2011 | Ministry of Finance of Malaysia 2010 | It provides information about amount of financial allocation for MoHM in ICT development and procurements. |
| National Strategic Planning: Tenth Malaysian Plan 2011-2015 | Economic Planning Unit 2010 | It provides information about the Malaysian government's plans and initiatives to empower ICT in the health care under 10 th Malaysian plan. |
| Newsletter: Information division's newsletter 2010 (first six months) | Ministry of Health of Malaysia 2010b | It informs about the latest progress and updates about ICT in Malaysian health care in 2010 |
| Newsletter: Information division's newsletter 2010 (last six months) | Ministry of Health of Malaysia 2010c | It informs about the latest progress and updates about ICT in Malaysian health care in 2010. |
| Circular and letter: Guideline for administering and managing the patient records for all public hospitals and health agencies MOH/P/PAK/199.10 (GU). | Ministry of Health of Malaysia 2010a | It provides information about guideline to administer patient records in the public hospitals and health agencies. |
| Circular and letter: to prepare medical records for public hospitals and health agencies under the Ministry of | Ministry of Health of Malaysia 2010b | It assists the researcher to understand mechanisms and policies in preparing medical records for both |

Research Methodology

| Document Types | Organisations and years | Relevancy to this research |
|--|---|--|
| Health of Malaysia MOH/P/PAK/201.10 (GU). | | paper-based and electronic. |
| Report: Delivering basic infrastructures | Ministry of Rural and Regional Development 2010 | It provides information about the latest efforts by the ministry to improve the infrastructures in rural areas. |
| Report: Electricity supply industry in Malaysia: Performance and statistical information 2009 | The Energy Commission of Malaysia 2010 | It informs about the latest statistical information about electricity penetration in both urban and rural areas. |
| Circular: The Malaysian public sector ICT strategic planning 2011-2015 | MAMPU 2011 | It informs the direction of Malaysian government including ICT in health care. |
| Circular: The guidelines for direct negotiation for services and procurements | Ministry of Finance of Malaysia 2011a | It assists the researcher to understand about the mechanisms that involved in direct negotiations. |
| Circular: The procurement of ICT and Internet networks | Ministry of Finance of Malaysia 2011b | It gives information about flow of processes and financial allocation to modernise the ministries using ICT. |
| Circular: The guidelines for establishments in the public sectors | Commission of Public Services 2011 | It provides information about the establishments in Malaysian public sectors concerning the posts, grades, specialisations and job designations. |
| Report: MyHIX | Ministry of Health of Malaysia 2011 | It informs about the latest progress in MoHM's efforts to initiate health data exchange among different HTIS. |
| Webpage: Open source in Malaysia | Open Source Competency Centre MAMPU 2011 | It informs about the latest progress done by this centre to widen the use of OSS in Malaysian public sectors. |

4.6.5 Triangulation

The triangulation in this research is to validate findings from the interviews with document analysis (documentation and archives). Triangulation by using multiple sources of evidence, which include data, investigator, theory and methodological triangulation has been proposed (Ying, 2009, p. 116; Kalof et al., 2008, p. 25; Patton 2003, p. 247). The purpose of triangulation is to maintain the validity of the findings. Gray et al. (2007, p. 75) recommends that different source of evidence should be used in triangulation and to avoid using the same data source, for example questionnaires should not triangulate other questionnaires.

This research uses three types of evidence. The first evidence is from semi-structured interviews with those involved directly in managing and using EHR and HTIS. The second evidence is archival documents in the form of government circulars, directives, letters, newsletters, proposals and national planning. The final source is the academic literature. The purpose of this triangulation is threefold. The first purpose is to converge the findings. The data from the interviews provide various insights that are based on the officials' experiences. Therefore, inputs from the document analysis converge the discussion so that it represents the reality of ICT adoption in Malaysian health care. The second and third purposes are to identify inconsistencies and contradictions in the evidence. In order to do that, a series of telephone conversations were undertaken with all interviews on February 2012 and a series of meetings were held with all interviewees in June 2012. The purpose of these conversations and meetings was to identify any contradictions between interviewees and between the interview data and secondary documentary evidence. Any contradictions between individual interviewee responses and between their responses and documentation were investigated during these discussions. Triangulation with documentation helps to validate the findings and clarify whether inconsistencies or contradictions are genuine, accidental or due to misunderstandings of an interviewees comments. This process is suggested by Mathison (1988, p. 15).

4.7 Overview of data analysis

This section explains the data analysis process used in this research. There are three main processes involved in the data analysis for this research: data reduction, displaying and interpretation. Each process contains a series of sub-procedures.

The formation of the interview questions was based on the units of analysis and theoretical propositions. The five components of the units of analysis were used to make templates for semi-structured interviews, described below:

- ICT strategic planning and infrastructure
- The selection of standards to support interoperability
- The use of electronic health records
- Organisational and administrative issues in ICT adoption
- The potential of using open-source applications in Malaysian public hospitals

The foundations of these units of analysis are based on three components, namely research questions, the aim and objectives and the statement of the problems. Their function is to provide the boundary of this research. The research propositions are the blueprints that steered the researcher to conduct this research. They highlight the type of evidence to be collected during the fieldwork; for example, proposition number one: *‘The implementation of interoperable EHR in Malaysian public hospitals is hampered because of limitations in ICT infrastructure to support the complexity of health information systems’*.

To analyse the data from the interviews, two mechanisms are used. The first method uses thematic analysis. Thematic analysis, according to Braun and Clarke (2006, p. 79), refers to methods of identifying, analysing and reporting themes or patterns within data. This technique is used to provide themes for the second mechanism, theme matching. Theme matching is done by testing the identified themes with nine theoretical propositions, as listed in section 4.3.1.2. Each quotation represents the conceptualised themes before generation of the final findings.

Research Methodology

Braun and Clarke (2006, p. 87) suggest six phases for thematic analysis. Table 4.7 describes these phases. However, in this research, the researcher has improvised the sequences by combining the relevant phases and restructuring the sequences. In presenting their ideas about this technique, Braun and Clarke (2006) use descriptions and examples. After reviewing the whole ideas behind this technique, the researcher has modified the technique to meet with the types of data in this research.

Table 4.7: Phases of thematic analysis (modified from Braun and Clarke, 2006, p. 87)

| Phases | | Descriptions and remarks |
|--------|---------------------------|--|
| 1. | To be familiar with data | Requires transcribing, re-reading the data and noting down or reducing the data into ideas |
| 2. | To generate initial codes | Requires coding features of the data in a systematic way across the entire data set, and collating the relevant data to each code |
| 3. | To search for themes | Requires assembling the codes into potential themes and gathering all relevant data to each theme |
| 4. | To review themes | Requires checking the themes to suit each coded quotation and generating the thematic map of analysis |
| 5. | To define and name themes | Requires refining the specific subject of each theme and generating clear definitions and names for each theme |
| 6. | To produce the report | Requires reporting the final analysis of the quotations and extracts by comparing with research questions, objectives and literature |

The third and fourth phases were combined together in this research, because the processes involved in them are quite similar. For the sixth phase, the findings were incorporated with propositions through matching the themes with propositions.

4.7.1 The familiarity of data

This phase requires a few processes such as transcribing and reading the data exhaustively to search for concealed meanings and semantic themes. It also aims to reduce the data into specific ideas (Braun & Clarke, 2006, p. 87). Compared to the suggestion by other qualitative researchers such as Miles and Huberman (1994, p. 10) and Thomas (2006, p. 78), this phase is more specific. This is because, according to Thomas (2006, p. 78) and Miles and Huberman (1994, p. 10), data reduction itself should include processes like writing summaries, coding, developing the themes, creating clusters of data, partitioning and memo writing. The section under this phase discusses data reduction and how it is applied to this research data set.

4.7.1.1 Data reduction

Ulin et al. (2005, p. 160) view data reduction as a process that aims to distil the information so that essential concepts and relationships between the concepts are visible. They propose that it be done after the data has been transcribed, coded and themed. However, in this research, data reduction only includes data transcription and translation, because the coding process was done after these two processes are finished.

4.7.1.2 Transcribing and translating the data (interviews)

Fourteen interviews were conducted with four high-ranking officials of the MoHM and ten physicians from three hospitals. The output from the interviews was transcribed from audio records into a written format. Since the interviews were conducted in the Malay language, they were translated into English before being coded using 'Atlas.ti' (software for qualitative research).

4.7.2 Data coding

The coding of the data was done with the assistance of the software Atlas.ti. Ulin, Robinson and Tolley (2005, p. 147) suggest flexibility in coding the data. The use of words or part of words to describe the ideas is also called thematic coding. Since there is a high possibility that the coding will be misled, the coding process

Research Methodology

should reflect the research questions (Miles & Huberman 1994, p. 55). They define codes as:

‘...tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study. Codes usually are attached to “chunks” of varying size-words, phrases, sentences, or whole paragraphs, connected or unconnected to a specific setting.’

Based on the data from two divisions and three hospitals, 36 codes were extracted from the transcripts. Miles and Huberman (1994, p. 55) suggest that it is important to have a clear relationship between the codes and research questions. To ensure that the codes are relevant to the research questions, a mapping process was conducted by matching the codes to the relevant research questions.

Table 4.7.2 describes how these things are related. The codes are written in short form using capital letters. The final column contains the research questions that are relevant to the codes. In order to ensure the consistency of the codes used in the research, Miles and Huberman (1994, p. 63) suggest the use of operational definitions for each code. These definitions also provide guidelines for the researcher in coding the interview output, so that the codes will not be misleading or redundant.

Table 4.7.2: Illustration of codes (modified from Miles & Huberman, 1994, pp. 59-60)

| Description of codes | Codes | Research questions |
|--|---------------------|---|
| The basic electricity infrastructure to support ICT adoption | BASC-INFERS-ELE-ICT | How capable are elements of information systems in Malaysian hospitals of supporting interoperability of electronic health records? |

Research Methodology

| Description of codes | Codes | Research questions |
|---|-----------------|---|
| A failure to execute plans related to ICT adoption in Malaysian public health care including EHR plans | FAIL-EXE-PLN | How influential are managerial and administrative entities on affecting implementation of interoperable electronic health records and HTIS? |
| The financial barriers that hamper the adoption of ICT in Malaysian public health care including EHR projects | FINAN-BAR | |
| The functionality of HIS to integrate all inputs from various departments and produce EHR | HIS-USE_EHR | How capable are elements of information systems in Malaysian hospitals of supporting interoperability of electronic health records? |
| The health information system which is owned by MoHM | HTIS-OWN-MOH | Why can hospital information systems that use the same standards not support interoperability of electronic health records in Malaysia? |
| The ICT strategic planning | ICT-ST-PLN | How influential are managerial and administrative entities in affecting implementation of interoperable electronic health records and HTIS? |
| Inter hospital data exchange | INTER-HOS-EXC | Why can hospital information systems that use the same standards not support interoperability of electronic health records in Malaysia? |
| Intra-hospital department data exchange | INTR-DPT-DT-EXC | |
| No inter-hospital relationship exists | NO-INTER-HOS | |

Research Methodology

| Description of codes | Codes | Research questions |
|---|-------------------|---|
| Non-technical barrier for EHR implementation | NONTECH-BAR-EHR | How influential are managerial and administrative entities in affecting implementation of interoperable electronic health records and HTIS? |
| The period of phases for EHR implementation | PERIOD-EHR | |
| The external influences in ICT projects | EXT-INFL-ICT-PROJ | |
| The pilot project for EHR | PLT-PRJ-EHR | Why can hospital information systems that use the same standards not support interoperability of electronic health records in Malaysia? |
| There is a need to have research in EHR projects | RESEARCH-EHR | How capable are elements of information systems in Malaysian hospitals of supporting interoperability of electronic health records? |
| The segregation of health information systems that are currently being used in Malaysia | SEGR-THIS | Why can hospital information systems that use the same standards not support interoperability of electronic health records in Malaysia? |
| An awareness of the issues related to interoperability | AWR-ISS-INTPR | |
| The standards that enable interoperability | STD-INTPR | |
| The basic modules of HIS for hospital operation | BASC-MOD-HOS | How capable are elements of information systems in Malaysian hospitals of supporting interoperability of electronic health records? |
| The complexity of health information systems | COMPL-HTIS | |

Research Methodology

| Description of codes | Codes | Research questions |
|--|------------------------|---|
| The cooperation from users with regards to the use of HTIS and EHR | COOP-USER | How influential are managerial and administrative entities in affecting implementation of interoperable electronic health records and HTIS? |
| The motivation for EHR | MOTV-EHR | |
| The inspection done by the inspectorate unit of MoHM | INSPECTION | |
| The efforts to upgrade both system and health application software | SFTWRE_UPGD | How capable are elements of information systems in Malaysian hospitals of supporting interoperability of electronic health records? |
| The technical barriers that hamper the progress of EHR | TECH-BAR-EHR | |
| The attitude of MoHM administrators that have low confidence on their ability to manage EHR without following steps by developed countries | ATTD-CONF- ADMN-EHR | How influential are managerial and administrative entities in affecting implementation of interoperable electronic health records and HTIS? |
| The centralised decision in ICT procurements at the MoHM | CENT-DEC | |
| The chain of command of the MoHM in the procurement process and decision making in relation to ICT | CHN-COMMD | |
| The task to coordinate tasks for any EHR projects under MoHM | CORD-TSK-EHR | |
| | | |

Research Methodology

| Description of codes | Codes | Research questions |
|---|---------------------|--|
| The dependence on vendors in ICT procurement for the MoHM | DEPN-VEND | |
| The direct negotiation in procurement of ICT in Malaysian health care | DIRECT-NEGO-ICT | |
| The efforts to be independent from totally relying on vendors in ICT procurement | EFF-INDPN-VEND | |
| The external influences by lobbyists in the decision by the MoHM to procure new ICT hardware and software | EXT-INFL-ICT | |
| The establishment of posts of ICT officers | ICT-ESTBMNT | |
| The establishment of an independent agency to cater for EHR implementation | INDPN-AG-EHR | |
| The layers of flow of proposals from health agencies to get approval from the central committee at MoHM | LAY-PR-FL | |
| The piecemeal application for urgent need by health agencies for a new health information system | PCEML-APP-URG | |
| The open-source software is irrelevant for Malaysian health care | OSS-IRRLVNT-MYS-EHR | Why is open-source technology not widely used in Malaysian public hospitals despite its notion |

| Description of codes | Codes | Research questions |
|----------------------|-------|-------------------------|
| | | of being open and free? |

After all the codes were formed based on the semi-structured interviews, each code was analysed. Using the Atlas.ti software, the codes can be viewed easily together with their remarks and comments. To get an accurate assessment, each quotation for each code was examined. Figure 4.7.3 demonstrates how the code was analysed using Atlas.ti through its view menu for the code's quotations and comments.

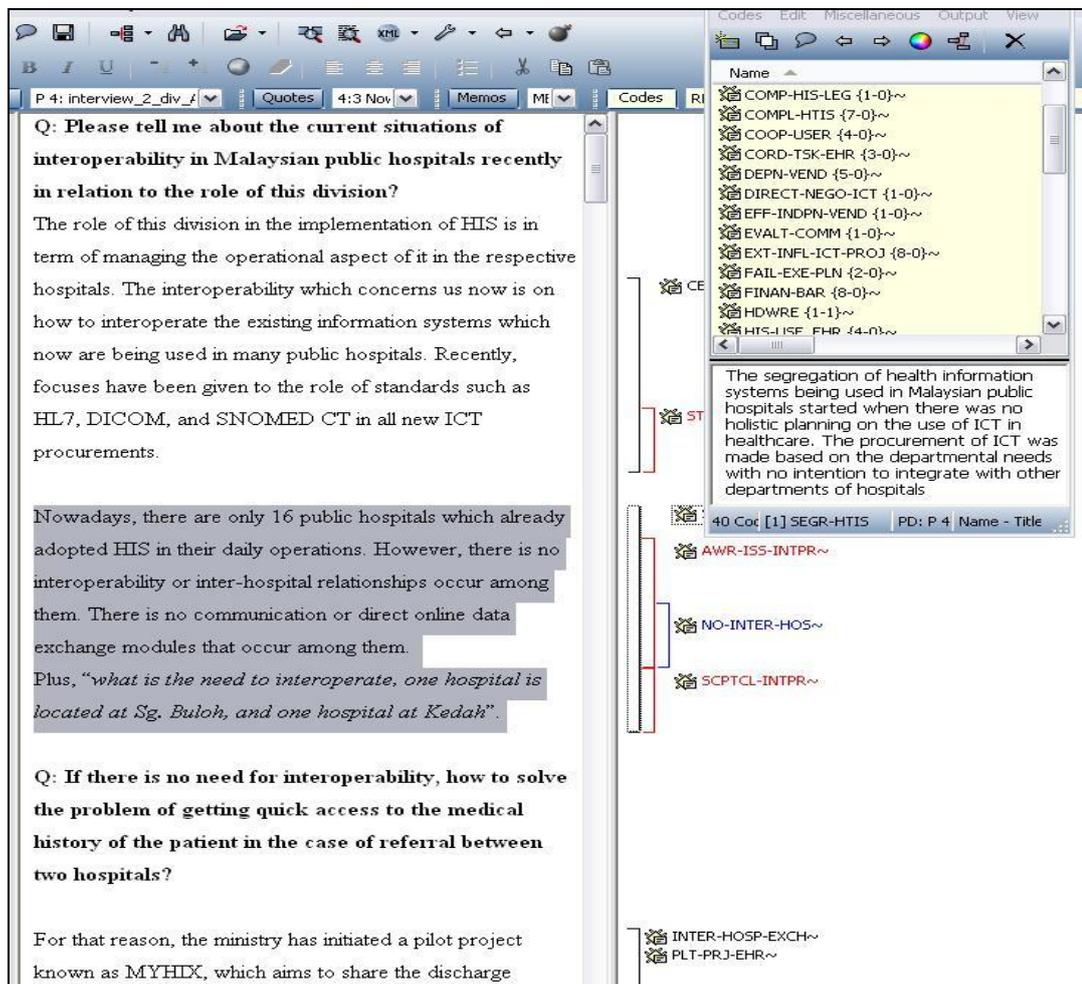


Figure 4.7.3: Coding process using Atlas.ti

4.7.3 Searching and reviewing the themes

Searching for themes started after the codes had been identified across the data set. It involved sorting different codes into potential themes and gathering

quotations within those themes. Tables and other graphic representations can be used to display the collating process. The researcher improvised the phases of thematic analysis by Braun and Clarke (2006) through modification of the sequence. The actual sequence is presented in Table 4.7. Two processes were used for searching and reviewing the themes: creating and naming the themes, and thematic mapping.

4.7.3.1 Creating and naming the themes

Each code contains a different type of quotations and remarks. Using Atlas.ti, the retrieval process of quotations for each code is an easy process. The quotations were analysed and classified into various categories or families. The categorisation of codes enabled the researcher to extract the themes that represent the main ideas behind each code. These themes were developed through a process of filtering and synchronising all 36 codes derived from the interviews. Table 4.7.3.1 describes the categorising process.

Table 4.7.3.1: Categories of themes and their codes

| No. | Themes | Codes |
|-----|----------------------------------|--|
| 1. | ICT INFRASTRUCTURAL ISSUES | 1) BASC-MOD-HOS 2) BASC-INFRS-ELE-ICT 3) DIRECT-NEGO-ICT 4) ICT-ST-PLN 5) HIS-USE-EHR 6) HTIS-OWN-MOH 7) NO-INTER-HOS 8) RESEARCH-EHR |
| 2. | METHOD OF PROCUREMENT | 1) DEPN-VEND 2) DIRECT-NEGO-ICT 3) EFF-INDPN-VEND 4) ICT-ST-PLN 5) ISSUE-INTEL-PROP 6) PCEML-APP-URG |
| 3. | FLOW IN ICT | 1) CENT-DEC |

Research Methodology

| No. | Themes | Codes |
|-----|---------------------------------|--|
| | PROCUREMENT | 2) CHN-COMMD 3) CORD-TSK-EHR 4) DIRECT-NEGO-ICT 5) EXT-INFL-ICT-PROJ 6) FINAN-BAR 7) ICT-ST-PLN 8) INSPECTION 9) LAY-PR-FL 10) PCEML-APP-URG 11) PERIOD-EHR |
| 4. | EFFICIENCY OF ADMINISTRATORS | 1) ATTD-CONF-ADMN-EHR 2) FAIL-EXE-PLN 3) FINAN-BAR 4) ICT-ESTBMNT 5) IC-ST-PLN 6) KNOWL-GAP-EHR 7) RESEARCH-EHR |
| 5. | LOBBYIST | 1) CENT-DEC 2) CHN-COMMD 3) DEPN-VEND 4) DIRECT-NEGO-ICT 5) EXT-INFL-ICT-PROJ 6) LEGL-ISS-EHR |
| 6. | MOTIVATION FOR INTEROPERABILITY | 1) AWR-ISS-INTPR 2) HIS-USE-EHR 3) INTER-HOSP-EXCH 4) INTPR-DPT-DT-EXCH 5) LEGL-ISS-EHR 6) MOTV-EHR 7) NO-INTER-HOS 8) PLT-PRJ-EHR 9) STD-INTPR |

Research Methodology

| No. | Themes | Codes |
|-----|---|---|
| 7. | THE REALITY OF HTIS IN MALAYSIAN PUBLIC HOSPITALS | 1) BASC-MOD-HOS 2) COMPL-HTIS 3) INTPR-DPT-DT-EXCH 4) ISSUE-INTEL-PROP 5) NO-DIR-OSS 6) NO-INTER-HOS 7) OSS-IRRLVNT-MYS-EHR |
| 8. | USER ACCEPTANCE AND ATTITUDE | 1) ATTD-CONF-ADMN-EHR 2) CHNG-MGT-EHR 3) COOP-USER 4) COMPL-HTIS 5) CONTNT-EHR 6) FINAN-BAR 7) LAY-PR-FL 8) MOTV-EHR 9) KNOWL-GAP-EHR 10) PCEML-APP-URG |
| 9. | BARRIERS TO EHR IMPLEMENTATION | 1) ATTD-CONF-ADMN-EHR 2) BASC-INFRS-ELE-ICT] 3) CHNG-MGT-EHR 4) EXT-INFL-ICT-PROJ 5) FINAN-BAR 6) LEGL-ISS-EHR 7) NONTECH-BAR-EHR 8) SEGR-HTIS 10) TECH-BAR-EHR |
| 10. | THE AUTHORITY TO MANAGE EHR | 1) CENT-DEC 2) CHN-COMMD 3) EXT-INFL-ICT-PROJ 4) FAIL-EXE-PLN 5) FINAN-BAR 6) INDPN-AG-EHR |

| No. | Themes | Codes |
|-----|--------|----------------------------------|
| | | 7) INSPECTION 8) LEGL-ISS-EHR |

4.7.3.2 Thematic mapping

Thematic mapping is the final product from theme searching before it is reviewed to see the relevancy to this research. This process refers to creating relationships between codes and themes. The relationships also include interactions between codes and themes (Braun & Clarke, 2006, pp. 89–90). The thematic mapping is displayed in the next chapter in which the extracts from the themes are matched with the research propositions under theme matching.

4.8 Theme matching

Theme matching in this research was derived from pattern matching. According to Yin (2009, p. 136), pattern matching compares an empirically based pattern with a predicted one or with several alternative predictions. If the patterns match, the result can help a case study to confirm its internal validity. This technique deals with dependent and independent variables or causes and effects for explanatory case study research. Yin (2009, pp. 137–141) suggests three patterns that can be used to analyse data using pattern matching: non-equivalent dependent variables, rival explanations as patterns and simpler patterns.

Trochim (1989a, p. 356) defines a pattern as ‘any arrangement of objects or entities’. This definition implies that a pattern is not random and illustrative. In this research, the researcher used the word ‘theme’ as opposed to pattern. This is because the themes contain codes that were arranged to become more illustrative and describable. Ryan and Bernard (2003, p. 85) support this view, and suggest that one phase in text analysis is to link the themes into the theoretical model.

Therefore in this research the themes were then matched with the theoretical propositions of this study (see Chapter 5). Figure 4.8 describes the process involved in the pattern-matching process as suggested by Trochim (1989a, p. 356) and its transformation into the new model used in this research.

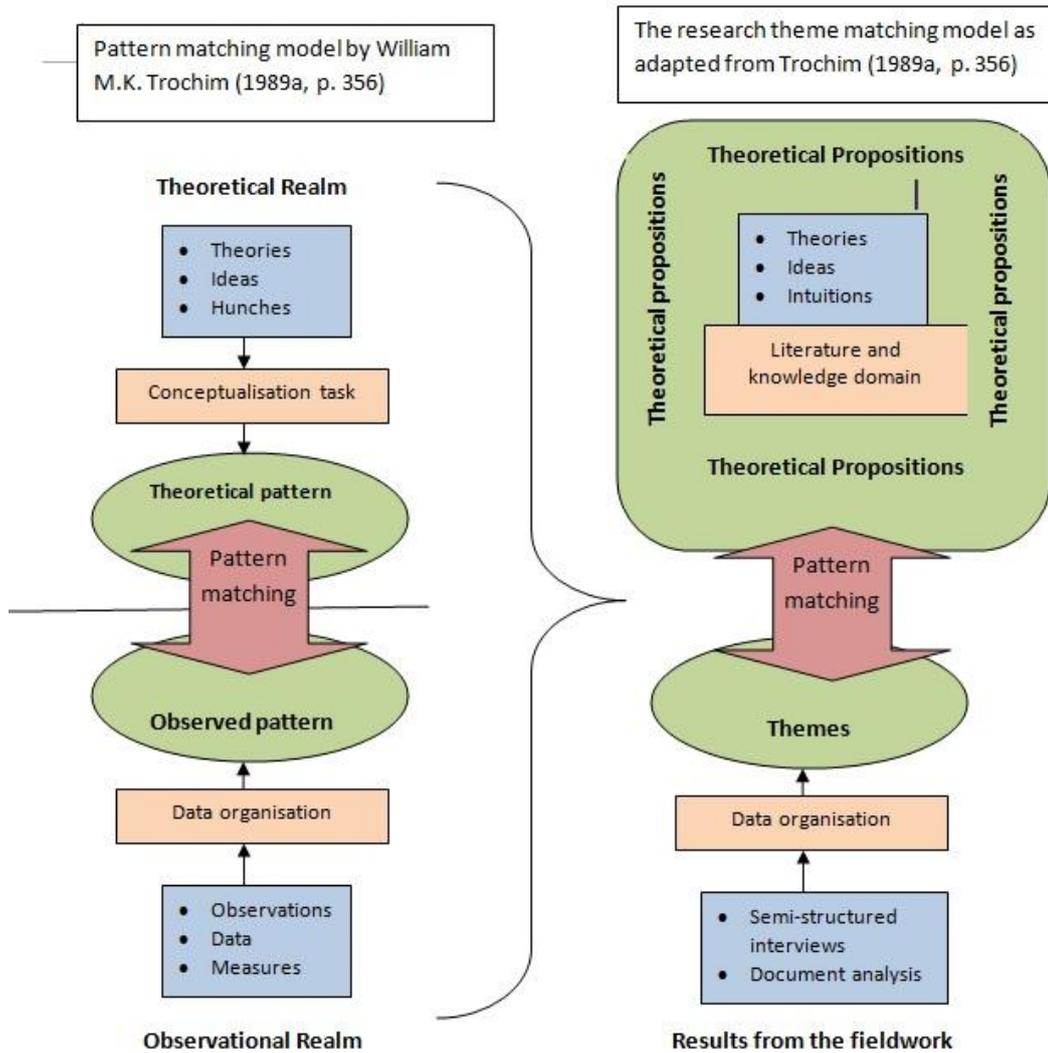


Figure 4.8: Pattern/theme-matching models (modified from Trochim, 1989a, p. 356)

The model by Trochim (1989a, p. 356) comprises two parts. The top part contains all the entities that form the theoretical realm or patterns that are suggested by theories or the researcher’s ideas and intuition. The process of conceptualisation involves the translation of the ideas/theories/intuition into a specific theoretical pattern, which is indicated by the green oval on the left of the figure. The lower part consists of three parts. They represent the observational realm or impressions from the field notes, observations and fieldwork. These data are organised and form the observed pattern, which is indicated by the lower green oval. The patterns from these two parts are inferred with a matching process, indicated by the red two-way arrow.

Research Methodology

A few modifications were made to ensure that this model suited the research design, which contained theoretical propositions and their outcomes. The top part contains the theoretical propositions developed based on the relevant theories or researcher's ideas. Apart from that, the literature and knowledge domain of the researcher also contributed to the development of the outcomes. The lower part comprises the results obtained from the fieldwork. Two outputs were used, from semi-structured interviews and document analysis. The outputs were then organised by using the coding process, and themes were suggested. The themes were then matched with the outcomes, as indicated by the red two-way arrow.

With regard to the sources of the outcomes for the proposition, Trochim (1989a, p. 356) categorises three sources, which he describes as '*the realm of theory*'. These categories are:

- Propositions from the existing theory
- Ideas or intuition of the researcher
- A combination of propositions from the existing theories and ideas of the researcher

For example, one proposition of this research states that: 'The limitation in ICT infrastructure to support the complexity of health information systems hampers the proliferation of EHR implementation'. The data from semi-structured interviews and document analysis was used to assess whether there is a match between these two (proposition and themes). In order to do that, a series of issues are developed for each proposition, for example:

- infrastructures that affect EHR implementation
- causes of inadequacies in those infrastructures

Therefore, if results from the data or *observational realm*, as described by Trochim (1989a, p. 356), match these two questions, a solid conclusion can be made about the importance of correlation between ICT infrastructure and development of interoperable EHR implementation as a national project.

CHAPTER FIVE

DATA ANALYSIS AND DISCUSSION

5.1 Introduction

This research implied nine theoretical propositions, and they were matched with the themes arising from the fieldwork. The propositions consist of a series of sub-questions that shape the discussion and conceptualisation of the findings. Those sub-questions are extracted from the interview questions and units of analysis.

These propositions will be tested with the relevant themes as derived from the interviews. The themes that arose are listed below:

1. MOTIVATION FOR INTEROPERABILITY
2. FLOW IN ICT PROCUREMENT
3. THE REALITY OF HTIS IN MALAYSIAN PUBLIC HOSPITALS
4. USER ACCEPTANCE AND ATTITUDE
5. METHOD OF PROCUREMENT
6. LOBBYIST
7. EFFICIENCY OF ADMINISTRATORS
8. ICT INFRASTRUCTURAL ISSUES
9. THE AUTHORITY TO MANAGE EHR
10. BARRIERS TO EHR IMPLEMENTATION

For source recognition in each quotation, the interviewee is recognised according to the labels. Table 5.1A illustrates the labels.

Table 5.1A: The illustrations of the interviews roles in ICT in Malaysian health care

| Labels | Interviewees |
|----------------------|---|
| Interview_1_div_A_AM | The first interviewee from division A of the MoHM, is a manager in IT (senior official) |
| Interview_2_div_A_AT | The second interviewee from division A of the |

Data Analysis

| Labels | Interviewees |
|------------------------|---|
| | MoHM, is a technical person in IT (senior official) |
| Interview_3_div_B_BM | The third interviewee from division B of the MoHM, is a manager in Telehealth and ICT (senior official) |
| Interview_4_div_B_BT | The fourth interviewee from division B of the MoHM, is a technical person in IT (senior official) |
| Interview_5_HIS_A_HDIT | The fifth interviewee from Hospital A that uses HIS, is the head of the IT department |
| Interview_6_HIS_B_HDIT | The sixth interviewee from Hospital B that uses HIS, is the head of the IT department |
| Interview_7_HIS_B_HDRM | The seventh interviewee from Hospital B that uses HIS, is the head of the Medical Records department |
| Interview_8_HSP_C_HDRM | The eighth interviewee from Hospital C that uses paper-based records, is the head of the Medical Records department |
| Interview_9_HIS_A_DOC | The ninth interviewee from Hospital A that uses HIS, is a medical doctor |
| Interview_10_HIS_A_DOC | The tenth interviewee from Hospital A that uses HIS, is a medical doctor |
| Interview_11_HIS_A_DOC | The eleventh interviewee from Hospital A that uses HIS, is a medical doctor |
| Interview_12_HIS_A_DOC | The twelfth interviewee from Hospital A that uses HIS, is a medical doctor |
| Interview_13_HSP_C_DOC | The thirteenth interviewee from Hospital C that uses paper-based records, is a medical doctor |
| Interview_14_HSP_C_DOC | The fourteenth interviewee from Hospital C that uses paper-based records, is a medical doctor |

Data Analysis

After reviewing all the quotations for each code under each theme, the researcher identified the matching combinations between the themes and propositions. Table 5.1B describes the combination between these two entities.

Table 5.1B: The propositions and respective themes

| The propositions | Themes |
|---|--|
| The implementation of interoperable EHR in Malaysian public hospitals is hampered because of the limitation in ICT infrastructure to support the complexity of health information systems. | ICT INFRASTRUCTURAL ISSUES |
| The procurement of ICT hardware and software based on departmental needs will cause segregation of health information systems and hamper the interoperability process. | METHOD OF PROCUREMENT and FLOWS IN ICT PROCUREMENT |
| The competency of people who administer ICT on interoperability in the MoHM contributes highly to the success of implementing interoperable EHR | EFFICIENCY OF ADMINISTRATORS |
| The hierarchical system of Malaysian government administration has permitted external influences to interfere in decision-making for ICT procurement. | LOBBYIST |
| The selection of certain standards by the MoHM for all health information systems procurement does not guarantee interoperability of their digital output and EHR across different hospitals. | MOTIVATION FOR INTEROPERABILITY |
| Open-source technology requires supporting | THE REALITY OF HTIS |

Data Analysis

| The propositions | Themes |
|---|--------------------------------|
| variables before it can be used in Malaysian public hospitals despite its notion of being open and free. | IN MALAYSIAN PUBLIC HOSPITALS |
| The willingness of physicians to use the hospital information systems contributes to successful interoperable EHR implementation. | USER ACCEPTANCE AND ATTITUDE |
| Successful interoperable EHR implementation in Malaysian public hospitals will depend on the ability to accommodate the current barriers faced by the hospitals into a manageable ICT procurement plan. | BARRIERS TO EHR IMPLEMENTATION |
| The management of interoperable HTIS and EHR implementation requires leadership by an external agency that is independent and authoritative in its decision-making. | THE AUTHORITY TO MANAGE EHR |

Sections 5.2 to 5.10 discuss each proposition in turn, with a summary of the main findings following in Section 5.11

5.2 First proposition

This proposition suggests, ‘The implementation of interoperable EHR in Malaysian public hospitals is hampered because of limitations in ICT infrastructure to support the complexity of health information systems’.

This proposition seeks answers to the following questions:

1. What are the infrastructures that might affect EHR implementation?
2. What are the causes of inadequacies in those infrastructures?

3. Are they really affecting EHR implementation?
4. Is the MoHM aware of these inadequacies?
5. Are current ICT infrastructures sufficient to support legacy systems?
6. How complex are health information systems in Malaysian health agencies?

In seeking the answers, the following sections related to the theme ICT INFRASTRUCTURAL ISSUES conceptualise the discussion.

5.2.1 The infrastructures that affect EHR

This section aims to identify the infrastructural inadequacies that affect EHR implementation, and uncover causes for the inadequacies. It is an important issue because it determines the feasibility of interoperable EHR and HTIS implementation in Malaysia. After reviewing the quotations in the theme, the researcher identified four issues that are relevant to this topic. Table 5.2.1 illustrates these four issues and the number of occurrences in all interviews. The frequency of occurrence assists the researcher to identify the level of understanding of the MoHM's officials on the issue of infrastructure.

Table 5.2.1: The four categories

| Categories | Number of occurrences in all interviews |
|---|---|
| Electricity infrastructure | Seven times |
| ICT infrastructure | Nine times |
| The infrastructure to support a Patient Management System | Four times |
| The legacy systems and ICT infrastructure | Three times |

5.2.1.1 Electricity infrastructure

The electricity infrastructure refers to the ability to provide a power supply to run the HTIS 24 hours a day. It is apparent from the document analysis that some rural areas in Malaysia still do not have a sufficient electricity supply (MOSTI,

2011). An insufficient electricity supply will distort ICT penetration into Malaysian health care.

One senior official in IT shared his experience of facing insufficient electricity power during the installation process of HTIS. According to him:

'There was one incident when I was installing a clinical system at one government clinic where ten times electricity [was] lost. As a solution, to make sure the system could be running 24 hours a day; an electricity generator was purchased to supply electricity power to that area, which had added a new cost. This demonstrated the limitation in our electricity infrastructure, which would not be able to support health information systems in some areas.' (Interview_4_div_B_BT)

The above statement is evidence of the inadequacy of electricity infrastructure in some rural areas. However, it does not represent the inadequacy in Malaysian public hospitals. Most public hospitals are located in urban areas with a minimal likelihood of power outages.

One medical doctor perceives that electricity inadequacy is irrelevant for this research, because all public hospitals are located in urban areas.

'One more thing, all district hospitals are located in urban areas where fiscal and basic infrastructures already exist. Therefore, I do not understand why people see electricity infrastructures as the main problem in EHR implementation. However, if you are referring to the computer hardware such as monitor and CPU, yes it is essential, because without those hardware EHR could not be implemented.' (Interview_9_HIS_A_DOC)

According to him, an inadequate electricity infrastructure does not affect the adoption of EHR because most hospitals are located in urban areas. The problem

Data Analysis

that affects EHR adoption is an insufficient ICT infrastructure such as computers and networking facilities.

In Malaysian health care, health agencies are dedicated to providing health services to certain areas. One head of the medical record department asserted this by saying:

‘There is still a big gap between rural and urban areas concerning basic electricity infrastructures. Without sufficient electricity supplies, ICT could not be functioning. Health agencies such as community clinics [are] normally located at rural areas, and district hospitals are located at urban areas. The penetration of electricity infrastructures is still low to support if Malaysian government wants to implement interoperable HIS for whole health agencies across Malaysia.’

(Interview_8_HSP_C_HDRM)

Rigorous efforts have been made by the Malaysian government to balance the electricity infrastructure in both urban and rural areas. For 2011, for example, the government has a target to supply electricity to 26,882 houses in rural areas. However, based on a document from a recent ministerial report on 31st September 2011, only 7,288 houses receive electricity (Ministry of Rural and Regional Development, 2011). This limitation, according to one head of the medical record department, affects the implementation of interoperable EHR and HTIS. She said:

‘Another barrier is infrastructures; I still believe Malaysia is still far from a platform to have integrated EHR. I had been in some places, especially in rural areas, where the basic electricity is still not 24 hours, so imagine if MoHM install EHR system at a clinic in that area, of course the effect is not optimum.’ **(Interview_8_HSP_C_HDRM)**

Another statement that links inadequacy of electricity with rural location is from a medical official:

'I must admit, in rural areas, electricity, communication and ICT infrastructures are still not sufficient and need to improve. However, the question is for the hospitals; normally they are located in district areas, where basic infrastructures I think should be enough. The main infrastructural problems I believe need more attention are communication and ICT infrastructures.' (Interview_11_HIS_A_DOC)

The outage of electricity power is common even in urban areas. Based on an extract from the annual report from the Energy Commission of Malaysia (2009, p. 30), the average power outage for all states in West Malaysia was 9,581 minutes, which was 2.1% below 2008. West Malaysian states are the most developed regions in Malaysia, where almost 80% of the cities are (Ministry of Federal Territories and Urban Wellbeing). This evidence suggests that electricity inadequacy is not only an issue with rural location but is also a problem for urban areas.

To sum up, no direct relation has been established to link electricity inadequacy with problems in EHR implementation across Malaysian public hospitals. This is because all quotations in the theme mention that inadequacy is related to insufficiency of electricity in rural areas. However, all public hospitals are located in urban areas. Nevertheless, urban areas are not excluded from this inadequacy, albeit a very rare occurrence. This is supported from the figures provided by the agency that handles energy in Malaysia.

5.2.1.2 ICT infrastructure

The issues of ICT infrastructure refers to inadequacy in ICT hardware, software and networking to support interoperable EHR and HTIS implementation. It is apparent from the theme that all interviewees who mentioned this issue agree about the inadequacy in both HTIS and non-HTIS hospitals. Reviewing all nine quotations in the theme discloses two issues that support the discussion. These issues are described below in Table 5.2.1.2.

Data Analysis

Table 5.2.1.2: The issues in ICT infrastructure

| Categories | Number of occurrences in all interviews |
|--------------------------------|---|
| The reasons for ICT inadequacy | Three times |
| The types of ICT inadequacy | Six times |

A) The reasons for ICT inadequacy

This subset aims to define the reasons for insufficient ICT components (hardware, software and networking). The interviews suggested two reasons. The first reason is financial limitation. The second reason is human intervention. Other developed countries, for example New Zealand, recognise that ICT infrastructure is an important component in the adoption of ICT in health care, and includes broadband connections and capable computer hardware (UMR Research, 2008, p. 68).

For the first reason, one senior official raised the issue of the cost of HTIS and the effect of political interference. He said:

‘However, how to capture the medical records, which means there must be tools to capture the medical records through a use of ICT. Then, most people will think, how about HIS? Instead of using paper based format in a manual way or upgrading of the manual based system into electronic records, why not use HIS that will take over the whole process of medical records. The problem with HIS based on Malaysian context, it is not cheap. Not only it is not cheap, HIS procurement in Malaysia is more politically driven.’ (Interview_4_div_B_BT)

From the budget allocation, it is apparent that the Malaysian government is committed to increasing the use of ICT in health care. This commitment is interpreted from an extract from a document produced by the Ministry of Finance of Malaysia; the Ministry of Finance of Malaysia labels purchasing ICT devices under the budget for services and supplies. There was a 50% increase from 2010

for the 2011 budget, from RM61,480,400 to RM99,156,000 (Ministry of Finance, 2011).

Many directives and procedures in the MoHM also appear to support the view that procurement is politically driven. Layers of approval by three different committees, as stated in the Figure 5.3.1.1A are an example that illustrates how human intervention adversely affect attempts to improve the ICT infrastructure. This issue will be discussed further in section 5.3.1.1

B) Types of ICT inadequacy

This section aims to suggest types of ICT inadequacy that are apparent. The interviewees suggested three types of ICT inadequacies. The first type is hardware inadequacy. One remark from the head of the medical record department of a non-HTIS hospital emphasises this category.

‘The number of computers or other hardware to support EHR also I think does need to be increased. You can have a good HIS or EHR system, but if the computers are not enough or if a network switch is too old to support vast data transaction, I do not think EHR can be implemented successfully.’ (Interview_8_HSP_C_HDRM)

The above statement contains important points. Firstly, it outlines the real problem for non-HTIS hospitals, which is insufficient computer hardware to support EHR. Secondly, it suggests the inability of certain technology to support existing HTIS, which in the context of non-HTIS is the Patient Management System (PMS). Section 3.4.2 discusses PMS in detail.

The second type of ICT infrastructure that needs to be improved is networking and communication infrastructure. One senior official in IT explained this inadequacy based on his experience:

‘The second thing is communication infrastructure. There was one case where an ISDN switch was installed at one health agency in Kuala

Lumpur, but when I examined the wire under the ground, apparently they were still using the old copper wire. Other infrastructures also need to be emphasised; for example, the number of computers for every hospital, it is very expensive to equip the whole health agencies with computers but they are the basic requirements for electronic health records. All these computers need to be linked to both a Local Area Network and Wide Area Network, which means that another cost will be incurred.'
(Interview_4_div_B_BT)

Surprisingly, no direct quotation mentioned the inadequacy of software to support interoperable EHR. One interviewee suggested that it is irrelevant to discuss this issue because a more important issue is the procurement method often used by the MoHM – a fuller discussion on this issue is discussed in Section 5.3.1

5.2.1.3 The infrastructure to support the Patient Management System

The Patient Management System (PMS) is a HTIS owned by the MoHM with the full right to be installed at any health agency without any constraint. PMS is an alternate ICT solution for non-HTIS hospitals. Section 3.4.2 discusses this HTIS in detail. This section aims to comprehend whether the current ICT infrastructure is able to support PMS.

It should be noted that PMS has been designed for small scale hospitals and administration services. This leads to a situation where, although the basic electrical infrastructure is sufficient to support PMS in all hospitals, the PMS software itself is not appropriate for use in larger hospitals; one senior official stated:

'The modules that are offered by Patient Management Systems (PMS) are only sufficient to support small-scale operations and administration by hospitals. Therefore, PMS is not suitable for use in big hospitals. This information system has undergone many upgrade processes, and the division is in the process of developing new modules into it. In other words, PMS is not able to replace HIS which are used currently in hospitals.' (Interview_1_div_A_AM)

It is clear that the ICT infrastructure is sufficient to support PMS in most public hospitals. The ability of ICT infrastructures to support PMS is also supported by the extract from the document analysis of MAMPU. The Committees from MAMPU (2010b, pp. 25–26) suggested to the MoHM that they extend PMS into all non-HTIS as part of the modernisation of Malaysian health care.

Another quotation also suggests that the ICT infrastructure in non-HTIS hospitals are able to support the modules in PMS. One head of the medical record department at a non-HTIS hospital acknowledged the adequacy of ICT support but again queried the extent of PMS in fulfilling the requirements of a HTIS.

'I am aware about that system, but I believe it still does not cater [for a] clinical information system, only for registration and patient information management. A simple information system of course can be supported by our networking and electricity infrastructures.'

(Interview_8_HSP_C_HDRM)

To sum up, it would appear there is no infrastructural ICT inadequacy to support the installation and use of a Patient Management System (PMS) at all Malaysian public hospitals, either HTIS or non-HTIS hospitals. For that reason, PMS is feasible as the foundation HTIS for all non-HTIS hospitals.

5.2.1.4 Legacy systems and ICT infrastructures

This section discusses the current ability of infrastructures to support legacy systems. Legacy systems refer to any information system that was purchased or developed before hospital information systems (HIS) and used by the respective department to perform specific tasks, either clinical or non-clinical. The remarks from the interviews showed that Malaysian public hospitals still use these legacy systems in their daily operations.

A discussion of a legacy system by one senior official in IT outlines the adequacy of the existing infrastructures (ICT and electricity) to support its installation and uses.

Data Analysis

'First of all, legacy systems are not part of HIS. They are the systems which are either developed or procured to support departmental needs and requirements. For example, there was a system known as Patient Registration System which was used by all public hospitals in 1994, but when HIS was introduced, the system could not be upgraded and was disposed of. The integration problem occurred due to the use of legacy systems. For example, one public hospital in Kuala Terengganu owned a variety of legacy systems; when the hospital started to use HIS, almost all existing legacy systems were disposed of due to the problems of integration into the HIS. The integration problem was mostly caused by different technology and platforms.' (Interview_2_div_A_AT)

The above statement signals adequate infrastructural capabilities. It appears that after HIS, in some hospitals, legacy systems were disposed of. However disposal happened not because the existing infrastructures could not support those systems but because they cannot be integrated into HIS modules. In some hospitals, legacy systems are used together with HIS, which suggests the adequacy of both the ICT and electricity infrastructures to support them. One senior official in IT conveyed their feasibility by saying:

'However, there are legacy systems which can be categorised as 'higher level' or specialised information systems for specialised medical fields. These systems are not disposed of, but they operate by using the digital inputs from HIS. For example, "Medical Record Information System", which is used by many public hospitals, and also a system known as "E-Notifikasi". These two legacy systems were developed by this division and are currently being used in many government hospitals. They are supported by HIS. The support which is given by HIS to these two systems is in term of digital inputs related to the patient medical data.' (Interview_2_div_A_AT)

To sum up, the findings confirm the ability of existing infrastructures (ICT and electricity) to support most legacy systems. However, the reason why most legacy

systems were disposed of is the failure to integrate them into new HIS, and not infrastructural issues.

5.2.2 Infrastructure for interoperability

The purpose of this section is to discuss whether current ICT infrastructures are able to support interoperability. The theme suggests an isolation of HTIS within the respective hospitals. These HTIS are vendor-based technology, and have diversified architectures. Two interoperability types are extracted from the theme. Table 5.2.2 describes those two types.

Table 5.2. 2: The types of interoperability

| Categories | Number of occurrences in all interviews |
|--|---|
| Support for inter-hospital data exchange | Six times |
| Support for inter-department data exchange | Seven times |

5.2.2.1 Support for inter hospital data exchange

The purpose of this section is to discuss whether infrastructural inadequacy is a factor that hampers interoperability among hospitals. Six quotations from the theme represent this section. Generally, no quotations link the inadequacy of infrastructures to a failure to have inter-hospital relations. However, the quotations also confirm the absence of inter-hospital relations among public hospitals. The discussion is based on three arguments.

Firstly, it is apparent from the theme that all HTIS hospitals are sufficiently equipped with infrastructures to support the operation of HTIS. Nevertheless, inter-hospital data exchange is unattainable even with sufficient infrastructures. One senior official in IT confirmed this by saying:

‘One patient, who receives treatment at Selayang hospital, will not be able to access his medical record at Putrajaya hospital even though both of them have HIS or EHR systems. (Interview_2_div_A_AT)

Data Analysis

Much of the literature suggests that interoperability depends on sufficient ICT infrastructure (Blumenthal, 2009, p. 1478; Kaye et al., 2010, p, 173), however, based on the above statement, it is not possible to conclude that infrastructures are contributing to the lack of interoperability.

Secondly, it is possible that the inadequacy of infrastructures is not contributing to inter-hospital relations because the majority of public hospitals still use paper-based systems instead of HTIS. Therefore, to link infrastructural inadequacy with the absence of interoperability is inaccurate. The following quotation supports this:

'The problems that this division face are related to the wide scopes of ICT projects in health care. The LHR project, for example, which aimed to roll out in all hospitals in Malaysia, requires solutions to handle the manual based hospitals.' **(Interview_2_div_A_AT)**

Thirdly, a pilot project to integrate six health agencies that use different HTIS is evidence of the adequacy of existing infrastructures to support inter-hospital relationships. A senior IT official confirmed this by saying:

'The LHR previously was led by our Under Secretary, and then after a few years it was reintroduced with a new small project known as Malaysian Health Information Exchange (MyHIX). It is a project under LHR which involves six health agencies, including four under MoHM and two other government health agencies. This project is led by MDEC using their budgets. The application for this project has been developed, just waiting time to launch, November this year, but in terms of use requirements, it is still not completed. The integration process will enable different information systems in various hospitals to access data from MyHIX system as their mother system, where it will connect directly to the central database that is located at the MoHM.' **(Interview_3_div_B_BM)**

To sum up, the ability to interoperate among different hospitals is not related to infrastructural inadequacy. This conclusion is based on the three arguments extracted from the theme.

5.2.2.2 Support for inter-department data exchange

The purpose of this section is to discuss whether or not infrastructural inadequacy is contributing to a lack of inter-departmental data exchange. Seven quotations from the theme represent this section. These seven quotations suggest that all HTIS hospitals are able to conduct inter-departmental data exchange. Examples of quotations that show the inter-departmental interoperability follow.

First example:

'All reports from departments of this hospital are generated using the HIS. For example, X-ray reports can be viewed with the PACS via the HIS if it came from the Radiology Department of this hospital. In some cases, an email is used to transmit the digital output among the doctors in different hospitals, on condition that the hospital that received the output must use the same HIS. If not, the format must be in JPEG. If there is a need to access patient records by other hospitals with permission by the hospital, a printout of the records will be provided by the department.' (Interview_7_HIS_B_HDRM)

Second example:

'All of them could not communicate with other hospital information systems. The data communication can only be done among their own departments, which is internal data communication. For example, hospital information system in Selayang hospital can only communicate with its own departments.' (Interview_3_div_B_BM)

Third example:

'The data integration only happens in their internal departments within the same hospitals. We may conclude that EHR in Malaysia is still not interoperable and [there are] no online inter-hospital relationships in Malaysian public hospitals. One patient who receives treatment at

Data Analysis

Selayang hospital will not be able to access his medical record at Putrajaya hospital even though both of them have HIS or EHR systems. The Master Patient Index (MPI) is only stored locally at the hospital where the patient receives the treatment and not shared over the different hospitals' networks.' **(Interview_2_div_A_AT)**

Despite the agreement by the interviewees about the infrastructural adequacy to support inter-departmental interoperability, two issues are highlighted from these quotations.

Firstly, it appears that existing infrastructures in HTIS hospitals are able to support a variety of ICT solutions. There are a number of ICT solutions attached to the main HIS, and all of them are able to exchange data with HTIS from other departments. Even though different vendors develop or procure those solutions, inter-department interoperability is achievable . One head of an IT department confirmed this by saying:

'Every new health application is developed by different vendors. For example, HIS is procured from a vendor, billing application from another vendor, and these include other health information systems. From the aspect of compatibility, configurations need to be done until compatibility can be reached to a certain optimum level, because in most cases even with compatibility, integration is still not reached.'
(Interview_6_HIS_B_HDIT)

Secondly, despite infrastructural support, contractors still need to test the compatibility before new software can be integrated into the main HIS. This situation was suggested by one head of IT department, who said:

'Vendors are given chances to test the level of compatibility with our main system, which is HIS. If the test is failed then the proposal will be rejected; if they are compatible then the proposal will be considered.'

Normally, the proposed system will be compatible with HIS if the system requirements are similar to [this hospital's] technology and infrastructures. (Interview_6_HIS_B_HDIT)

The testing referred to above, also includes the testing of third party application to identify compatibility with communication and storage infrastructures. This was suggested by other heads of the IT department:

'Third party applications require a standard interface. For example, Selayang hospital is using ILMS system for their laboratory system. The data capture process by ILMS must be configured so that the HIS server will be able to recognise the input and output. The configuration is for the integration. Here, the role of standards such as HL7 and DICOM are needed.' (Interview_5_HIS_A_HDIT)

5.3 Second proposition

This proposition suggests, 'The procurement of ICT hardware and software based on departmental needs will cause diversity of health information systems and hamper the interoperability process'

The proposition seeks answers to the following questions:

1. How is procurement of ICT managed and administered?
2. What are the factors that influence ICT procurements in the MoHM?
3. What are the real problems in ICT procurement at the MoHM?
4. With a diversity of health information systems, how is intellectual property managed?
5. With a diversity of health information systems, is there any effort to be independent from vendors?

In seeking the answers, the following sections related to the theme METHOD OF PROCUREMENT and FLOWS IN ICT PROCUREMENT conceptualise the discussion.

5.3.1 The management of ICT procurement

This section aims to identify methods and means to manage ICT procurement by the MoHM. It discusses how procurement of ICT is managed and explains the difficulty in managing it. To discuss this subject, two issues are identified supporting the discussion. Twenty quotations from the theme represent issues behind this section. Table 5.3.1 describes these two issues.

Table 5.3.1: Two issues in managing ICT procurement

| Categories | Number of occurrences in all interviews |
|---------------------------|---|
| The stages of approval | Twelve times |
| The implementation method | Fourteen times |

5.3.1.1 Stages of approval

The management of ICT procurement is an effort to ensure that new ICT procurement accommodates the strategic planning of the Ministry of Health. Concerning the stages involved for the approval of ICT procurement, two categories of approval stages were identified from the interviews, which describe stages of the approval. These are the centralisation and decentralisation of approval. Table 5.3.1.1 describes the category.

Table 5.3.1.1: The categories of approval stages

| Categories | Number of occurrences in all interviews |
|----------------------------------|---|
| The centralisation of approval | Eight times |
| The decentralisation of approval | Four times |

A) The centralisation of approval

The centralisation of approval refers to central committees appointed by the MAMPU and Treasurer to filter proposals for new ICT procurements before being endorsed by MAMPU and the Treasurer (Ministry of Health of Malaysia ,2009). They are known as ICT Steering Committees. Membership of a centralised committee is based on the member's position in the MoHM. The co-chairman of this committee is the Secretary General of the Ministry of Health of Malaysia and

the Director General of Health. Other members who assist them are all the Deputy Secretary Generals of the MoHM, all the Deputy Directors of Health, all the Under Secretaries of the MoHM, all Division Directors, Legal Advisors, Heads of Internal Audit and the Head of the Health Informatic Centre (Ministry of Health of Malaysia, 2009).

To avoid redundancy and segregation, the MoHM empowers centralised committees to approve proposals for new ICT procurement. One high-ranking official suggested this by saying:

'Going back to the procurement process at the Ministry, everything must be approved by the committee and the approved proposal will be managed by the division. All procurements, either small or big projects, must get approval at the central committee. This central approval is to avoid any redundancy and segregation of hardware or software procurements by the Ministry. However, even with this committee, the issue of diversity of HTIS is still unresolved. This happens because sometimes approval is given to projects that are not in accordance with the plan but because they are urgent.' (Interview_1_div_A_AM)

The filtering mechanism used by this committee is based on two things: cost and types of ICT procurement. Any procurement that involves software development and incurs a cost of more than RM500,000 must be tabled to two centralised committees for technical advice and approval. They are the Appraisal Committee and the ICT Steering Committee. The committee also endorses any proposal that involves non-software development of more than RM500,000 and less than RM3 million. For procurement that is more than RM3 million, final approval must be obtained from MAMPU (Ministry of Health of Malaysia, 2009). Figure 5.3.1.1A illustrates the empowerment and type of procurement under the centralised committee.

Data Analysis

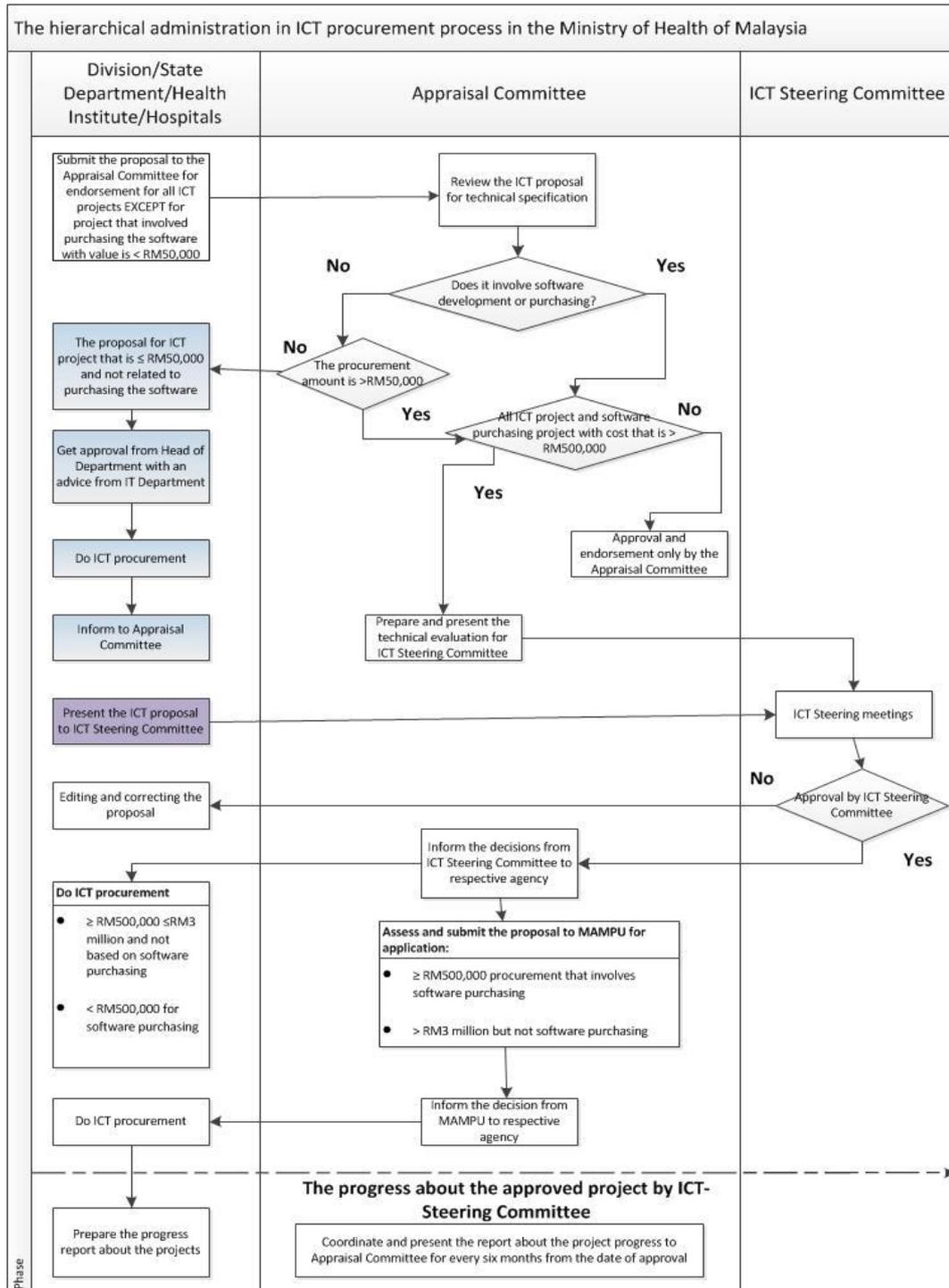


Figure 5.3.1.1A: The allocation of power to approve based on the incurred cost of ICT procurements (Ministry of Health of Malaysia, 2009).

Sometimes, the central committee needs to approve new procurements from different departments because they are deemed urgent. This situation contributes to the diversity of HTIS in health agencies under the MoHM. One senior official in IT acknowledged this scenario by saying:

Data Analysis

'At the same time, there are urgent needs of hospitals to have HTIS, and they are offered directly by some companies who claim to have good HTIS, so for the short-term planning, approvals were given based on piecemeal applications. As a result of procurement based on individual and respective hospitals' requirements ... segregation of HIS cannot be avoided. Then there is a problem to integrate all of those applications.'

(Interview_1_div_A_AM)

This statement is evidence of procurement that is not under the plan of the MoHM but urgently needed by some health agencies. The flexibility to entertain proposals for new HTIS or EHR systems that are not planned has caused the isolation of those systems and hampered their interoperability. The reason behind the flexibility to endorse unplanned but urgent proposals is due to the many process steps that must normally be undergone before the Treasury will give final approval with a financial allocation.

A quantitative study by Hussein et al. (2005) of information system success in Malaysian e-government identifies a positive relationship between centralised decision-making and the success of ICT adoption. Apart from that, they describe it as a traditional way of making decisions in an organisation. In terms of managerial effectiveness, flexibility in decision-making shifts an organisation from too much to less hierarchical bureaucracy (Ndou, 2004, p. 11).

To sum up, even with centralised approval, departmental based procurement is still inevitable. The flexibility in decision-making and urgency for particular HTIS contributes to the segregation of HTIS.

B) The decentralisation of approval

The decentralisation of approval refers to the empowerment given to directors of health agencies to endorse proposals for new ICT procurements. An extract from the document analysis of the Ministry of Health of Malaysia (2009), suggests that any proposal that is related to non-software development and below RM50,000 only requires endorsement from a director of the respective agency. The purchase of new software that is below RM500,000 is endorsed by the Appraisal

Committee and not the ICT Steering Committee. One high ranking officer confirmed this flow:

‘Under the procurement process for ICT, this division acts as a secretariat for ICT Steering Committee at the ministerial level. All proposals related to ICT need to be endorsed by this division first before they are tabled in ICT Steering Committee meeting. Normally, in every meeting there are many proposals being tabled and discussed. However, everything will depend on the financial allocation from the Ministry for ICT procurement. Then, every approved proposal should be referred to MAMPU (Malaysian Administrative Modernisation and Management Planning Unit) for ICT coordination and planning.’
(Interview_2_div_A_AT)

The positive implication of this approach is that it speeds up the approval process. It also reduces the number of urgent requests because it bypasses the central committee. The negative implication of this practice is that it means there is less control to monitor segregation of HTIS among different departments. This is because once the proposal is endorsed, the purchased software is often not shareable with other departments, as it is bound under an agreement between the department and the vendor. Thus, the problem of segregation of HTIS among different departments remains unresolved.

5.3.1.2 The implementation method for ICT procurement

This section is concerned with the method of implementation. Two categories of implementation methods are identified from the interviews. The first category is staged procurement, and the second category is national-based project. Table 5.3.1.2 illustrates these two categories.

Data Analysis

Table 5.3.1.2: The categories of implementation methods of ICT procurement

| Categories | Number of occurrences in all interviews |
|-----------------------------|---|
| Staged procurements | Five times |
| National-based procurements | Nine times |

A) Staged procurements

This refers to ICT procurement that is proposed and endorsed by stages according to separate departmental needs and not based on ICT strategic planning. The output from the interviews appears to both oppose and support this method.

The supporters for this staged method perceive it as a feasible approach. One senior official in IT perceives staged projects as the foundation for expansion:

'The situations in Malaysia require the EHR implementation to be done in stages, and later be expanded. For example, MYHIX project, which is a pilot project for LHR, is planned to enable a patient's discharge summary to be shared and integrated electronically by five different health agencies. It is a first step before it can be expanded to widen the scope in future.' (Interview_2_div_A_AT)

The interviewee highlighted one important point related to this method. The situation in Malaysia makes it unfeasible to have one big project for ICT in health care. The issues of infrastructure discussed in the first proposition suggest the unsuitability of a national ICT project. Kovindha acknowledges this challenge in her report to the United Nations ESCAP (2007, p. 4). According to her, the challenges faced by Malaysia to expand the e-health initiative are cost, inadequate human resources, computer literacy and the inadequacy of infrastructures.

In supporting staged procurement, one interviewee (a medical officer) had a different perception of how ICT should be adopted in health care.

'I see the method of implementation by stages for the time being is feasible, because not all hospitals really need to be computerised, only

Data Analysis

some of them. Not every department needs to be computerised, only some of them. With a limited budget under development financial allocation, MoHM must plan wisely the procurement of ICT because it is very costly. Plus, MoHM also needs to entertain projects that are endorsed by the top management that are out of plan, which for me might distort the planning by MoHM.’ (Interview_14_HSP_C_DOC)

This statement supports the arguments that staged procurement is a feasible method of ICT procurement. It also shows an interesting point, which is that not every hospital demands to be fully computerised, and not all departments in a hospital require computerisation. It also shows the practicality of department-based procurement.

The opponents of a staged method of procurement see it as a source of segregation and obsolescence. One senior official who was involved in Telehealth during 1997 suggested:

‘If you ask me, once again, when will we achieve the full implementation of EHR, I will answer straight away that it will not be in the next twenty years. Please imagine, without a clear timeframe with 131 hospitals and only 16 hospitals that are using HIS, with almost all of those procurements directed from the top authority, how can the integration of EHR be achieved with all these situations? Let’s pass the next twenty years, so what will happen to 16 hospitals who already have the HIS? Of course their systems are already obsolete. That’s why a concrete strategic planning must be proposed at the national level and the implementation of the plan cannot exceed more than five years, otherwise many problems will appear if it is more than five years.’ (Interview_4_div_B_BT)

The above statement suggests two solutions for discrete HTIS among different health departments: a timeframe for interoperable EHR implementation and accomplishable strategic planning. Technological obsolescence is a potential

Data Analysis

problem of this method. A lesson from ICT adoption in Hong Kong (section 2.3.6.2) shows the importance of having a timeframe that can be accomplished. The strategic planning under the national plan not only provides a direction for the MoHM for EHR implementation but also avoids obsolescence of HTIS. The example of ICT adoption in Singapore, under *Singapore One Infrastructure* (section 2.3.5.2), is an example of proper strategic planning to adopt ICT in health care.

The latest update shows that the Malaysian government under MAMPU leadership has already developed a strategic plan for ICT in the public sector for 2011–2015. An extract from the document analysis shows the problem of segregation of ICT applications among government agencies is one of the challenges identified by the plan (MAMPU 2011a, p.6). To solve the problem of segregation of ICT applications among government agencies including health care, MAMPU (2011a, p. 34) plans to execute three programmes. Table 5.3.1.2A describes these plans and their performance indicators.

Table 5.3.1.2A: Programmes and performance indicators for ICT strategic planning of the Malaysian public sector for 2011–2015 (generated from MAMPU 2011a, p. 34)

| Programmes | Performance indicators |
|--|--|
| To inculcate information sharing and interoperability | <p>2012: Development of an Information Architecture application for citizen’s touch point services</p> <p>2013: Deployment of citizen’s touch point services</p> <p>2015: Establishment of Connected Government Information Architecture applications</p> |
| To have cross-agency collaboration for seamless services | <p>2012: Establishment of Service Intelligence System</p> <p>2015: Establishment of Health, Transport and Education Intelligence System</p> |

Data Analysis

| Programmes | Performance indicators |
|---|--|
| To establish government shared services | 2011: Implementation of Government Integrated Telecommunication Network (1Gov.Net) 2012: Expectation of 200,000 users to have access to Government Unified Communication (an application for 1Gov.Net) 2012: Securing 20 agencies' tenancy in Public Sector Consolidated Data Centre under 1Gov.DC) |

Information about this strategic planning is highlighted in different sections of this government document. After reviewing the whole sections, the researcher has tabulated the information according to the specific programmes. By tabulating that information, it assists the researcher to align the interview feedbacks with the MAMPU's strategic planning.

The above information provides an indicator of the direction that the Malaysian government is taking to resolve the issue of segregation of ICT solutions in government agencies including health care. The limitation of that planning is it does not mention legacy systems that are currently used in government agencies including hospitals and methods to integrate them into suggested infrastructures and platforms.

B) National-based procurements

This method refers to procurements in line with national ICT strategic planning for all health agencies. The discussion aims to suggest the implications of this approach for the diversity of HTIS under department-based procurements.

The Malaysian government adopted this method in 1997, but due to financial, personnel and infrastructural challenges, the project failed to achieve the desired outcome. One senior official in IT who was involved in this project commented:

'Actually, Malaysia in 1997, in its effort to widen the use of ICT in health care, had come out with a good and advanced plan compared to other

Data Analysis

countries. However, the problem was during the implementation stage. Malaysia had planned something that was ahead of other Asian countries, but due to some hindrances, Malaysia was unable to continue with the planning.’ (Interview_2_div_A_AT)

As a result, staged procurement has become an acceptable approach. The same interviewee acknowledged this:

‘There was an intention to implement this project in a large-scale project, but due to the financial constraint, the Ministry decided to implement it in stages.’ (Interview_2_div_A_AT)

Her comment referred to a project to equip hospitals with HTIS, which was done by stages due to financial constraints.

Considering HTIS implementation in other countries such as the UK, staged implementation was a failure. Before 1998, almost all ICT procurement for health care was staged, which caused disintegration of HTIS (Brennan, 2005, p. 31).

According to one interviewee, achievable strategic planning determines the success of national-based procurement. This senior IT official, who has been handling ICT adoption in Malaysian health care since 1997, said:

‘In my rough estimation, if the Malaysian government is committed to implement EHR, the total cost will be around RM4 billion. But we must have proper strategic planning. The data capture has been done by the Department of Health for a long time, so we do not need to start from scratch.’ (Interview_4_div_B_BT)

However, he makes no suggestions for legacy HTIS after the implementation of national-based procurement. Even with the stored data from the Department of Health, automatic data transfer into new HTIS may be impossible and may have to be done manually.

5.3.1.3 Vendor management

This refers to the MoHM's ability to manage vendors in department-based procurements. Twelve quotations on the theme suggest one relevant subject in relation to the proposition, which is that there is too much dependence on vendors.

A) Dependence on vendors

This section relates how dependence on vendors contributes to segregation of HTIS and department-based procurements. The discussion is based on quotations on the theme.

Firstly, vendors will try to remain as the main providers for any ICT projects. The practice of department-based procurement promotes unhealthy competition among vendors. The reluctance to cooperate with requests from clients (health agencies) to facilitate the integration process is an example of this implication, especially when new software is purchased from another vendor. One head of an IT department highlighted this issue when she was asked about ICT projects in her hospital:

'The vendor seemed to be reluctant to permit integration unless some cost was incurred. After we evaluated the vendor's proposal, we decided it was not cost-effective to continue with the project.'

(Interview_5_HIS_A_HDIT)

To manage this situation, hospital administrators normally refer to the contracts for the level of the service agreement between the MoHM and vendors. One interviewee confirmed this practice:

'Normally, if a problem occurs, we will look back at the contract to find out the service level agreement between us and the vendors in relation to integration.' **(Interview_6_HIS_B_HDIT)**

Secondly, hospital building in Malaysia uses the concept of 'turn-key'. The 'turn-key' concept means that one vendor is granted the contract to build a hospital together with its HTIS. Any misunderstanding between the client's requirements

Data Analysis

and specifications from the vendors leads to new procurement. The new procurement is normally opened to a new vendor, because the MoHM considers that the former vendor is incompetent. This situation also contributes to the segregation of HTIS. One senior official in IT acknowledged this situation:

'Most HIS projects in Malaysia are done through a method known as 'turn-key', where every hospital building is developed together with a package of HIS. This package is included as a part of the hospital building development project. In other words, the vendor that supplies the HIS to a new hospital is the same vendor who developed it. Whenever a clash of specification happens, MoHM will consider the vendor as incompetent and normally a new proposal from another vendor is proposed. The former vendor is considered in breach of contract and the legal system will be enforced.'

(Interview_2_div_A_AT)

Thirdly, the integration of HTIS is also affected by unresolved agreements between the vendors and the MoHM for some ICT procurements. One deputy head of Telehealth for the MoHM claimed that in some ICT projects, the vendor owns the licence.

'I think it is quite difficult to do that because everything depends on the licence as agreed between the government and vendor. Most of the systems are procured from different vendors. If the licence belonged to the government then it can be done, but if it belonged to the vendors than it could not be done. I think this thing happened because before there is no coordination among different health agencies.'

(Interview_3_div_B_BM)

To prevent these situations reoccurring, the MoHM issued clear directions in 2007 on how to prepare specification documents, and in 2010 on how to manage vendors in ICT procurement. These directions are understood from the document analysis from two Newsletters from MoHM (Ministry of Health, 2007; 2010c).

All the problems raised in this section occurred before these two documents were drafted. However, since no national-based procurement is used they might happen in the future.

5.3.2 The issue of direct negotiation

This section discusses factors that influence the procurement of ICT for Malaysian health care by focusing on the issue of direct negotiation. Direct negotiation is the direct approval given by the top management of the MoHM to any proposal without a need to table the proposal to the central committee. Five interviewees gave ten statements about the direct negotiation approach used in health ICT projects in Malaysia. Their views are conceptualised into two issues below. Table 5.3.2 describes these categories.

Table 5.3.2: The issues of direct negotiation

| Categories | Number of occurrences in all interviews |
|---|---|
| The unsuitability of direct negotiation | Eight times |
| The feasibility of direct negotiation | Two times |

The discussion aims to identify the link between department-based procurement and direct negotiation. The link is used to suggest how it contributes to the segregation of HTIS.

5.3.2.1 The unsuitability of direct negotiation

This refers to the negative perception of the feasibility of direct negotiation and its relationship with department-based procurement. The prevalence of this practice has made the interviewees aware of it. Four issues are extracted from the interviews that frame the discussion.

Firstly, the practice of direct negotiation appears to bypass the standard procurement policy. One senior official who managed ICT for decades commented on direct negotiation by saying:

'Most ICT projects were procured through direct negotiation, and were not based on any market survey or study. Direct negotiation is decided by the top management of the Ministry but managed and monitored by this division.' (Interview_2_div_A_AT)

The practice mentioned in the above statement contradicts the Malaysian Treasure Order clause 169.1(2008, p. 74), which states that it is compulsory for all government agencies to conduct a market survey prior to procurement. Therefore, three interpretations explain this view. The first interpretation is that direct negotiation procurement does not comply with normal procurement. Secondly, the rules and regulations are only applicable to normal procurements. Thirdly, the discretionary powers of politicians enable them to bypass laws and procedures. These interpretations comply with a claim made by the Malaysian Prime Minister (Malaysian Prime Minister Speech 2010), who promised to reduce all discretionary powers in public procurement under the 10th Malaysian Plan for 2011–2015.

The second issue is that direct negotiation might lead to misjudged procurement decisions because it is based on individual preferences. One senior official in ICT acknowledged this by giving an example from a previous procurement:

'For example, HIS which we procured for our hospitals; if we properly evaluate that system, we will find out that it is already obsolete in those developed countries; they just want to find the dumping ground for their obsolete health information systems. MEDICOM, for instance, this system had been rolled out in eight hospitals in Saudi Arabia, then the Saudi government did not want to use this system, but still we procure it and use it in some of our hospitals. So please tell me, what to do?' (Interview_4_div_B_BT)

The above statement also suggests a level of vendor influence on politicians. It is prevalent because each politician has his or her own individual preferences for certain issues and methods to tackle the issue. The literature has identified the fact

that vendor-based technology promotes heterogeneous health information systems because it is done according to individual or partisan preference (Wu et al., 2006, p. 749).

The third issue is that direct negotiation is a top-down directive and not done according to the strategic planning of the MoHM. One senior official in IT acknowledged this:

'To sum up, EHR is highly needed. However, the main question is how to subscribe to the idea? Yes, undoubtedly few hospitals already implement EHR. Another problem in Malaysian ICT procurement for health care is that almost 99% of procurement decisions are directed from the top authority [i.e. direct negotiation], and only 1% of that is totally according to the strategic plan. Whenever a directive is given about certain projects, the Ministry has no choice except to implement and try to ensure the projects will be slotted into the planning that has been set up. This thing is very difficult to implement. You just imagine, let's say, the total allocation for ICT in health care is around RM1.5 billion; only RM100 million of procurement cost will be according to our plan, and the rest are not. Therefore, that is the reason we are having a variety of health information systems. A part of that, the Ministry of Health is too much depending on vendors and consultants in ICT project implementation.' (Interview_4_div_B_BT)

Based on the above statement, it is apparent that ICT procurement that is not based on proper planning promotes disintegration, because different vendors might use different technologies. Using the same standards does not guarantee that interoperability can be achieved. The above statement also contains a few indicators that illustrate the implications of this approach. Firstly, the approval of a project does not always follow the normal procedures. The circular of the MoHM (2008 and 2009) regulated that all new ICT procurement must get endorsement from the central committee of the MoHM, which is known as ICT Appraisal and the ICT-Steering Committee. If a project does not follow normal

procedure there is no mechanism to prevent segregation of procured HTIS. Secondly, this approach contradicts the notion of transparency in government procurement. The extract from the 10th Malaysian Plan (Economic Planning Unit, 2010, p. 355) asserted the commitment of the Malaysian government to be transparent in all government procurements. Thirdly, this approach distorts the ICT planning by the MoHM. The distortion happens because the MoHM needs to support decisions that are not based on strategic planning.

5.3.2.2 The feasibility of direct negotiation

The feasibility of direct negotiation refers to its suitability based on the capacity and financial resources of the MoHM. Direct negotiation is suitable in situations where outsourcing is still used and the source of HTIS is the same. Outsourcing through a vendor has become acceptable practice in the Malaysian government, and HTIS' are imported from developed countries. One Head of Medical Records commented on this:

'I do not see any severe impacts from the direct negotiation method because nowadays all technologies are quite the same. All vendors normally will use technologies from US, UK to supply to MoHM. Vendors will also make sure they are following the standards that are set by the MoHM for HTIS and EHR systems. The top management of MoHM is aware about that requirement, so if the decision is coming from them it contributes to shorten the processing time of ICT procurement.' (Interview_8_HSP_C_HDRM)

This statement provides a logical argument for why direct negotiation is still relevant in Malaysia. The first argument is that this approach shortens the processing time of ICT procurements compared to normal procedures that take months before the systems can be installed. The second is that the same standards are used and no contradiction of policies ever occurs with regards to standard compliance.

The conflicting arguments presented in sections 5.3.2.1 and 5.3.2.2 indicate that the contribution of direct negotiation to the lack of interoperability among HTIS is debatable, however more comments were made relating to a negative impact than a neutral or positive one. The impact of direct negotiation is therefore something that MOHM needs to carefully consider.

5.3.3 The issue of intellectual property

This section aims to answer the question of how intellectual property is managed within the diversity of health information systems being procured by the MoHM. Intellectual property in this section refers to issues of ownership and licensing of HTIS, which specifies the MoHM's freedom to use it beyond the contractual agreement. The extraction from the interviews identifies two issues related to intellectual property. Table 5.3.4 illustrates the issues and their occurrences in the interviews.

Table 5.3.3: Issues of intellectual property in HTIS procurement

| Categories | Number of occurrences in all interviews |
|---|---|
| Freedom over the software | Six times |
| The efforts to be less dependent on vendors | Four times |

The discussion tries to relate department-based procurement and issues of intellectual property.

5.3.3.1 Freedom over the software

Freedom over the software refers to the client's freedom to roll out procured software. The problem of 'who owns the software' affects the right to control the installation. Almost all software, which is procured through vendors, is proprietary and restricted under a licensing agreement. It appears from the interviews that departmental-based ICT procurement limits the freedom of the MoHM. This condition is illustrated by the remarks from two senior officials in IT:

'The drawback of this procurement process is that the Ministry does not own the intellectual property of the product including the licence, as it

Data Analysis

belongs to the vendor, and any rolling out to other hospitals requires permission from the vendor.’ (Interview_2_div_A_AT)

‘If the licence belongs to the government then it can be done, but if it belongs to the vendors then it cannot be done. I think this thing happens because before there is no coordination among different health agencies.’ (Interview_3_div_B_BM)

An extract from MAMPU’s guidelines (2006b, p. 14) states that all procured software belongs to the Malaysian government. This is in conjunction with the Copyright Act 1987, Section 11 (1). Section 26 (3) of the Act specifically states:

‘Copyright conferred by section 11 shall vest initially in the Government, Government organization or international body and not in the author.’

Therefore, there should be no issue about ownership as highlighted in the above quotations. In an agreement between Kersuma Nyata Sdn Bhd and the Ministry of Energy, Green Technology and Water, it clearly states that all source codes and software belong to the Malaysian government. The only thing that limits the freedom to roll out the software is the clause which strictly specifies the offices and locations for installation (Kersuma Nyata Sdn Bhd, 2009).

Because of the limitation in the MoHM’s freedom to install the software, there is an impression that the software belongs to the vendor. One head of an IT department admitted to this situation:

‘The agreement has specified certain clauses that limit ownership of MoHM ... Therefore, it is not permissible to install the application at other hospitals even though they are under the MoHM. If there is a need to install the application, different payment should be paid to the vendor under a new agreement.’

(Interview_5_HIS_A_HDIT)

In relation to the proposition, the issue of intellectual property occurs because each health agency proposes new ICT procurement just to meet its own requirements and needs. Since the software is purchased from a vendor through outsourcing, segregation and limitation of the MoHM's freedom is inevitable. A statement from another Head of an IT department acknowledged this:

'The HTIS of this hospital was developed using the proprietary technology and the licence belongs to this hospital. This hospital is permitted to install this system in an unlimited number of terminals as long they are used inside this hospital.' (Interview_6_HIS_B_HDIT)

The above statement explains an example of department-based ICT procurement. It shows that any hospital equipped with HTIS is departmental and its licence may be confined to the respective hospitals.

5.3.3.2 Efforts to be less dependent on vendors

This section discusses the efforts of the MoHM to provide ICT HTIS to non-HTIS hospitals without being concerned about licensing or agreements with vendors. Two efforts have been initiated for that purpose. The first effort is through in-house software development, and the second effort is through open-source software. The Patient Management System (PMS) was developed to meet the first effort. One senior official in IT said:

'In the beginning, the Patient Management System (PMS) was developed using JAVA technology, but nowadays it has been modified to adopt open-source technology. This division aims to introduce [PMS] to non-HIS public hospitals with the open-source version. Through the adoption of current technology, the open-source version will allow the Ministry of Health of Malaysia to expand the use of PMS to all health care agencies under the Ministry without a need to obtain licensing from the vendor.' (Interview_2_div_A_AT)

Section 5.7.2.1 discusses this application in detail. In relation to department-based procurement, the adoption of PMS is an example of the effort of the MoHM to

unify segregated HTIS among public hospitals. The installation of PMS into non-HTIS hospitals will prevent different hospitals requesting a similar application that leads to segregated HTIS. Section 3.4.2.1 mentions nine modules of PMS and the requirement to upgrade PMS to function as a Hospital Information System.

5.4 Third proposition

This proposition suggests, ‘The competency of people involved in ICT projects in the MoHM contribute highly to the success of implementing interoperable EHR’.

The proposition seeks answers to the following questions:

1. How does competency affect the implementation of interoperable EHR?
2. How is the decision of previous leadership valued in the MoHM?
3. What is the level of the knowledge gap among those involved in ICT projects?
4. Is a research culture in health informatics progressing in the MoHM?

The people involved in ICT projects refer to administrators and end users. In seeking the answers, the following sections related to the theme EFFICIENCY OF ADMINISTRATORS conceptualise the discussion.

5.4.1 The level of competency to manage EHR and HTIS

This section discusses the competency in the MoHM to manage interoperable EHR and HTIS. The level of competency refers to the ability and proficiency of those involved in ICT projects. The quotations under the theme identify two levels of competency that affect the implementation of interoperable EHR and HTIS.

Table 5.4.1: Levels of competency of the MoHM’s administrators

| Categories | Number of occurrences in all interviews |
|-------------------------|---|
| The level of innovation | Ten times |
| Technical competency | Three times |

5.4.1.1 The level of innovation

The level of innovation refers to the competency of administrators to innovatively draft the solution and execute it to resolve segregated HTIS across public hospitals. The quotations on the theme identify three issues related to the level of innovation and competency. Table 5.4.1.1 describes these issues.

Table 5.4.1.1: Issues of the level of innovation and competency

| Categories | Number of occurrences in all interviews |
|--|---|
| The imitative attitude | Four times |
| Knowledge gap | Four times |
| Research in Malaysian health informatics | Two times |

A) The imitative attitude

The imitative attitude in this section refers to the attitude of ICT administrators in reacting to innovative projects such as interoperable EHR and HTIS. One senior official suggested that ICT administrators tend to perceive that any HTIS from developed countries is the best:

‘We are also well known as those who like to blindly follow anything that comes from the developed countries, and viewing that whatever technologies they offer are the best.’ (Interview_4_div_B_BT)

In innovation studies, this attitude is known as imitative behaviour (Johansson & Lindberg, 2011; Qu & Wang, 2011, p. 438). An innovative or imitative attitude is a result of a person’s knowledge or personality variables, which influence his or her preferences in deciding whether to proceed with an innovation or discontinue it (Rogers, 2003, pp. 171–172, 177).

However, many factors contribute to this attitude. A shortage of staff is one factor that appears to contribute to this attitude. One Head of Medical Records acknowledged this factor:

'I think if you visited their offices, you will see the shortage of staff they are facing right now. Currently, there are two officials and three supporting staff to cover the whole operations of this hospital. This hospital also has a few systems, for example, Radiology, Lab, and a department-based system, which require maintenance. Therefore, you can imagine the day-to-day workload. For them to propose new technology is just a burden to what they are having right now.'

(Interview_8_HSP_C_HDRM)

Consequently, in order to avoid a new burden of work from a new idea, innovative ideas are avoided. Maggio and Powell (1983, p. 155) describe this attitude as mimic behaviour. It happens during conflict to achieve the organisational goal with internal problems in which organisational members find it easy to imitate others' approach rather than their own ideas. This remark is in alignment with a finding of a quantitative study by Papastathopoulou et al. (2006, p. 25), who consider staff attitude, either positive or negative, as the internal environment that determines the success or failure of ICT projects.

Any new idea, practice, or object that is perceived to be novel to another individual is innovation (Rogers, 2003, p. 12). In 1997, an innovative idea was initiated with a detailed blueprint. The plan was a response to a new government programme known as Multimedia Super Corridor (MSC). It aimed to integrate all health agencies under the MoHM using Telehealth technologies. Unfortunately, the plan had problems at the implementation stage. Those problems included technological and infrastructural readiness, which were not at a level required by the plan. One senior official confirmed this:

'Actually, Malaysia in 1997, in the effort to widen the use of ICT in health care, had come out with innovative ideas. However, the problem was in the implementation stage, for example in the Telehealth project in

1997. Malaysia had planned something, which was ahead from other countries, but due to hindrances, Malaysia was unable to continue with the planning. Then the concept was developed and successfully implemented in other countries.’ (Interview_2_div_A_AT)

The above statement is an example of what Rogers (2003, p. 190) calls discontinuance. Discontinuance, according to him, refers to a decision to reject or discontinue the innovation after previously adopting it, or, in this case, previously planning it. Rogers (2003, p. 179) also highlights the problem of different attitudes between those who plan the innovation and those who are going to implement it.

In relation to the proposition, no quotations show clear evidence to link an imitative attitude with a lack of competency to handle interoperable EHR implementation.

B) Knowledge gap

Knowledge gap in this section refers to a different understanding between medical and ICT specifications among ICT administrators in the MoHM. Many authors acknowledge this; for example, Coeira (2007, p. 3) mentions that it is unusual to find a workforce that is knowledgeable in both ICT and health.

A senior IT officer confirmed this condition when she was asked about the gap in medical and ICT specifications in Malaysian health care.

‘I think it does contribute. One more thing: e-health is very complicated, which IT people like us find difficult to understand. It is not straightforward like developing business information systems. This is a gap between IT professionals and medical doctors, unless there are doctors who are experts in IT, but it is rare to find people like that.’ (Interview_2_div_A_AT)

The organisational chart (Ministry of Health, 2010b) also illustrates the different specialisation between ICT and medical professionals. The document analysis

from the guideline of the Commission of Public Service (2011) shows that officials who lead the IT departments in all public hospitals come from Computer Science or Information Technology backgrounds. They are categorised under grade F for their scheme of services. Grade 'F' represents officials who are accountable for information technology. None of them is a medical doctor.

The establishment of posts in Malaysia still uses the specialised scheme of services that represent the respective job description. Medical officials use the code 'UD41' and information technology officials use the code 'F'. Both schemes of services are specialised in two different disciplines (The Commission of Public Services, 2011). In the Malaysian public servant scheme of services, a crossover between the services happens rarely. Officially, no medical officers can hold the post as 'F' officials, and vice versa.

One Head of an IT department acknowledged this situation:

'Establishment factors also play an important role for this division to be more efficient in managing HIS.' (**Interview_5_HIS_A_HDIT**)

In Malaysia, the responsibility for the establishment and recruitment of federal government officers at all grades is under the jurisdiction of the Public Service Commission. Nowadays, there is no specific grade for medical informatics, i.e. a medical officer to cater for information technology in health care.

The above discussion outlines the role of human resources in the knowledge gap. Human resource specialisation in Malaysian public administration is due to specialisation in tertiary education (The Commission of Public Services, 2011). Genova and Greenbergh (1979, p. 90) identify that education contributes little to the knowledge gap, they report that it is the attitude towards knowledge acquisition that causes the knowledge gap. In 2007, the Malaysian National News Agency or Bernama, reported on one medical doctor who had developed a hospital information system using open-source software which was being used in one of the tertiary hospitals in Malaysia (Daud 2007). It appears from the report that tertiary specialisation is not a major factor that contributes to the knowledge gap to administer ICT in Malaysian health care.

C) Research in Malaysian health informatics

This section discusses the research culture of health informatics in Malaysia. The discussion seeks answers to the importance of health informatics research, and methods to motivate practitioners to be involved in health informatics research. Health informatics in this context refers to the application of ICT solutions in Malaysian health care to improve health service delivery to the patients by facilitating access to data and information.

When asked about the nature of HTIS and EHR projects in Malaysian health care, one high ranking technical official responded:

'What we need is cooperation between ministries. The Ministry of Higher Education should initiate many efforts to conduct research and development in ICT for health care. I believe this is what Tun Dr Mahathir would like to have seen in 1997 after the launch of Telehealth under the flagship of Multimedia Super Corridor (MSC). The emphasis should be given to research being conducted in ICT for health care and not the number of procurements of health solutions from vendors. The research hopefully will discover the best and most cost-effective way to store, process and share patient health records across different hospitals.' (Interview_4_div_B_BT)

The above expression provides interpretations that highlight the current conditions of research in Malaysian health informatics. Firstly, there is a need to have more cooperation between relevant ministries for research and development in health informatics. Secondly, Telehealth projects should be more than efforts to procure ICT solutions from vendors. There should be more research conducted under this flagship scheme that promotes the use of ICT in health care. The research should identify the tools that enable patient data to be stored electronically and shared across the different hospitals. The research needs to consider tools that are feasible and economically effective. Thirdly, there are still many opportunities in Malaysian health care for health informatics research, since it is apparent that current ICT solutions fail to offer the best mechanism for storing and sharing

patient records across public hospitals. Finally, the statement provides an indicator that the researcher interprets as an alert to the low number of health informatics research projects in Malaysian health care.

The research in health informatics is also linked with career path. When a medical doctor was asked whether he has ever conducted research in health informatics, he replied:

'My requirement is to conduct research related to my interest as preparation for my specialist course; for example, I am interested in orthopaedics, so the requirements set by my boss is to conduct research in this field. With regard to ICT research, I don't think it is relevant for my career development. I think there is one specialist at one public hospital who is an expert in ICT, but not many people are like him, as it requires dedication and time. Our workloads now are already too big. I think to conduct that type of research will increase the burden.'

(Interview_12_HIS_A_DOC)

The interviewee mentioned two issues that link to methods of improving research in health informatics. The first issue is related to career development. One interpretation of the above statement is that a flexible requirement for medical doctors in research subjects would encourage Malaysian doctors to conduct health informatics research based on the Malaysian context. Secondly, conducting research should be included in the workload for medical doctors, so that it is not an additional workload for them.

5.4.1.2 Technical competency

Technical competency refers to the ability of those involved in ICT projects (administrators or end users) to support the implementation of interoperable EHR. Support varies according to involvement. For administrators, their competency is assessed according to their ability to manage and administer the flow of EHR implementation. For the end users, their competency is evaluated by their ability to specify the requirements and expectations of EHR implementation.

Data Analysis

There are remarks from the interviews that highlight the technical ability of administrators and end users. One statement, for example, suggested a high level of technical competency of MoHM administrators, because they are clear what they want from ICT and how ICT can accomplish it. When asked about how detailed the requirements requested from the vendors are, one high ranking official responded:

‘Currently, the responsibility to manage HIS procurement for a new hospital building is given to this division. There are three projects which this division totally manages. For each project, there are groups of teams that are specialised in certain aspects, for example the project management team and the implementation committee. There is also one team from the centre of health informatics to monitor the use of standards in HIS projects. The outputs from each team will be synchronised by this division. Our team also needs to equip ourselves with all technical jargon and how those things apply in system development, otherwise we can easily be manipulated by vendors. Knowledge is important, that’s why our staff are sent for further training almost every month.’ (Interview_2_div_A_AT)

The above statement describes the competency of ICT administrators to manage various HTIS projects under the MoHM. Synchronisation of activities between different teams is used as part of the managerial strategy. The team is also aware of technical jargon and specifications to assist their work. This practice follows the MoHM’s guidelines (2007, p. 15) as suggested in the document analysis. A study by Bassellier and Benbasat (2004, p. 681) also recognises that synchronisation of work is part of technical competency in managing ICT projects.

The technical competency of those administrators refers to their ability to identify the requirements and specifications from vendors in ICT projects. In other words, it only covers the management of technical aspects to ensure that the final product

meets the client's needs. One medical doctor who has been working in a HIS hospital confirmed this:

'I used to attend a meeting between ICT administrators of MoHM and medical officers of this hospital with regard to policy and latest updates about ICT requirements. It seems to me that they know their subjects very well. I have a few friends who work as IT officers at MoHM; based on their inputs, I can conclude that they are clear about what to expect from vendors in ICT projects. They are clear about what to expect and the types of specification for any health solution. Since I have never worked with them, it is not fair for me to judge their competency.'
(Interview_10_HIS_A_DOC)

The technical competency among administrators and medical professionals (end users) is viewed as contributing to the successful adoption of ICT in health care. Herbs et al. (2008, pp. 674, 678), in reflecting on a programme for security in health information technology (HIT), acknowledges the requirement for both administrators and medical professionals to be aware of security threats in HIT. Wu et al. (2009, p. 80) propose four knowledge domains that determine the competency of professionals involved in HIT adoption: health care organisation overview, external knowledge networking, health care technology integration and management and interpersonal skills.

5.5 Fourth proposition

This proposition suggests, 'The hierarchical system in ICT procurement has permitted external influences to interfere in decision-making'.

The proposition seeks answers to the following questions:

1. What is the meaning of 'hierarchical system' in ICT procurement of the MoHM?
2. What are the external influences that interfere in the decision-making of ICT procurement?

3. How is external influence able to interfere in the decision-making of ICT procurement?
4. How do the external influences affect the implementation of interoperable EHR?

In seeking the answers, the following sections related to the theme LOBBYIST conceptualise the discussion.

5.5.1 The hierarchical system of ICT procurement at the MoHM

The overview of the Malaysian administrative system was discussed in section 3.2. However, this section discusses the hierarchical system in the Malaysian administrative system that refers to the MoHM's ICT procurement. The hierarchical system consists of three groups of committees who are responsible for endorsing new ICT procurement proposals. The groups are known as the Appraisal Committee, the ICT Steering Committee, and a Committee from MAMPU. Two issues are extracted from the theme. Table 5.5.1 describes the issues and number of occurrence in the interviews.

Table 5.5.1: The issues in hierarchies

| Categories | Number of occurrences in all interviews |
|---------------------------------|--|
| The authority of each hierarchy | Ten times |
| The reasons for the hierarchies | Seven times |

Prior to the discussion, Figure 5.5.1 illustrates the flow of ICT procurement for health agencies under the MoHM. This flow chart is based on a circular from the MoHM (2009). The figure describes the flow of proposals from health agencies to procure new ICT hardware and software. It also illustrates the bases on which the Appraisal, ICT Steering and MAMPU Committees make a decision.

Data Analysis

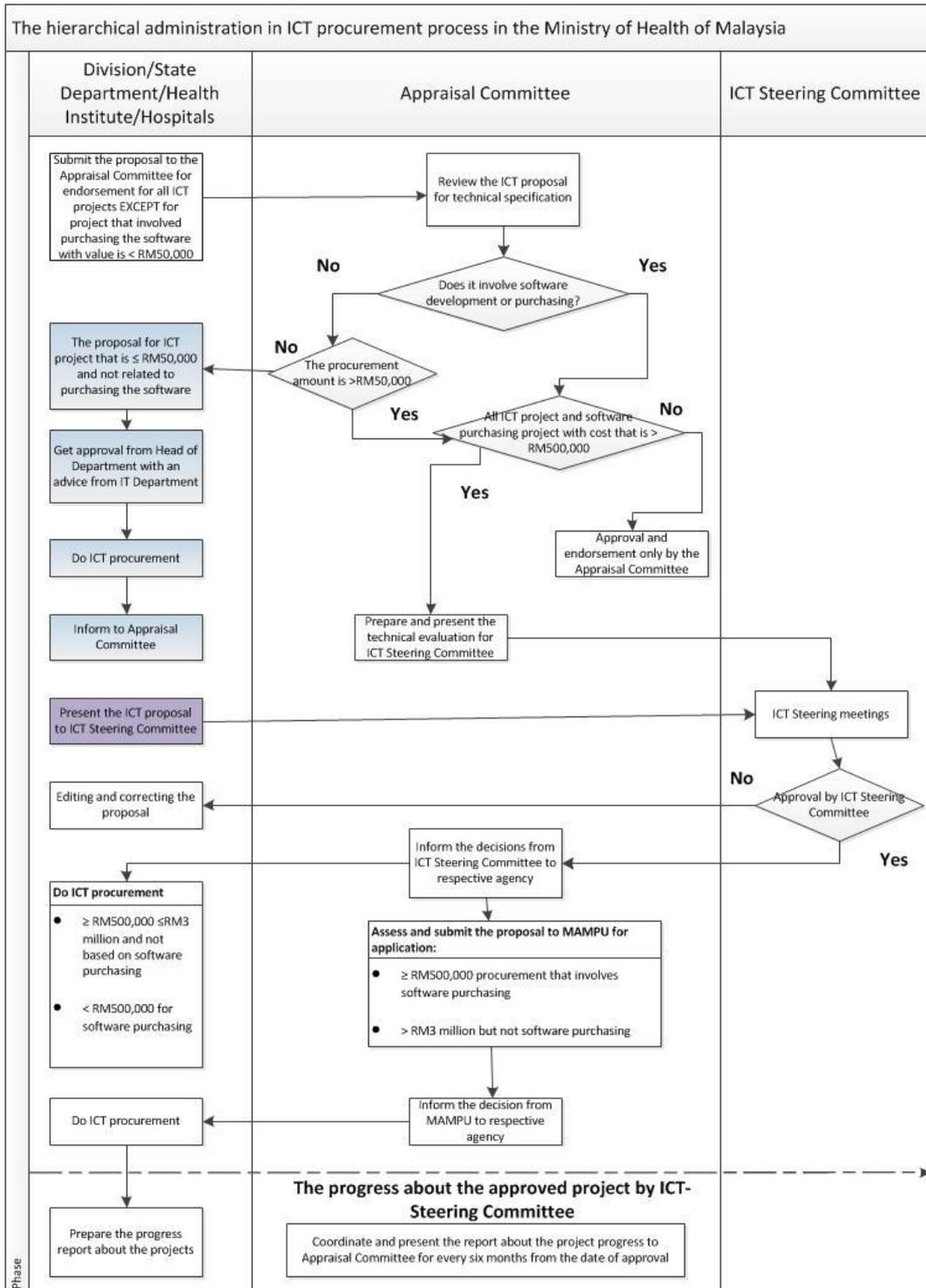


Figure 5.5.1: The flow of processes in ICT procurement at the MoHM (Ministry of Health of Malaysia, 2009)

5.5.1.1 The authority of each hierarchy

The authority of each hierarchy refers to the job scopes and responsibilities that are empowered by the MoHM to endorse proposals related to ICT. The theme has identified four related issues.

Firstly, authority is defined according to the amount of projects. Analysis of MoHM's circular (2009) specifies three groups of decision makers based on the nature and amount of projects. A summary of this directive is described below:

After the evaluation, an ICT project that costs RM50,000.00 or less and is not related to the development of a new application can be endorsed by the head of department of the respective agencies. The management of this project requires technical input from the Appraisal Committee. After the procurement is made, the agency must notify the Appraisal Committee for its records.

A software development project of more than RM50,000.00 but less than RM500,000.00 only requires a second evaluation by the Appraisal Committee. If the committee disagrees with the project, the proposal will be returned to the respective agencies, and if the committee agrees, then the procurement can be made.

An ICT project that is worth more than RM500,000.00 requires endorsement from the ICT Steering Committee of the MoHM. The proposal will be tabled in meeting. If the committee disagrees, the proposal will be returned to the agencies for modification, and if they agree, the proposal requires assessment and endorsement from MAMPU. The decision by MAMPU is final.

A statement from one senior official in IT acknowledged this categorisation:

'Concerning the delay of approval, actually MoHM under the directive of the Treasurer has categorised the procurements into a few categories. For example, if the procurement is below RM50,000, then the proposal is sufficient to be endorsed by the Head of Department but with evaluation

Data Analysis

from this division. If the procurement is more than RM50,000, then the proposal must be tabled to the Centralised Committee or ICT Steering Committee. After that, if the price ranges between RM500,000 and RM3 million, then MAMPU endorsement is required. MoHM always in its best capacity tries to make sure the process for each layer is done within a short period of time.’ (Interview_3_div_B_BM)

Secondly, this illustrates that the committees are responsible for filtering all proposals, especially high-cost procurements. One interviewee acknowledged the filtering authority of those committees for every proposal:

‘A central committee known as ICT Steering Committee decides ICT procurements in the Ministry, and the meeting is managed by a secretary from the division. The flow of any proposal related to ICT procurement starts with the preparation of proposals, and the proposal will be channelled to the committee at the State Health Department before being tabled to the central committee at the MoHM.’ (Interview_1_div_A_AM)

According to a circular from MAMPU (2010b), the composition of the ICT Steering Committee involves high-ranking officials of the MoHM. The involvement of senior management is an indicator of efficient IT governance with their positions and access to information (Maidin & Arshad, 2010, p. VI-535).

One senior official in IT of the MoHM acknowledged the above process:

‘Once it is approved, the proposal will be sent to MAMPU for further checking to find out whether there is other similar procurement being made by another agency. If there is a redundancy, MAMPU will ask the MoHM for an explanation. Most of the time, the issue of intellectual property is the main reason for the redundant procurement. If MAMPU endorsed the proposal, then the executive summary that includes the last

Data Analysis

version of financial implication shall be sent to the Ministry of Finance for the payment. (Interview_1_div_A_AM)

Thirdly, the authority of those committees is limited to common ICT procurement only. Common ICT procurement refers to planned procurement and requires that standard procedures are followed. It is different from direct negotiated procurement. Direct negotiation applies different procedures and decisions. One senior official in the IT department of the MoHM lamented this situation:

'Only a small percentage of ICT procurements under the Ministry are purely planned by the divisions; most of them use direct negotiation, which may have some involvement of politics in the project.' (Interview_2_div_A_AT)

She also explained the mechanism that the MoHM uses to ensure that direct negotiation procurements are properly managed:

'If the evaluation committee found out that the system is not compliant with the requirement by the Ministry, the vendors will be asked to follow the recommendations and comments, otherwise the project will not be continued.' (Interview_2_div_A_AT)

Fourthly, the above statement also illustrates the authority of the committees in managing direct negotiation projects. The committees have authority to cancel the project if, after their evaluation, they discover shortcomings caused by the vendors.

In relation to the proposition, the flow of decisions is an illustration of the hierarchical structure of the ICT procurement process. It is also a manifestation of the effort of the Malaysian government to provide transparency and good governance in decisions involving ICT procurement. Based on the above discussion, the tendency for external influences to interfere in decision-making is reduced, with the major exception of direct negotiation proposals.

5.5.1.2 Reasons for the committees

After defining the job scope for the committee, this section addresses the reasons that the MoHM employs those committees. The theme characterises three reasons for having these committees.

The first reason associates those committees with the strategic planning of the MoHM. An excerpt from a statement by one senior official in IT suggests this reason:

‘Under the procurement process for ICT, this division acts as a secretariat for the ICT Steering Committee at the ministerial level. All proposals related to ICT need to be endorsed by this division first before they are tabled in an ICT Steering Committee meeting. Normally, in every meeting there are many proposals being tabled and discussed. However, everything will depend on the financial allocation and planning from the Ministry for ICT procurement. Then, MAMPU (Malaysian Administrative Modernisation and Management Planning Unit) will synchronise each proposal for coordination and planning.’
(Interview_2_div_A_AT)

Employing those committees causes some delays for health agencies in attaining the final decisions about their proposals. On the positive side, it enables the MoHM to achieve three outcomes. The first outcome is the achievement of targeted ICT procurements. Secondly, having these layers ensures a reduction in procurement redundancy among health agencies under the MoHM. The third outcome is transparency in government procurement.

Analysis of MoHM’s circular (2009) details the job scope of these committees, especially the ICT Steering Committee. These jobs can be summarised in five key words: planning, coordination, administration, decision and synchronisation.

The second reason for having these committees is that they act as advisors for respective health agencies in technical specifications and requirements.

'Our division also is responsible for monitoring, evaluating and advising any health agency that would like to procure new health solutions. We provide advice with regard to technological specifications, requirements, but sometimes their officials have already included the specifications in their proposals. We also must make sure vendors are following those requirements, otherwise we will refer the case to our legal division as a breach of contract if the vendor fails to follow our specifications and requirements.' (Interview_2_div_A_AT)

The above statement also includes the fourth reason for having these committees, which is to manage the vendors and assess their products.

To sum up, the discussion has answered the rationale behind the hierarchical administrative systems in the MoHM. It also outlines the chain of command which prevents the possibility of external interference occurring. Prevention is achieved through layers of decisions that need to be fulfilled.

5.5.2 External interference in ICT procurement

Despite the committee structure outlined in 5.5.1.2, external interferences in the decision making process for ICT procurement do occur – this section considers these interferences.”. Two issues are extracted from the theme. Table 5.5.2 describes the issues and number of occurrences in the interviews.

Table 5.5.2: The types of external influences

| Categories | Number of occurrences in all interviews |
|--------------------------------------|---|
| Types of external interference | Thirteen times |
| The implications of the interference | Nine times |

5.5.2.1 Types of external interference

This section defines the types of external interference that interfere in decision-making for ICT procurement. Two types of external interference are identified from the theme. Table 5.5.2.1 describes those categories and number of occurrences in the interviews.

Table 5.5.2.1: Categories of external interferences

| Categories | Number of occurrences in all interviews |
|------------------------|---|
| Vendor interference | Ten times |
| Political interference | Twelve times |

A) Vendor interference

The first category identifies the vendor as, potentially, an external interference. Vendor interference refers to the efforts by vendors to interfere in ICT procurement decisions. The ten quotations from the theme suggest two interferences by vendors.

Interference by vendors happens when they interfere with the technical specifications and modules of the HTIS. One statement by a senior official in the IT department of the MoHM suggests this interference:

‘With regard to the issue of different versions of hospital information systems that are used by public hospitals, it is due to the complication of the hospital information system itself. Whenever a company proposes a proposal, there is no certainty on the quality of the product. Many things need to be considered. At the same time, there are urgent needs by hospitals to have HIS, and the vendors have approached them directly with all good things about their products technically..’
(Interview_1_div_A_AM)

Data Analysis

Another example of an effort to interfere in decision-making also occurs when the vendors show no corporation with the process of upgrading or procuring new HTIS, especially when other contractors are granted parts of the project. This attitude is an attempt to influence the hospital administrators in their decision. One head of an IT department confirmed this:

'The vendor seemed to be reluctant to permit integration unless some cost was incurred. After we evaluated the vendor's proposal, we decided it was not cost-effective to continue with the project.'

(Interview_5_HIS_A_HDIT)

The solution for the above problem is found through legal procedures and service level agreements. The same head of an IT department commented on this:

'Normally, if a problem occurs, we will look back at the contract to find out the service level of agreement between us and the vendors in relation to integration.' **(Interview_5_HIS_A_HDIT)**

In relation to the proposition, the committees do reduce opportunities for interference from vendors, however vendors can interfere outside the meetings of those committees (the ICT Steering and ICT Appraisal Committee). Two situations permit their interference in decision-making. The first situation is before the project is proposed through their liaison with politicians or top management of the MoHM. The second interference happens when they are able to convince hospital management about in the benefits of their technical specifications and modules. Normally, this situation happens when a hospital urgently needs a new ICT procurement. To minimise the interference, the Appraisal Committee is also responsible for evaluating any technical specifications and modules offered by the vendors to all health agencies.

B) Political interference

The second category is political interference. Political interference refers to interference by politicians in decisions related to ICT procurement. Two reasons for interference are identified from the twelve quotations. Prior to the discussion,

Data Analysis

an explanation of the nature of Malaysian politics is essential to understand why politicians interfere in decisions related to ICT procurement.

Each politician in Malaysia represents a political party from either the government or the opposition. In Malaysia, since 1955 the ruling party is a coalition of 134 parties known as the National Front, which have won the last 12 elections since 1955. Three major opposition parties have also formed another coalition since 2004, known as the People's Pact. Each politician with ministerial power is a parliament member and is high ranking in the party. Before he or she can be elected to represent their party in a parliamentary seat, he or she needs to secure his or her place in party administration. To secure the party seats, financial support is required. Most of the time, there are lobbyists among businesspeople and contractors who support those politics. After winning the election and being elected as minister or deputy minister, the general perception is that he or she has an unwritten obligation to pay back those who have supported his or her political career. This notion is sometimes known as crony capitalism or business politics (White, 2004, pp. 390, 392; Wikipedia, 2011; Sikorski, 1997, p. 444).

Firstly, politicians interfere for political mileage to succeed in their political careers. One senior official in the IT department of the MoHM suggested this by saying:

'There are three drives that motivate adoption of ICT in Malaysian health care. The drives are political, necessity, and people. We as administrators base our drives on necessity and requirements, but most of the time political and people drives overrule our preferences. Politicians try to use the adoption as supporting their political mileage to get support from people (supporters).' (Interview_4_div_B_BT)

The above statement describes two drivers (politics and people) that motivate political interference in decision-making in relation to ICT procurement. These two drivers are examples of political mileage that will increase the popularity of a politician.

Another type of interference by politicians is the practice of direct negotiation in government procurement. This practice interferes in ICT management in the MoHM. Section 5.3.3 discussed this practice in length. One head of a medical record department said:

'In my opinion, the main player in any procurement is support from politicians. I believe there is only a small percentage of procurement which is based on proper planning, and the rest is based on decisions by the top management or what is called direct negotiation. So you can imagine, currently we have around 130 public hospitals, and I believe only 13–16 hospitals are equipped with HIS, and the rest are not, every year there is only a few meetings to discuss new ICT proposals at MoHM. This shows that direct negotiation is a main method for ICT procurement currently.' (Interview_8_HSP_C_HDRM)

This section links direct negotiation with external interference in decision-making. Section 5.3.3.1 mentions how direct negotiation surpasses the normal procurement process. The outcome from that practice actually interferes in decision-making. Another interviewee who linked politicians with direct negotiation was one senior official in IT, who said:

'Only a small percentage of ICT procurements under the Ministry is purely planned by the divisions; most of them are done using direct negotiation, which may have some involvement of politics in the project.' (Interview_2_div_A_AT)

In relation to the proposition, political interference happens in the decision-making process when it outranks the opinions of the committee regarding ICT procurement. Therefore, to limit this, the Ministry of Finance of Malaysia (2011) has enforced the guidelines on how to manage direct negotiation. However, even with the guidelines, most approvals remain unchanged because the proposal comes from the top. This is supported by a claim from a senior official described

in section 5.3.3.1 that direct negotiation contributes to 99% of ICT procurement in the MoHM.

5.5.2.2 The implications of external interference

This section discusses the outcomes from external interference in the implementation of interoperable EHR and HTIS. Two implications are extracted from the theme. Table 5.5.2.2 describes those implications and the number of occurrences in the interviews. The negative and positive implications of external interference are defined based on the interpretation of all quotations on the theme. The results assist the researcher to understand how external interference (both vendor and political) can affect the implementation of interoperable EHR and HTIS.

Table 5.5.2.2: Two implications of external interference

| Categories | Number of occurrences in all interviews |
|---------------------------|---|
| The positive implications | Six times |
| The negative implications | Seven times |

A) The positive implications

The positive implications refer to the outcomes enjoyed by health agencies as a result of vendor and political interference in ICT procurement decisions. Three positive implications are identified from the theme.

The first outcome is that it shortens the processing time. The processing time, as illustrated in Figure 5.3.1.1A shows the possibility of it taking months before the proposal can be approved. Thus, instant approval by a politician in a direct negotiation approach shortens the processing time. A comment from one medical doctor supports this argument:

‘I think the procurement of ICT for health care is influenced by political motives. I am informed that the majority of procurements are based on decisions made by top management, and the IT division is to endorse the

decision and try to slot it to suit the planning of MoHM. I notice there is a committee that is responsible for endorsing any proposal for new ICT procurement before it is approved by MAMPU, but I think the meeting is not done frequently. So it shows most procurements are done through direct negotiation. For the rest of the procurements that follow the normal policies normally take months before final approval is given. As a medical practitioner, I understand if there are complaints from doctors on the delay, because it really affects their work. I also understand the hurdles faced by MoHM to endorse the project because everything must be according to the procedures.’ (Interview_13_HSP_C_DOC)

Another outcome of external interference is that it assists the health agencies in choosing a range of technical specifications from the vendor rather than depending on technical committees of the MoHM to decide on technical specifications. This positive implication is interpreted from a comment by one head of an IT department:

‘Everything depends on tender advertisement, where MoHM will inform the requirements and technical specifications. Then, the vendors will submit the proposal that suit the MoHM system requirements. Normally, all vendors will present the same things required by MoHM, then the cost factor will be evaluated, or guarantee duration and maintenance.’ (Interview_6_HIS_B_HDIT)

B) The negative implications

The negative implications refer to outcomes that are associated with both vendor and political interference. Four negative outcomes are identified.

The first negative outcome is that external interference affects ICT administrators’ planning. One senior official in IT suggested this outcome:

‘The problem with political-need is it meddles with our planning. The directive from the top overrules all planning we have on ICT adoption.’

The directive is something that is unavoidable and we could not do anything about it. (Interview_4_div_B_BT)

The second outcome is that it bypasses some procedures that apply to all ICT proposals such as market surveys and analysis. One senior official in IT suggested this by saying:

‘Most of the ICT projects are being procured through a direct negotiation, where most of the time no market surveys were conducted. Direct negotiation is decided by the top management of the Ministry but being managed and monitored by this division.’ (Interview_2_div_A_AT)

The third outcome is that external interference encourages the culture of favouritism among government administration to please people at the top. One high-ranking official in IT also suggested this outcome:

‘They should not interfere in other people’s jobs. What happens now is everybody wants to influence one another. Another problem is government officers. There is [a need] in their career path that requires a favour from politicians as an additional requirement to their merits. As a result, those who have power to determine another’s career path sometimes tend to interfere in administrative decisions, which is sometime beyond the current policies.’ (Interview_4_div_B_BT)

5.6 Fifth proposition

This proposition suggests, ‘The selection of certain standards by the MoHM for all health information systems procurement does not guarantee interoperability of their digital outputs and EHR across different hospitals’.

The proposition seeks answers to the following questions:

1. What is the role of standards to enable interoperability?

2. What are the MoHM's policies for the selection of standards in ICT procurement?
3. Why does the MoHM select those standards?

In seeking the answers, the following sections related to the theme MOTIVATION FOR INTEROPERABILITY conceptualise the discussion.

5.6.1 The role of standards

This section discusses the actual role of standards in interoperability based on the remarks and opinions of the interviewees. The researcher has identified issues, Table 5.6.1 illustrates these issues with the number of occurrences in the interviews.

Table 5.6.1: Roles of standards

| Categories | Number of occurrences in all interviews |
|---|---|
| Factors for interoperability | Twelve times |
| The enabler for inter-department and inter-hospital relations | Fifteen times |

Understanding the technical meaning of 'standard' is a first step to comprehending its role in the implementation of interoperable EHR and HTIS.

The British Standards Institute (BSI) defines a standard as a:

'Document, established by consensus and approved by a recognised body that provides for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.' (BS EN 13606-1: 2007, p. 28)

This definition outlines the entity that forms the standards, their application, objectives and outcomes. The next sections discuss the technical factors for interoperability, and inter-hospital and department interoperability.

5.6.1.1 Technical factors for interoperability

These factors refer to elements of standards that enable different HTIS to exchange data. The discussion aims to identify whether standards are important technically for interoperability. The quotations on the theme suggest one role, which is to create common ground in data transaction. One senior official in IT suggested this role:

'In my opinion, the standard is not a serious issue with the implementation of Electronic Medical Records because integration is a possible process. A standard is needed to ensure data and information can be exchanged and understood. The use of HL7 and DICOM is to ensure there is common ground at every level or layers, from the lower layer to the top layers.' (Interview_4_div_B_BT)

The role of standards to facilitate data capture and comprehension is proposed in many experimentation studies. HL7, for example, defines how non-imaging data is transferred across different computers, and DICOM defines data structures for medical images in health information systems (Magni et al., 2007, p. 118). Blazona and Koncar (2007, p. 430) report the ability of HL7 to understand and process radiology data in different HTIS. They integrate components of HL7, Clinical Data Architecture (CDA), into DICOM, which they name DCM CDA. Their finding also supports the above statement that perceives that the functionality of standards is primarily limited to technical grounds.

One remark clearly mentions the functionality of HL7 and DICOM as tools for data sharing:

'They are used for integration purposes. For example, the lab information system normally uses DICOM so that medical devices like PACS will be able to communicate with HIS. The configuration is done at the central server of the hospital and managed by the hired contractor

but with close monitoring by this division.'

(Interview_5_HIS_A_HDIT)

The above statement acknowledges the suitability of HL7 and DICOM standards for data exchange across different departments in the same hospital. However, there is no guarantee that integration will occur across different hospitals even with the same standards. This non-integration is confirmed by one senior official who has been managing ICT projects for the MoHM for decades:

'There is no interoperability or inter-hospital relationships occurring among them. There is no communication or direct online data exchange modules that occur among them. Why should they interoperate? One hospital is located at Sg. Buloh, and one hospital at Kedah.'

(Interview_2_div_A_AT)

The above statement shows the absence of interoperable EHR across Malaysian public hospitals, which makes this research viable and original.

A MoHM manual about recommended standards for telemedicine projects in 1997 shows the technical contribution of standards to enable interoperability (Ministry of Health of Malaysia 1997). The document comprises eight categories of standards that were considered technical enablers to interoperate various HTIS under telemedicine projects. These standard categories are described in Table 5.6.1.1B. These technologies were based on 1997 and some of them are obsolete, for example using a VHS recorder as a storage format for teleconferencing should be changed to optical disc or external HDD (Wikipedia, 2011). The latest version of the format is highlighted in italics.

The contents of the table indicate that the reason behind the failure of telemedicine projects was not that the MoHM overlooked the issue of standards – a document about standards was waiting to be implemented.

Data Analysis

Table 5.6.1.1B: Summary of recommended technical standards for telemedicine projects (Ministry of Health of Malaysia, 1997, pp. 3-4)

| Object categories | Storage formats | Transmission | | |
|---------------------------------------|---|----------------------------|----------------------------|---|
| | | Source to EMR | EMR to users | Between users |
| Video conferencing/Audio conferencing | VHS recorder (Optical disc or External HDD) | VHS (DVD or External HDD) | VHS (DVD or External HDD) | H.320 |
| Audio data | MPEG2 | Not applicable | | H.320 etc, T.120, FTP, SMTP/MIME |
| Still Medical Images | DICOM 3.0, JPEG2 | DICOM 3.0, JPEG2 | DICOM 3.0, JPEG2 | T.120, FTP, SMTP/MIME |
| Moving Medical Images | DICOM 3.0 | DICOM 3.0 | DICOM 3.0 | T.120, FTP, SMTP/MIME |
| Still General Images | JPEG, GIF, TIFF, PICT | JPEG2 | JPEG2 | JPEG2 |
| Moving General Images | M-JPEG2, MPEG2 | M-JPEG2, MPEG2 | M-JPEG2, MPEG2 | M-JPEG2, MPEG2 |
| Text Data | ASCII, SGML, HTML | HL7, TC251/WG3, UN/EDIFACT | HL7, TC251/WG3, UN/EDIFACT | T.120, HL7, TC251/WG3, HTTP, FTP, SMTP/MIME, UN/EDIFACT |
| Binary data | BINARY STRING | E1467, P1073 | | T.120, FTP, SMTP/MIME |

The contents in Table 5.6.1.1B is also evidence of standardised decisions by the MoHM regarding the selection of standards to enable interoperability.

A response from one interviewee illustrates the role of standards in interoperable EHR implementation. When asked about the application of standards in the 1997 telemedicine project, one senior official of IT replied:

'Standards are just tools to support interoperability. Scientists propose certain standards because they believe those standards are relevant to certain tasks. Implementing EHR is not just about applying certain standards or regulating all ICT solutions to be compatible with them. It is more complicated. I have been involved in the Telehealth project for decades, and I can conclude that standards only contribute 20% of all factors.' (Interview_4_div_B_BT)

In relation to the proposition, the theme acknowledges the role of standards as a technical tool for interoperability. This acknowledgement is seen from the directive of the MoHM for all HTIS and EHR systems to be compliant with two standards (HL7 and DICOM). The literature also recognises the importance of standards to enable interoperability among different HTIS. However, it appears from the discussion that technical specifications from the standards cannot guarantee that interoperability will be achieved among HTIS used in Malaysian public hospitals. The next section discusses the role of standards in inter-hospital and departmental interoperability.

5.6.1.2 Inter-department and inter-hospital interoperability

An inter-departmental relation refers to different HTIS used by different departments in the same hospital. Those departments are able to exchange data through the central hospital information system. An inter-hospital relationship refers to the ability of HTIS in different hospitals to exchange, capture, comprehend and use the data. All interviewees acknowledge that all procured HTIS must be compliant with two main standards, HL7 and DICOM. Therefore, the discussion aims to answer why and how HTIS that are compliant with certain

Data Analysis

standards are still not able to interoperate. Based on the fifteen quotations on the theme, two issues are identified, as suggested in Table 5.6.1.2.

Table 5.6.1.2: Issues in interoperability

| Categories | Number of occurrences in all interviews |
|--------------------------------|---|
| The reasons for disintegration | Nine times |
| The prospect for integration | Six times |

A) The reasons for the lack of interoperability

This section refers to standard-related reasons that hinder interoperability across different HTIS. The discussion includes both reasons for inter-department and inter-hospital relations. All HTIS procured by the MoHM must be compliant with two main standards, HL7 and DICOM. This was mentioned by one head of an IT department:

'Based on what I am aware of, MoHM has already specified all HTIS or any procurement for information system must be compliant with HL7 and DICOM.' (Interview_6_HIS_B_HDIT)

Three reasons are extracted from the theme, which highlight the functionality of standards to enable interoperability.

The first reason suggests that configuration by vendors during HTIS installation determines interoperability, especially for interacting with external data. In other words, the functionality to interact with external data was disabled by the vendors. This notion was suggested by one remark by a head of an IT department:

'CERNER HIS was set up for internal use only. But there is a possibility for this system to be configured so it will be able to communicate with external parties. However, it is still not being done. The compatibility issues are also important if the Malaysian government has the intention to create inter-hospital data exchange. For the time being, various hospitals are using different technologies under different vendors like KOMPAKAR, Systematic Conglomerate, etc.'
(Interview_6_HIS_B_HDIT)

Data Analysis

The configuration during installation determines whether HTIS can interact with external data even if underlying standards such as HL7 or DICOM are supported. Departmental HTIS is normally a stand-alone application, which requires custom-made interfaces (Hammond, 2005, p. 1207). One statement from a medical doctor supports Hammond's view:

'Based on what I am aware of, MoHM has already specified all HTIS or any procurement for information system must be compliant with HL7 and DICOM. Vendors are aware of that, and officials who endorse the application also know about that. In my opinion, since it has become a common rule for procurement of ICT, but still no interoperability of EHR happens, then I dare to say that standards is just a technical formality and it is not the main factor to enable interoperability. Like this hospital, for example, I know one vendor who was granted ICT projects for numbers of departments, but still those departments could not exchange the data simultaneously except by request, in which certain configuration must be made.' (Interview_13_HSP_C_DOC)

The above statement reports that vendor's configuration determines the ability of various departments to interoperate.

The second reason suggests that the limitation or absence of certain elements in standards contributes to the lack of interoperability of HTIS. The absence of a uniform Master Patient Index was an example given by one interviewee:

'The data integration only happens in their internal departments within the same hospitals. We may conclude that EHR in Malaysia is still not interoperable and [there are] no online inter-hospital relationships in Malaysian public hospitals. One patient who receives treatment at Selayang hospital, will not be able to access his medical record at Putrajaya hospital even though both of them have HIS or EHR systems. The Master Patient Index (MPI) is only stored locally at the hospital

where the patient receives the treatment and not shared over the different hospitals' networks.' (**Interview_2_div_A_AT**)

Quinn (2008) and Hovenga (2008, p. 163) suggest that the inability to access a complete data dictionary and model from different HTIS contributes to the failure to interoperate. A Master Patient Index is an example of a data dictionary that is required to be stored in a central server and be accessible to all HTIS before inter-hospital interoperability can be achieved.

The third reason proposes that closed and proprietary technology hampers interoperability even under the same standards.

'After the upgrade process, I think the integration process can be done more easily. It has become the policy for this hospital, for any proposal of ICT procurement, vendors are given chances to test the level of compatibility with our main system which are HIS. If the test is failed then the proposal will be rejected; if they are compatible then the proposal will be considered. Normally, the proposed system will be compatible with HIS if the system requirements are similar with CERNER technology and infrastructures.' (**Interview_6_HIS_B_HDIT**)

The use of different technologies leads to non-interoperability, especially under the MoHM's ICT procurement practice. ICT solutions are procured through different vendors who might use closed and proprietary technology. The above statement is an example of how difficult it is to achieve interoperability even with the same standards. The difficulty to achieve interoperability with a mixture of vendors' HTIS is acknowledged by Quinn (2008), who suggests that different platforms and system architecture contributes to a lack of integration.

B) Prospect for integration

This section discusses the potential for interoperability that is enabled by standards. Standards are recognised as technical tools to enable interoperability in two projects under the MoHM, namely telemedicine projects and MyHIX

Data Analysis

(Ministry of Health of Malaysia, 1997; 2011). Analysis of a report by MoHM (2011) describes MyHIX as a pilot project under the administration of the MDEC and the MoHM, that aimed to test the sharing of summary medical records across different health agencies. The selection of standards for interoperability, according to one high-ranking official, includes both clinical data and image standards.

'This process does take a long time and the MyHIX system may shorten the time for the referral cases. The main standards which are used to support this project are CDA, HL7, SOAP, and TLS.'

(Interview_3_div_B_BM)

The above statement mentions four standards/protocols that are used to support MyHIX. No further details were provided about those standards by the interviewee.

CDA or Clinical Document Architecture is an ANSI standard from HL7 that functions to postulate the syntax and framework of clinical documents. Examples of CDA application in clinical contents are Discharge Summary, Imaging Report, Admission and Physical, and Pathology report In other words, CDA is a package of HL7 (Blozana & Koncar, 2007, p. S426).

HL7 or Health Level Seven is one of several ANSI (American National Standard Institute) standards which is accredited by the Standard Development Organisation (SDO). It specialises in clinical and administrative data. Its name symbolises interoperability that occurs at level seven of the OSI (Open System Interconnection) model (Health Level Seven, 2011; Eichelberg et al., 2005, p. 285).

SOAP or Simple Object Access Protocol is a protocol that used to exchange information and data in distributed and decentralised conditions. Based on XML, it comprises three components, an envelope to define the blueprint for describing the message, encoding rules for conveying instances of defined data types, and a

Data Analysis

convention for representing distant procedure calls and responses (The World Wide Web Consortium, 2000).

TLS or Transport Layer Security is a successor of Secure Socket Layer (SSL) that provides communication security over the Internet between the server and the client using encryption techniques. It enables both the server and the client to authenticate each other while communicating and certifying the encrypted messages and cryptographic keys among them (Allaert, 2002, pp. 165-166).

The MyHIX project will be an indicator of the possibility that current health information systems can interoperate. One senior official in IT acknowledges the ability of different departmental HTIS to interoperate:

'The integration process will enable different information systems in various hospitals to access data from MyHIX system as their mother system where it will connect directly to the central database which is located at the MoHM.' (Interview_3_div_B_BM)

Given that one interoperability project (MyHIX) was successful. One question that needs to be asked is could all medical records be shared in this way? The answer is that Malaysian laws do not permit the sharing of EHR across different hospitals without the consent of patients and the government. One senior official in IT confirmed this:

'The main issue of this question is whether the medical legal policy allows the sharing of patient medical records. Currently, in Malaysia it is not permissible. The Ministry has done research on this matter, and it is decided that no details of patient medical records can be shared across the information system, except the summaries of the EMR. The summaries will include discharge, visit, encounter, episode and other summaries from EMR. If there is a need to share the details, formal applications must be made to the patient, and doctors. Therefore, the Ministry has come out with a project which aims to share the summaries

of EMR. The Ministry is aiming to gather all summaries of individual medical records and store them in national repositories.'

(Interview_4_div_B_BT)

The success of interoperable EHR and HTIS cannot be attained if no policy is enforced across Malaysian public hospitals. Those policies define the codes, procedures and processes according to the respective standards. One senior official in IT commented on this:

'A policy must be gazetted and synchronised. For example, the use of codes must be standardised, for example drug codes and diagnostic codes, and this includes the types of procedures to be used. We would not want to see a medical facility describe something but got a different meaning.' **(Interview_4_div_B_BT)**

To summarise, the fifth proposition has considered the issue of standards, and it seems that the success of interoperable EHR and HTIS cannot be attained if no policy is enforced across Malaysian public hospitals. Those policies define the codes, procedures and processes according to the respective standards. One senior official in IT commented on this:

'A policy must be gazetted and synchronised. For example, the use of codes must be standardised, for example drug codes and diagnostic codes, and this includes the types of procedures to be used. We would not want to see a medical facility describe something but got a different meaning.' **(Interview_4_div_B_BT)**

5.7 Sixth proposition

This proposition suggests, 'Open-source technology requires supporting variables before it can be used in Malaysian public hospitals despite its notion of being open and free'.

The proposition seeks answers to the following questions:

1. What is open-source software according to the understanding of the MoHM?
2. What are the supporting variables for open-source technology?

3. Are those supporting variables manageable?

The supporting variables in this proposition refer to features, elements, or factors that are involved in adopting open-source technology in Malaysian health care. The identification of the variables assists the researcher to understand the reasons that open-source technology is still not fully exploited to widen the use of ICT in health care.

In seeking the answers, the following sections related to the theme THE REALITY OF HTIS IN MALAYSIAN PUBLIC HOSPITALS conceptualise the discussion.

5.7.1 The key terms in open-source technology

A few key terms in open-source software guide the discussion of this proposition: open source, free and open-source software (FOSS) licences and proprietary software. Three main sources are used to define the terms. The first source is The Free Software Foundation (FSF) webpage (www.fsf.org) and the second is the Open Source Initiative homepage (opensource.org), and finally published articles about open-source software. The application of these terms to the proposition's findings is through comparing what the interviewees have suggested with notions of the terms.

5.7.1.1 Open-source software and free software

Laterally, free software and open source are defined as two different entities but with shared concepts and foundations. The FSF (2011) is an organisation that believes in free software, whereas the Open Source Initiative also believes in other aspects. The FSF upholds the concept of freedom in the software environment, which gives users the freedom to use software according to these four conditions (Hemphill, 2005, p. 486).

1. The freedom to run the program, for any purpose (freedom 0).
2. The freedom to study how the program works, and change it so it does your computing as you wish (freedom 1). Access to the source code is a precondition for this.

3. The freedom to redistribute copies so you can help your neighbour (freedom 2).
4. The freedom to distribute copies of your modified versions to others (freedom 3). By doing this you can give the whole community a chance to benefit from your changes. Access to the source code is a precondition for this.

Richard Stallman (2009, p. 31), who is a founder of FSF, considers free software to be a '*social movement*', whereas open-source software is '*development methodology*' that promotes powerful and reliable software. His definition reflects the ethical values of free software that promotes freedom among humanity.

The Open Source Initiative (2011) defines open-source software as software that is developed according to these ten principles:

1. Free distribution of software
2. The availability of source codes including the compiled form.
3. Derived works; modification and distribution under the same terms of the original software must be allowed.
4. Integrity of the author's source code
5. Discrimination against persons or groups is not allowed.
6. Discrimination against fields of endeavour such as business or research is not allowed.
7. The distribution of software is employed equally without a need for an additional licence.
8. The licence must not be specific to a product or part of a particular software distribution.
9. The licence must not restrict other software that is distributed along with the licensed software. Integration to other software requires the same licence (general public licence)
10. The licence must be technology neutral and not be predicated on any individual technology or style of interface.

The Open Source Software unit of MAMPU also applies these ten principles in defining OSS technology for the Malaysian public sector (OSCC MAMPU, 2011).

The similarity between these two initiatives is that both are working towards developing free software with permission to share, use, modify and improve the software for the betterment of the community (Stallman, 2009, p. 32). Hemphill (2005, p. 486) suggests that the distinction between free and open-source software is in the perception of how the software should be shared. According to him, the Open Source Initiative philosophy excludes a price for access to software, whereas free software gives users the ability to use the software freely.

5.7.1.2 Free and open-source software (FOSS) licence

The basic concept of the FOSS licence is ‘copyleft’. This is the opposite of copyright. A copyleft licence sets conditions before the software can be distributed and modified. One example of a condition is to make sure the software remains free before and after modification. FOSS can have a strong or weak copyleft, or even no copyleft at all. However, the same principle applies, which is to create a large pool of software that permits the integration, combination, modification and creation of new software (Fontana et al., 2008, p. 4).

Fontana et al. (2008, pp. 4-8) classifies four types of licence that are applicable to FOSS. The first category is the GNU, General Public Licence. This licence has been used by most FOSS since 1991 and is also known to have strong copyleft. The suitability of this licence depends on the nature of the project and its aims. If the software developer wants his project to be supported by a large number of existing libraries and technical support, this licence offers a great deal, because many FOSS are under this licence. Linking with other FOSS offers more exposure to large libraries and codes. This licence also promotes the notion of freedom and sharing, which are supported by both free and open-source software initiatives.

The second category is a Permissive Licence, also known as BSD-Style. This licence sets a minimum restriction on later development and distribution, which does not require source code distribution unlike the first licence. Under this

licence, other developers are allowed to incorporate the FOSS in their closed-source and proprietary products, and conceal the modifications they made to the FOSS codes. This licence is more tolerant in redistribution and incorporation even with proprietary software. It also does not promote strong copyleft in software distribution, because it permits modifications to the original source codes to be concealed.

The third category is the GNU Lesser General Public Licence. This is a weak copyleft licence for FOSS because it permits incorporation with proprietary software in software distribution. It is also considered to be intermediate between the first and second category.

The last type of FOSS licence is the GNU Affero General Public Licence (AGPL). This is a modified version of the GNU General Public Licence, which reviews the sharing of source codes. The sharing of source codes applies only when the software is directly distributed in an object code from/to a user. This also applies for interactions that do not require the source codes to be shared. An example of such an interaction is the client/server relationship. The client does not need to have the source code from the server in each interaction.

These four categories of licence are the references to discuss the proposition's findings.

5.7.1.3 Proprietary software

Proprietary software reflects the ownership of the software by an individual or organisation. Ownership is defined under intellectual property and copyright protection (Hemphill, 2005, p. 485). Intellectual property defines how the software can be distributed and used. Distribution and use is allowed through purchasing with a specific number of users and installations (Baird, 2008, p. 232). Davidson (2004), who represents the World Intellectual Property Organisation (WIPO), defines proprietary software as a type of software that is distributed in binary and executable form, whereby only developers or companies have access to the source code.

The Malaysian Copyright Act 1987 (p. 34) defines proprietary software as work that is guarded by law from reproduction, copy and use without consent (purchasing) from the owner of the programme. The use of proprietary software in the Malaysian public sector is a multi-million dollar operation . In 2008, by using OSS, the Malaysian public sector saved up to RM40 million (MAMPU 2009), and in 2010 the saving was RM200 million (Utusan Malaysia, 23rd August 2010). For the MoHM, the saving by using OSS is about RM5 million under an email client server application (MAMPU, 2009). Therefore, MAMPU has proposed that OSS is able to contribute economically to the Malaysian public sector. The following section discusses the application of OSS in Malaysian health care based on quotations on the theme and literature analysis.

In relation to the proposition, this section provides an insight into users' perceptions of open-source software. It guides the researcher in his effort to explain open-source software in Malaysian health care.

5.7.2 The application of open-source technology in Malaysian health care

This section discusses the reality and feasibility of using open-source software in Malaysian health care. The perceptions are based on the experiences of ICT administrators and physicians who are involved directly in using, managing, handling and administering ICT adoption in Malaysian health care. The discussion assists the researcher to decide whether the findings support the proposition in theme-matching data analysis. The quotations on the theme suggest two supporting variables that should be improved before this technology can be widely used in Malaysian health care.

Table 5.7.2: The supporting variables in the application of open-source technology in Malaysian health care

| Categories | Number of occurrences in all interviews |
|---|--|
| Financial and licensing implications | Eleven times |
| The directives for open-source software | Ten times |

5.7.2.1 Financial and licensing implications

These two issues are synonymous to open-source software. The purpose of the interviews was to disclose whether ICT adoption in Malaysian health care can benefit from open-source software (OSS). The financial implication refers to the perception that open-source software can reduce ICT procurement costs. The licensing implication is an understanding that open-source software is a solution for vendor-strict licensing requirements in ICT procurement. The contents of the eight quotations on the theme can be categorised into two sub-issues. The first is hidden cost in open-source software projects and the second issue is vendor contractual agreements. Table 5.7.2.1 describes these two sub-issues and the number of occurrences in the interviews.

Table 5.7.2.1: The issues of financial and licensing implications

| Categories | Number of occurrences |
|----------------------------------|-----------------------|
| The hidden cost | Four times |
| The vendor contractual agreement | Four times |

A) The hidden cost

The hidden cost refers to financial liability that is incurred during the development and maintenance phase of health solutions using OSS. Two different perspectives are derived from studies in OSS and its relation to cost liability in government projects. The first perspective suggests that OSS provides affordable and economical liability in ICT projects (Carnall, 2000). His suggestion on the economical liability is also supported by the extract from MAMPU's circular (2009) that suggests OSS does reduce the government's ICT expenditures. Other literature is sceptical about the economic feasibility of open-source software used by government agencies (Ven, Verelst & Mannaert, 2008, p. 55; Warring & Maddocks, 2005, p. 421).

The proponents of open-source suggest the huge opportunity for government agencies to exploit this technology. Carnall (2000), for example, reports how open-source technology financially saved Walton NHS Trust in 1995 through its ability to migrate all the data from the legacy systems after the proprietary

vendors called off the projects. However, those who are sceptical believe that there are hidden costs before and after implementation. Warring and Maddocks (2005, p. 421) and Young (2004) agree that other factors such as human resource competency contribute to the hidden cost of open-source.

One interviewee perceived that the hidden costs even started during the development phase:

'In an application development, JAVA applet, which is J2EE, for example, if we try to compare J2EE with .NET, we will find that in .NET, to describe one procedure normally we only need to write ten statements, but in J2EE normally we need to write 100 statements. So, if the developer cost is based on how many codes per line, which one is more expensive? For sure, open-source is more expensive.'

(Interview_4_div_B_BT)

The above statement illustrates an example of how hidden costs might be incurred by using OSS. This situation is supported by Ven, Verelst and Mannert (2008, pp. 54–55), who suggest that there is no zero-cost liability in OSS. An example of a hidden cost is dual licensing OSS. Dual licensing companies such as MySQL require all software developed using its database application to be licensed under GNU GPL, whereby its source codes must be made available. In order to keep the intellectual property of the software, the clients or vendors must pay MySQL for the commercial licence so that the software can become private.. This practice is in alignment with the provision of laws under FOSS licences as discussed in section 5.7.1.2.

One head of a medical record department also demonstrated a sceptical view of cost reduction using open-source technology:

'It is not that easy; first of all we do not have expertise to develop the system in-house. If we would ask vendors to develop the system for us using the open-source technology, still a proposal must be prepared for

endorsement by the central committee at MoHM. In the end, open-source technology will be the same like proprietary software. Unless the MoHM manages to improve the version of Patient Management Systems (PMS) into comprehensive HTIS and roll it out at all hospitals that are still not equipped with HIS or HTIS, I think it will be all right.'
(Interview_8_HSP_C_HDRM)

The above statement suggests that holistic changes in every aspect of ICT administration before OSS can contribute to a cost reduction in ICT procurement. The findings by Cassell (2010, pp. 229-230) agree that open-source software is not about cost reduction but is interrelated with other factors. He suggests four factors: collaboration among governments; greater liberation from commercial software providers; greater flexibility and security; and improved local economic development. According to him, after solving these issues, cost reduction from open-source software is achievable.

Based on the above discussion, it is clear that hidden costs in open-source technology are inevitable unless a few changes are made to the MoHM's ICT procurement methods. Two changes are needed to reduce costs in software development for the MoHM:

1. The mindset of those who manage ICT procurement in the MoHM must change from believing in the feasibility of hiring proprietary vendors to employing open-source vendors who comply with the ten principles of OSS as highlighted in section 5.7.1.1.
2. All procured open-source software must be licensed under a Permissive Licence or BSD-Style to reduce the requirement to share the source codes or involve dual licensing companies such as MySQL. This is because most health care solutions, especially EHR, requires databases to store the data, and licensing under this licence is economical, as suggested by section 5.2.6.1B.

Data Analysis

In relation to the proposition, no consensus agreement from the literature recognises the financial feasibility of open-source software. It appears that before it can be financially feasible, other factors are needed to support it.

B) The vendor contractual agreement

The vendor contractual agreement refers to the licensing specification that formalises the nature of ICT procurement. The prohibition of expanding installation into different government agencies is a limitation of proprietary software. The OSS licence that permits redistribution and sharing is an advantage to government agencies, which removes the limitation of proprietary licences (Oram, 2011, p. 241).

Almost all interviewees admitted that HTIS procurements based on a proprietary licence were very strict and that installation to other health agencies is not permitted. One interviewee mentioned:

'The drawback from this procurement process is that the Ministry does not own the intellectual property of the product including the licence, as it belongs to the vendor, and any rolling out to other hospitals requires permission from the vendor.' (**Interview_2_div_A_AT**)

However, this statement portrays a misunderstanding of the issue of ownership. The circular by the Ministry of Finance of Malaysia (2011) and Section 26 (3) of the Copyright Act 1987 (p. 36) clearly state the ownership of the software by the Malaysian government. The misunderstanding, however, might be resulted from the unresolved problems faced by the MoHM's administrators in dealing with vendors.

Nevertheless, the above statement might be true for the installation process, because the agreement specifies the location. An example is the agreement between Kersuma Nyata Sdn Bhd and the Ministry of Energy, Green Technology and Water (2010, p.22). The agreement confines software installation to specific places and further installation is not allowed without consent from the vendor. The installation must follow the agreed contract, and if the MoHM would like to

roll out the application to other health agencies, a certain payment is required. One head of an IT department confirmed this:

'Therefore, it is not permissible to install the application at other hospitals even if they are under the MoHM. If there is a need to install the application, different payment should be paid to the vendor under a new agreement.' (Interview_5_HIS_A_HDIT)

In response to that, the MoHM has developed an in-house project known as the Patient Management System (PMS). It is a limited version of HTIS with nine modules, as illustrated in section 3.4.1. According to one IT official, the MoHM intends to transform this HTIS into an OSS licence. She said:

'Through the adaption of current technology into an open-source version will allow the Ministry of Health of Malaysia to expand the use of Patient Management System to all health agencies under the Ministry without a need to obtain licensing from the vendor. The Ministry had stipulated the use of open-source technology so that the application will be under an open-source public licence. With that licence, the Ministry has a right to install it at any hospital under the Ministry.' (Interview_2_div_A_AT)

However, how can the MoHM transform proprietary technology into open-source? The interviewees were unable to respond to this question. According to the literature, two methods can be used for transformation. The first method is through changes in licensing criteria (Krishnamurthy, 2003, p. 50; Fontana et al., 2008, pp.4-8; Kilamo et al., 2011) and secondly by accessing the source codes (West, 2003, p. 1264; Lerner & Tirole, 2002, p. 223; Janamanchi et al., 2009, p. 470).

Based on the above discussion, transforming the licence into OSS licences is a feasible approach to permit sharing the PMS across different health agencies. Based on the recommendation in section 5.7.1.2, licensing the software in GNU GPL is not feasible because its copy-left requires the software to be distributed and source codes to be shared. The last two licences (Permissive and GNU Lesser

General Public Licence) are flexible to support the plan of transforming PMS into OSS.

In relation to the proposition, this section portrays the supporting variables that need to be managed before open-source software is feasible for Malaysian health care. The issues of hidden costs and modification of the licensing under open-source software are examples of variables in adopting OSS.

5.7.2.2 The directives for open-source software

The directive for open-source software refers to the commitment to adopt OSS in Malaysian health care. It also reflects the level of seriousness to adopt OSS in HTIS and EHR systems used in Malaysian public hospitals. An extract from MAMPU (2007, p. 8) suggests the commitment of Malaysian government to widen the use of OSS in the public sectors. As a start, MAMPU stipulate three conditions for OSS implementation in the Malaysian public sectors. The conditions are listed below:

1. Open-source software fits the purpose in terms of functionality as well as the technology platform.
2. Open-source software is least disruptive to the current business operations.
3. Open-source software must have the capability to co-exist with other legacy systems/solutions.

The quotations on the theme show two different reactions to the commitment of Malaysian government. Table 5.7.2.2 describes these reactions.

Table 5.7.2.2: Reactions to the OSS directive

| Categories | Number of occurrences |
|-----------------------------|------------------------------|
| Acceptance of embracing OSS | Four times |
| Resistance to embracing OSS | Six times |

A) Acceptance of embracing the OSS adoption policy

This section outlines the requirements that the MoHM needs before harnessing OSS in its health care. The establishment of a policy is one requirement that

Data Analysis

determines the success of OSS adoption. The success of adopting new technology in a developing country depends on how strong the policy is to motivate users to embrace the technology (Ehikhamenor, 2002, p. 618). His statement is based on a socio-factor study in Nigeria of the adoption of ICT in the media sector. Another study by Câmara and Fonseca (2008, p. 130) also suggests the same factor. Their study focuses on adoption of OSS in Brazil. Despite all the benefits, success is still unattainable because no public policy supports OSS.

When asked about a directive to widen the use of OSS, one senior official was aware of the policy:

'It has been a current policy for the Ministry to encourage the use of open source in operating applications, and any new purchase of computer by using the open-source application such as open office, Linux and red hat. We already have the policy. However, in certain cases, the Ministry did approve the proposal to procure proprietary software if health agencies could convince the committee of the needs to have that software with justified reasons.' (Interview_1_div_A_AM)

Based on a remark in the MoHM's newsletter (2008, p. 21), it appears that the policy is just an encouragement and not full enforcement. This situation might be due to three reasons. The document analysis from MAMPU's circular (2006b, pp. 44-45) describes these reasons as challenges to implementing OSS in the Malaysian public sector. The first reason is related to the nature of ICT procurement in health care. An ICT solution is procured to support two entities, medical devices and hospital operations. Most medical devices such as PACS or laboratory equipment rely on proprietary software, which not many OSS can support. The second reason is leniency and exceptions in the guidelines that permit the procurement of proprietary software for special devices and requirements that OSS cannot provide. The third reason is a lack of OSS proponents in the tender evaluation process at the agency. As a result, proprietary and OSS-based technology is treated as the same tender. These challenges promote resistance to embracing OSS in the MoHM.

The Malaysian public sector has shown high penetration of OSS into its services. Based on the latest data from MAMPU (2010d), there are 3,154 OSS projects in both federal and state agencies. Nevertheless, there is also low adoption of OSS by the MoHM. Figure 5.7.2.2 describes the number of OSS projects in the MoHM.

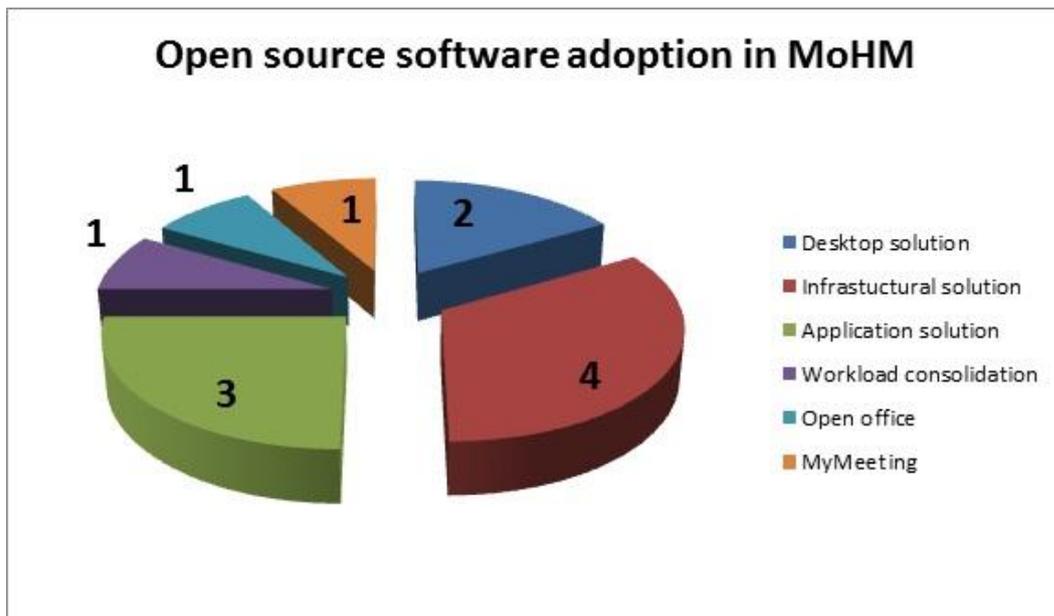


Figure 5.7.2.2: OSS implementation in the MoHM (MAMPU 2010d)

The details of this OSS are listed below:

1. Patient Management Systems (PMS)
2. Email client server
3. Web browser
4. Database
5. Content Management System
6. Clinical Resource Management
7. Firewall
8. Operating System virtualisation
9. Cube Application
10. Financial Assessment System
11. PHP
12. MySQL

B) Resistance to embracing the OSS adoption policy

This section highlights examples of resistance that distorts OSS adoption in the MoHM. The discussion supports what has been suggested by MAMPU (2006b, pp. 44–45) about the challenges to implementing OSS in the Malaysian public

sector. An opinion from one senior official in IT is an example of a negative reaction to the policy:

'The end users are not interested in the type of technology being used, whether it is JAVA or open-source technology. The most important for them is usability and uniformity of the system. Regardless of the location of the hospital, they want to see a uniform patient registration module, in which standards is the main player. They are not interested to hear any recommendations from MAMPU, for example, about directives to use open-source software in government agencies. For me, I see that recommendation is baseless without proper research.'

(Interview_4_div_B_BT)

According to MAMPU (2006b, pp.44-45), this resistance is a human-based challenge, which is due to five factors. The first factor is resistance to change. The issue of change management is discussed in the eighth proposition under section 5.9.1.1. The second factor is insufficient skilled personnel in OSS for technical support. Much of the literature highlights this issue and considers it as a challenge to adopting OSS in an organisation (Oram, 2011, p. 249; Ven, Vereist & Mannaert, 2008, p. 56; Young, 2004). The same official also highlighted the vacuum in technical skills among ICT administrators:

'We should understand that in the open-source technology, we should become the master of our own, then we can make it free and open. The master of our own is more towards the personal use and not for the organisational use. That's why I do not think open-source software is free for the business-oriented organisation. It is only applicable for the home users, like developing the home inventory then making it open and freely available for everybody to download. For example, MySQL database, it is free for the home user but for the commercial purposes, it is not free. The main drive for software development is business.'

(Interview_4_div_B_BT)

Data Analysis

Another reaction was also from the same official, whose opinion was in alignment with the findings of Ven, Vereist and Mannaert (2008, p. 55):

'In my opinion, the recommendation is made without evidence from proper research. If they did proper research, there is no special advantage from the use of open source. Will the development cost be reduced from RM100 into RM10 with the use of open source? The answer is no. Will the maintenance cost be reduced from 10% into 0% with the use of open source? The answer is still no. Therefore, what are the advantages of using the open source if all those things remain unchanged? The Malaysian mentality is still not achieving the actual open-source mentality, what we are looking is the free source, and not open source. We are still lacking in understanding of the real concept of open source.' (Interview_4_div_B_BT)

Ven, Vereist and Mannaert (2008, p. 55) highlight the issue of hidden costs in OSS adoption. The above statement also shows the scepticism of the interviewee about the reduction in costs by using OSS. It appears that he is not aware of the RM5 million cost reduction made by the MoHM every year by using an OSS email server known as MoHM CUBE Application (MAMPU, 2009, p. 6). It also shows how the OSS directive does not interest or is not well understood by all managerial levels in the MoHM.

Another reaction is the perception that it is unsuitable to adopt OSS under outsourcing practice. Outsourcing through vendors does not embrace the true concept of OSS. One head of a medical record department acknowledged this situation:

'I am not an expert to technically comment about this technology, but I think there is no big difference to open-source software or commercial software as long as MoHM is still using an outsourcing approach through vendors to procure ICT facilities. If, let's say, a vendor is using open-source software for a health care solution, I think still MoHM could

not easily roll out the software to any hospital without getting approval from the vendor. If that is the case, what is the significance of using open-source software? Unless there are experts among officials of MoHM who are able to develop in-house health care solutions using open-source software and make it open for all health agencies under MoHM to use it, then I agree on the benefits of open-source software.'

(Interview_7_HIS_B_HDRM)

The above statement concerns two things: software development and licensing. These issues require a solution for how to manage outsourced OSS through vendors. Mann (2006, p. 14) describes this method as the 'commercialising of open-source software'. Developing proprietary software under the OSS platform is common practice under this notion. In the MoHM, almost all ICT procurement is outsourced through vendors. The distribution of source codes is only applicable if the software is licensed under GNU GPL, but if the software is licensed as dual licensing or Permissive BSD, the distribution of source codes is not compulsory. However, the document analysis from MAMPU's circular (2006a, p. 55) suggests the guidelines to solve the problem:

1. The obligation and limitations in OSS licensing is only restricted to modification and not use of OSS.
2. Rights to use the software do not impose the same obligation as to the distribution of the modified versions.

This reaction is also another example of a failure to disseminate the correct information about the directive.

The lack of research in open-source technology is another negative reaction to the OSS directive. The same official made this comment:

'I am also not sure whether MoHM has conducted enough research to evaluate the feasibility of this technology. Coming back to the point which I highlighted on the difference between open-source and proprietary software, which I believed there is no difference between them. I also think there must be enough experts at MoHM level who are able to explore this technology.' **(Interview_7_HIS_B_HDRM)**

However, this opinion is less accurate and contradicts data from MAMPU. There have been thousands of case studies with regard to OSS implementation in the Malaysian public sector. The latest statistical data from MAMPU (2010a) shows a total of 3,154 OSS implementations, with 1,319 in federal government agencies and 1,835 in state government organisations. Nevertheless, these OSS projects may not represent the important issues that need to be highlighted by OSS research.

To summarise, in relation to the proposition, the discussion identifies other factors that need to be considered by the MoHM in its efforts to widen OSS. The factors include strong policy and justifiable solutions to manage resistance to OSS adoption. Human-based challenges are examples of variables that need to be tackled wisely in OSS adoption.

5.8 Seventh proposition

This proposition suggests, “The willingness of physicians to use the hospital information systems contributes to successful interoperable EHR implementation”.

The proposition seeks answers to the following questions:

1. What are the factors that affect the level of acceptance of physicians?
2. What are the benefits of using EHR systems and HIS for physicians?

In seeking the answers, the following sections related to the theme USER ACCEPTANCE AND ATTITUDE conceptualise the discussion.

The resistance to accept ICT by physicians or service providers is a common problem in health care. The World Health Organisation (2006, p. 29) suggests reasons behind the resistance. The impediment to changing to working with computers and a lack of skills to use computers are the main reasons behind the resistance. The quotations on the theme suggest three issues to explain the findings.

5.8.1 The factors that affect the level of acceptance

This section discusses the factors that affect the acceptance level of physicians of hospital information systems. The factors refer to situations and reasons that stimulate or put off physicians from using the HTIS or EHR systems. The level of acceptance refers to physicians’ willingness to change their working style and mindset to adapt ICT into their professions. The discussion assists the researcher to decide whether the findings support the proposition.

The quotations on the theme classify three issues that affect the level of acceptance. Table 5.8.1 describes the categories and number of occurrences in all interviews.

Data Analysis

Table 5.8.1: Classification of quotations that discuss factors affecting acceptance

| Categories | Number of occurrences in all interviews |
|----------------------|---|
| Attitudes | Sixteen times |
| Incomplete processes | Nine times |
| Support | Nine times |

5.8.1.1 The attitudes of physicians in perceiving ICT

This refers to the reaction of physicians to handling the computerised environment in their workplace. The computerised environment includes HTIS and EHR systems. Their reactions portray the actual acceptance level among Malaysian physicians. The foci of discussion from the sixteen quotations are categorised into two types. Table 5.8.1.1 describes the categorisation.

Table 5.8.1.1: Categories of discussions

| Classification | Number of occurrences in interviews |
|---|-------------------------------------|
| The resistance to change in working style | Nine times |
| The physician's perception of ICT and reactions to technical problems | Seven times |

A) The resistance to change in working style

The change in working style refers to attitudes of physicians in adapting to new working styles from paper-based to EHR. The number of hospitals still using paper-based systems indicates the high number of doctors who are still using paper-based records. The transformation is not easy. This is acknowledged by one senior official of IT based on his experiences of requesting doctors to use HTIS.

'Another issue is related with the obstacles in implementing HIS. It is not an easy task. For example, to ask a person who has been years writing something with a pen to use a keyboard is not easy. Therefore, for those who are going to be changing management in any hospitals or health

care agencies must have a strong determination.'

(Interview_4_div_B_BT)

The refusal by physicians to change their working style is well known in developing countries. It is considered to be resistance to computer technology among physicians (World Health Organisation, 2006, p. 28). Ludwick and Doucette (2009, p. 6) discovered that unfamiliarity with HTIS and a lack of training are the factors behind this resistance. The refusal by physicians to change their mindset also contributes to the resistance to EHR in Malaysia (Abd. Ghani et al., 2008a, p. 90).

One junior doctor suggested that seniority and age determines the level of acceptability to change:

'Based on my observation, junior doctors like myself are competent with the system, maybe because we are familiar with computers. Senior doctors, especially those who transfer from paper-based hospitals, are more reluctant and uncomfortable with HIS. But since it has become a policy for this hospital for all doctors to use HIS, so I think after some time there shall be no problem for them.' **(Interview_10_HIS_A_DOC)**

There is no consensus in the literature to suggest the contribution of age in determining the level of acceptance. The preliminary findings of many studies show a correlation between age and the tendency to resist. However, the correlation turns out to be insignificant after other variables are analysed. Age alone is not a determinant factor, because it is influenced by a lack of training and exposure to computers (Detmer & Friedman, 1994, p. 560; Morton & Wiedenbeck, 2010, p. 4;). The first fully computerised hospital with HIS in Malaysia appeared in 1997, 50 years after the hospital opened, however those doctors who graduated in the 1970s are still in service. Their exposure to computerisation is incomparable with medical graduates of the 2000s. This scenario explains some of the resistance by some senior doctors, as highlighted in the quotation.

In relation to the proposition, the resistance to adopt HTIS among physicians results from their refusal to change their working style, for example resistance among senior doctors. The discussion also highlights the positive reaction from junior doctors to HTIS use, which is due to their technological exposure from the beginning of their medical careers.

B) The physicians' perception of ICT and their reactions to technical problems

The physicians' perception of ICT refers to their stand on whether ICT benefits or detracts from their work. ICT in this section refers to HTIS and EHR systems. Their perceptions are normally based on their experiences of handling ICT or facing problems because of ICT. The quotations also discuss the perceptions in those two directions. One head of an IT department reported the positive attitude of physicians to using ICT:

'For the time being, our doctors seem to be quite comfortable using HIS in their work. For new medical staff attached to this hospital, a series of training will be conducted. The training is conducted by IT department once a month.' (Interview_5_HIS_A_HDIT)

Training is acknowledged by the literature as contributing to a positive perception and acceptance by physicians (Gagnon et al., 2010; Yarbrough & Smith, 2007, p. 664; Gravel, Légaré & Graham, 2006; p. 9).

Technical disturbance also influences physicians to have a negative perception of ICT. One head of an IT department reported this situation:

'The main problem for us is when the system breaks down and we [the IT department] could not sort the problems in a short period of time; then we feel disappointed and feel the need to have both manual and paper-based system used together.' (Interview_5_HIS_A_HDIT)

The literature also supports the above quotation. Holden and Karsh (2010, p. 164) tested four theoretical models that explain physicians' acceptance of ICT. They conclude that technical infrastructure and support are the facilitating conditions

that influence physicians to accept ICT in their work. Work by Schaper and Pervan (2007, p. S216) also discovered the same findings, even for different health professionals, i.e. Australian occupational therapists.

The efficiency of paper-based records also influences the perception of the use of ICT in health care. One head of a department of medical records commented:

'...why should we have EHR systems, if our staff manage to retrieve records in our manual systems in less than five minutes? Current retrieval systems still do not give any problem to us, and it is quite costly to have a new EHR system because HTIS or HIS are not cheap.'
(Interview_8_HSP_C_HDRM)

The above comment was given by a HOD of medical records in a paper-based hospital. One medical doctor in the same hospital also agreed with this perception:

'It depends because currently I have no problem with current procedures using paper-based records. They are retrievable in a reasonable amount of time and easy to manage. Maybe the problems from paper-based is space for storage. Using information system will maybe double up my work because I need to key in the data to the system. I know my friends who work at Putrajaya hospital are required to key in the data to the laptop while visiting the patient. I am not IT savvy, therefore I consider computerisation is not facilitating my work as a doctor.'
(Interview_13_HSP_C_DOC)

Shabbir et al. (2010, p. 287) conducted a comparative study to identify the time consumption of physicians using paper-based and electronic medical records. The study showed no significant difference in the time spent between paper-based and electronic medical records, even in a crowded hospital. A contradictory quantitative study by Mohd and Mohammad (2005, p. 81) however suggested that benefits can be enjoyed by Malaysian physicians from EHR. However, the

study was conducted in a hospital that already used HIS and not in paper-based hospitals.

5.8.1.2 The incomplete phases of ICT procurement

This topic refers to the outcome from EHR implementation processes that diminish physicians' interest in using HTIS and EHR systems. The incomplete phase of ICT procurement is a result of piecemeal applications and layers of endorsement. The nine quotations under this section classify the discussion into two types. Table 5.8.1.2 describes the classification.

Table 5.8.1.2: Categories of discussions

| Classification | Number of occurrences in interviews |
|---------------------------|--|
| The duration for approval | Four times |
| The flow of the process | Five times |

The second proposition discusses the nature of procurements that includes some of the quotations on the theme. This proposition focuses on how the processes involved in ICT procurement affect the level of acceptance by physicians.

Analysis of MoHM's circular (2009c) suggests the specification of all proposals that involve new procurements of software or hardware require three layers of endorsements before the final decision. The endorsers are namely the appraisal committee of the MoHM; the ICT Steering Committee of the MoHM; and the committee at MAMPU. Each committee has different roles and endorsement powers. The circular also has specified the composition of those committees. The Appraisal Committee of the MoHM comprises IT officials, and they are the project managers for all ICT projects under the MoHM. The Appraisal Committee of the MoHM evaluates each proposal from health agencies. The MoHM ICT Steering Committee consists of high-ranking officers ranging from Deputy General Secretary of the MoHM until the Under Secretary of the respective divisions. The committee at MAMPU includes high-ranking officials that range from Deputy Director General to the directors of the respective divisions.

Data Analysis

In relation to the proposition, these layers sometime contribute to delay for the approval. One medical doctor described an example of long waiting time because of these layers:

'I still remember, there was a need to have supporting clinical software for a new medical device; it took quite some time before the software can be purchased because there were many committees at MoHM level that assessed the proposal. Therefore, I do not know whether the claim that politicians determine ICT procurement is true or not.'
(Interview_12_HIS_A_DOC)

The explanation to verify the relationship between 'waiting period' and 'physician's acceptance' is discussed by Fendrick and Schwartz (1994, p. 74). They suggest that the intention to improve health service delivery to the patient contributes to the willingness of physicians to use ICT. As a result, any delay of acquisition affects their acceptance level. The above quotation supports this suggestion. The implementation procedures that involve policy makers, service providers and physicians also contribute to the level of resistance by end users of HTIS (Mohd & Mohamad, 2005, p. 76).

The limitation in financial allocation and technical support are among the reasons for delays in decision-making. One senior official of the IT department in the MoHM said:

'The reality is doctors need to understand how things are prioritised in ICT projects. The prioritisation happens due to the limitation in budgets and expertise. This understanding will enable them to realise the problems in HIS projects and why most modules are done in stages or piecemeal.' (Interview_2_div_A_AT)

The above quotation explains the relationship between incomplete phases of ICT procurement and the level of physicians' acceptance of ICT. In relation to the proposition, there is an indicator that incomplete phases of ICT do affect physicians' perceptions of the feasibility of HTIS.

5.8.1.3 Supports for HTIS and EHR implementation

There are expressions in the quotations on the theme that link the inadequacy of support and the level of physicians' resistance. Table 5.8.1.3 illustrates the classification of infrastructural inadequacy.

Table 5.8.1.3: The classification of infrastructural inadequacy

| Classification | Number of occurrences in interviews |
|-----------------------------|-------------------------------------|
| Technical support | Five times |
| The inadequacy of resources | Four times |

A) Technical support

System breakdown or disruption of medical data for technical reasons causes dissatisfaction among physicians. One head of an IT department confirmed this situation:

'The main problem for us is when the system breaks down and we [IT department] could not sort the problems in a short period of time, then we feel disappointed and feel the need to have both IT and paper-based systems used together.' (Interview_5_HIS_A_HDIT)

A qualitative study by Ismail (2010, p. 23) acknowledges the occurrence of system breakdown in hospitals with HIS. The above statement and this finding show that infrastructural inadequacy is an unresolved problem for all hospitals in Malaysia, even HIS hospitals. In another qualitative study, Ayatollahi et al. (2010, p. 195) suggests that the high expectation for HTIS robustness causes dissatisfaction among physicians whenever system downtime occurs.

The backup mode for HIS is used during a system breakdown. However, the functionality is not robust to support a high level of data transactions. One medical officer reported his experience dealing with a system breakdown:

Data Analysis

'There are some problems that they can resolve instantly, which only take a while. For the major problem, I think they still need to hire outside contractor to do the job. When there is a problem related to HIS that IT department could not resolve it, they will activate the backup HIS. However, this backup HIS could not support the large data retrieval unlike the normal mode of HIS.' (Interview_10_HIS_A_DOC)

The technological obsolescence to support new technologies is another concern that can cause the physicians' resistance. One head of an IT department commented on this:

'The HIS of this hospital is quite stable and very rarely a problem arises, but since the system is already nine years old and the hardware is almost obsolete and many technologies are not supporting this HIS, then upgrading is a must. Otherwise, this department will receive complaints from a senior specialist about the delay to have a new system for her equipment.' (Interview_5_HIS_A_HDIT)

According to Narayana et al. (2010, p. 207), technological obsolescence is also a threat for HIS implementation that can lead to untrustworthy systems. They define technological obsolescence as 'antiquated or out-dated infrastructure such as hardware, application software, and network equipment which can lead to unreliable and untrustworthy systems'.

B) The inadequacy of resources

The inadequacy of resources to implement HTIS and EHR systems can cause resistance among physicians. The quotations link inadequacy of resources to the limitation in financial resources. One senior IT official commented on this:

'In ICT procurement, cost and financial allocations are of primary importance. For example, in HIS procurements, it needs to be integrated into the medical devices or hardware, which are normally being done piecemeal due to the limitations in budget. The support of the medical

Data Analysis

hardware is very expensive, plus ICT is a costly business. The delay to integrate HIS into the medical hardware as a result of limitation in financial and technical support have caused grief among the doctors who are the users of the system.' (Interview_2_div_A_AT)

In another quantitative study of 55 British physicians, Horsley and Forster (2005, p. 482) suggest that cost and time are factors that contribute to the acceptance of ICT technology. Although, Yarbrough and Smith (2007, p. 659) consider the number of samples of Horsley and Forster's study to be insufficient for generalisation, the above quote adds weight to Horsley and Forster's suggestion.

One medical official believes that ICT is just a tool to assist doctors in delivering health services to the patients. This is a response to the financial limitation to support national implementation of ICT projects for all public hospitals. He said:

'Coming back to your question, whether I think a national project will assist the implementation or not. How much money will government spend to build up those infrastructures? I think EHR or HTIS are just tools to assist doctors, and they are not the ultimate objectives for us as doctors. The most important thing for us is the medical facilities, medicines and hospitals that can be used to deliver health services to patients. ICT is just a complementary tool.'

(Interview_11_HIS_A_DOC)

This perception is an example of the opposite of the 'perceived usefulness' of ICT in the workplace. 'Perceived usefulness' is defined by Davis (1989, p. 320) as 'the degree to which a person believes that using a particular system would enhance his or her job performance'. The quotation perceives HTIS as just a complementary tool and less important compared to other medical facilities. This perception may be an outcome of the lack of ICT penetration in Malaysian public hospitals. The information from MoHM document informs that only 16 out of 131 hospitals are equipped with HTIS because of financial limitations (Ministry of Health of Malaysia, 2011).

However, the inadequacy of resources can be less significant if physicians are able to see the benefits of HTIS in improving their work. Hu et al. (1999, p. 105), for example, suggest that perceived usefulness by physicians of ICT depends on its ability to function as a tool for improving health service delivery. Their study examined the use of telemedicine in tertiary hospitals in Hong Kong. A recent study by Pai and Huan (2011, p. 658) identifies the strong relationship between ‘perceived use of ease’ of HTIS and ‘perceived usefulness’ by physicians.

5.8.2 The benefits of electronic health records and HTIS

This section presents the benefits of EHR and HTIS as perceived by the interviewees. The discussion aims to identify the link between the benefits and physicians’ level of acceptance. Four categories of benefits are extracted from the quotations on the theme. Table 5.8.2 describes the categories and number of occurrences in all interviews.

Table 5.8.2: Classification of quotations that highlight the benefits of EHR

| Categories | Number of occurrences in all interviews |
|--|---|
| Storage and retrieval | Thirteen times |
| Improvement of health service delivery | Fifteen times |
| Medical data exchange | Twelve times |
| Reduction of mistakes | Four times |

5.8.2.1 Storage and retrieval

Record storage refers to keeping the patients’ data in the server by using , and retrieval is the process of retrieving the records to be displayed on HTIS. Thirteen quotations on the theme relate the above topic with physician acceptance. Table 5.8.2.1 describes the category of issues.

Table 5.8.2.1: Issues in storage and retrieval

| Categories | Number of occurrences in all interviews |
|-------------------------------------|---|
| Digitisation of paper-based records | Eight times |
| Keying health data into HTIS | Five times |

A) Digitisation of paper-based records

This subject refers to efforts to transform paper-based records into a digital format. The discussion focuses on hospitals that are non-HTIS and still using paper-based records. Two questions form the base of the discussion: what is the mechanism to digitise paper-based records and will it affect the operation of the hospitals? The answers to these two questions are derived from eight quotations that represent this section.

Different understandings are displayed between officials working at hospitals with HIS and those in paper-based hospitals. It is apparent that the benefits of EHR cannot convince officials in paper-based hospitals. One head of a department of medical records questioned the necessity to implement EHR:

'Firstly, why should we have EHR systems? Our staff can retrieve records based on the manual-based system in less than five minutes. Current retrieval systems still do not give any problem to us, and it is quite costly to have a new EHR system because it has to be HTIS or HIS. We used to have several meetings with doctors, asking their opinions about our plan to digitise the medical records. Many of them feel it is unnecessary because they are happy with the current method.'
(Interview_8_HSP_C_HDRM)

However, another head of a department of medical records at a hospital with HIS has a different opinion about EHR:

'Another aspect that need to be emphasised is the awareness of the advantages of EHR over paper-based records. Examples like convenience to retrieve the data, minimum use of space and better treatment for the patients should be highlighted so that end users will feel comfortable and happy to change their working style. Based on personal discussion with the majority of doctors in this hospital, they are happy to use EHR.' (Interview_7_HIS_B_HDRM)

Data Analysis

Two factors explain this discrepancy in opinion. Firstly, there is a big gap between hospitals with HTIS and without in Malaysia. Commenting on the adoption of EHR in the United Kingdom, Jha et al. (2008, p. 852) suggest that the positive reaction to computerisation in UK health care is due to financial incentives and support from the government. Computerisation in health care is a national project in the UK, in which all health agencies are involved, in contrast to Malaysia where only 16 out of 130 hospitals use HTIS. This situation creates a gap between hospitals with and without HTIS. Secondly, there is no significant difference between retrieval times for paper-based systems and HTIS (Shabbir et al. (2010, p. 285) As a result, members of non-HTIS hospitals feel that there is no privilege in using HTIS or EHR.

The interviewees also highlighted issues regarding methods to digitise paper-based records in non-HTIS hospitals. Officials from hospital C expressed their concern over the digitisation method. One head of a department of medical records said:

‘That is why you see it is not easy to change the way things are done for decades. Here, for example, if the management would like to adopt EHR system to replace current manual systems, the management should think of the best mechanism to transfer thousands of paper-based records into electronic. Who is going to key in the data to the systems? I do not think our staff are capable to do that, even if they are offered overtime incentives because it is a lot of work.’ (Interview_8_HSP_C_HDRM)

The above statement suggests a problem in digitising paper-based records which is related to resources. The transformation requires staff for data entry and financial emolument to pay for the services. In Malaysia, almost 80% of patients’ medical data is paper-based; therefore, it is highly probable that the digitisation of paper-based records will take longer. In the UK, a similar process was assumed to be easy because most data was stored in legacy systems, however the latest report by Randeep (2011), explains how the digitisation process was complex.

Data Analysis

The second concern from this section is whether efforts to digitise paper-based records will affect the operation of hospitals. The impression from the quotations suggests a negative effect on hospital operation. The head of the department of medical records of a non-HTIS hospital said:

‘Personally, I think installation can be made, but there are issues related to the installation. First thing, who is going to key the patients’ data into the systems? There are thousands of patient records that comprise sometimes hundreds of pages. If the MoHM directs my department to key in the data, I do not think we can accomplish the task shortly. A failure to comply with the timeframe, the records will be abundant and later no one will care about PMS anymore.’ (Interview_8_HSP_C_HDRM)

The above quotation focuses on the digitisation process in the form of data entry. It suggests it will be a distraction to hospital operation if the digitisation of paper-based records is assigned to the respective department. Several studies investigating the issue of digitisation agree on the issue of data entry. Bates et al. (2003, p. 7) report the resistance of physicians to adopting HTIS because of data entry efforts. Walsh (2004, pp. 1185–1186) itemises the barriers to EHR implementation that affect patient care. According to him, poor and inefficient data entry contributes to the failure of EHR implementation. However, the limitation of this impression is that it comes only from interviewees who are working in non-HTIS hospitals.

In relation to the proposition, two different opinions appear among doctors who work in hospitals with HIS and non-HTIS hospitals. Doctors in non-HTIS hospitals view the digitisation of paper-based records as unnecessary because no serious problem has ever occurred when using paper-based records. In contrast, hospitals with HIS perceive that EHR does facilitate their work, especially in retrieving patient records.

B) Capturing health data into HTIS

Whereas the previous section considered the capture of existing information, this section looks at how to capture new information into HTIS. This refers to the efforts to enter data into HTIS for storage purposes. The discussion focuses on hospitals that already implement HTIS. One question formed the basis of the discussion: who is going to key in the data? Six quotations answer the question.

One senior official in IT responded to the question of how medical records would be captured digitally:

'...we need to capture the summary, and who is going to capture them? If we are asking someone to capture them, he or she will ask, what are the benefits for me to do that? If there is no clear benefit, for sure he will refuse to entertain the request. A failure to come out with instant benefit is another problem in capturing the medical records.'

(Interview_4_div_B_BT)

The above statement suggests the occurrence of resistance to keying medical data into HTIS. A quotation from one medical official gave a reason behind the resistance:

'Some of them had been working at manual-based hospitals for ages, and when they were transferred to this hospital, they are required to key in their opinions, analysis and diagnosis into the computer using a keyboard; of course they feel HIS doubles up their work.'

(Interview_9_HIS_A_DOC)

The above quotation gives the impression that keying data into HTIS doubles physicians' routine work. One head of a department of medical records in a non-HTIS hospital supported the above quotation:

'I do not know about doctors in general, but I was told not all doctors who work at Putrajaya hospital were excited with the use of HIS in their work, because HIS has doubled up their work. For my staff, I totally

Data Analysis

disagree if the hospital management requests us to key in all data from the paper-based records to the EHR system. I think data entry should be done by part-timers. I am not against the use of EHR system, but I am happy with the use of paper-based system.'

(Interview_8_HSP_C_HDRM)

A number of studies suggest negative implications for medical records from the above situation. Saitwal et al. (2010, p. 505) suggest the potential errors that can occur when entering medical records to HTIS if the users are mentally fatigued or stressed. It is time-consuming to enter data into the system, which also causes dissatisfaction among physicians with the use of HTIS. Ash, Berg and Coeira (2004, p. 107) report this situation in their literature analysis study. In their study Greenhalgh et al. (2009, p. 730) report that distracting staff onto data entry can cause failure of EHR implementation.

It is normal practice in HTIS hospitals that physicians capture the medical records while diagnosing the patients. This practice was reported by one head of an IT department, who said:

'Each doctor will treat the patients and he or she is provided with a laptop on a trolley. The doctor will key in his opinions and diagnosis into the system, and the key-in process is done by the doctor himself. Each ward is provided with three or four laptops.'

(Interview_5_HIS_A_HDI)

The type of device on which the data is entered may determine the level of errors in record capture. Cole et al. (2006, pp. 726–727) tested five devices (conventional pen, tablet PC, d-pen, DTP hybrid and PDA) to assess their accuracy, speed, ease of use and user satisfaction. The results suggest that using a tablet PC is the fastest, results in fewer errors and is the most favoured by users among all electronic devices except the conventional pen. This finding acknowledges current practice in almost all HTIS hospitals in Malaysia.

5.8.2.2 The improvement in health service delivery

The improvement in health service delivery is another benefit suggested by the interviewees. The types of improvement from electronic health records and their influence on physicians' acceptance base the discussion. Two types of improvement are identified from the theme. Table 5.8.2.2 describes the categories and number of occurrences in all interviews.

Table 5.8.2.2: The categories of improvement

| Categories | Number of occurrences in all interviews |
|-----------------------------------|---|
| Continuity of medical information | Nine times |
| Access to medical resources | Six times |

A) Continuity of medical information

This refers to the continuity of medical records for each patient in all stages of record development from record creation, storage, use and disposition. All four stages of record development assist physicians to obtain updated information and give the correct treatment to their patients. The discussion focuses on both HTIS and non-HTIS hospitals. One question forms the basis of the discussion: what are the perceptions of Malaysian physicians and ICT administrators of EHR?

One head of the IT department in a HTIS hospital agrees with the ability of EHR to provide continuity of medical records:

'Nevertheless, the health information systems that we are using are able to facilitate health service delivery from the time a patient registers until he or she is discharged.' (Interview_5_HIS_A_HDIT)

Many studies suggest the feasibility of EHR to support health service delivery from registration until discharge (Tsai & Bond, 2008, p. 138; Roukema et al., 2006, p. 19; Czekierda et al., 2006, p. 94). Czekierda et al. (2006, p. 94), for example, classify three functions of HIS in hospital operation from patient

Data Analysis

registration until discharge: to store patient data and monitor their state, to assist data flow and staff management and to administer the financial aspects. The details for these functions are described in Table 2.3.1.

However, the continuity of medical records does not represent the majority of Malaysian public hospitals. Only 16 out of 130 hospitals use HTIS. One medical doctor raised this concern:

'As a medical doctor, I agree on the importance of EHR, but the most important thing in hospital is to deliver services to the patients, even using paper-based records. Now, I am working in a hospital that has HIS in both clinical and non-clinical; may be in future I will be transferred to other hospitals who do not use HIS, but still health services must be delivered to the patients. EHR systems or HIS are just tools to facilitate our work as doctors.' (Interview_9_HIS_A_DOC)

The above statement suggests the imbalance of EHR infrastructure in Malaysia. The imbalance of infrastructure is an outcome of the absence of implementation strategy. Assessing the implementation of EHR in five countries, Deutsch, Duftschmid and Dorda (2010, p. 218) identify six contributors that determine the success of EHR implementation, which include health policy-related goals and implementation strategy. In 1997, the MoHM published its first roadmap on how to implement EHR in Malaysia. The report included all implementation strategies and technical specifications. After two years, the project was shelved, until now.

The imbalance of EHR infrastructure between HTIS and non-HTIS hospitals shapes the perceptions of EHR among physicians. One medical official said:

'I have no problem with current procedures using paper-based records. They are retrievable in considerable amount of time and easy to manage. Maybe the problems from paper-based is space for storage. Using an information system may increase the burden in my work because I need to key in the data to the system. I know my friends who work at Putrajaya

hospital are required to key in the data to the laptop while visiting the patient. I am not IT savvy and I consider that condition is not facilitating my work as a doctor.’ (Interview_13_HSP_C_DOC)

This doctor works in a non-HTIS hospital. The environment in which he is working shapes his perception of EHR. A survey by Rouf, Chumley and Dobbie (2008) suggests that the environment and exposure to technology shapes the perception of medical professionals. Their study is based on third-year medical students in 2005, and the results show positive reactions to how EHR can assist their future professions.

In relation to the proposition, the use of EHR appears to be reliable to achieve continuity of medical records in Malaysian health care. However, the discussion also suggests it can still not be attained because the majority (almost 85%) of public hospitals are still using paper-based records.

B) Access to medical resources

This refers to EHR’s ability to provide more access to medical resources such as specialists using ICT. The discussion focuses on both HTIS and non-HTIS hospitals. One question forms the basis of the discussion: what are the perceptions of physicians and ICT administrators of this benefit?

The first perception is that the equitable access to medical services is the right of all taxpayers whether they live in rural or urban areas. One senior official of an IT department raised this concern:

‘Then, the concern is on equitable access. According to the Inland Revenue Act, everybody is obliged to pay the same rate of tax regardless of their place of living. They need to pay same amount of tax whether they are living in urban areas like Kuala Lumpur or rural areas. So it is so unfair if someone who pays the same tax but lives in Kuala Lumpur can enjoy all medical facilities, but someone else who lives in a rural area could not enjoy the same facilities. So, how to solve this issue? Does

Data Analysis

the government need to increase the number of medical doctors and specialists so that they will be available at all places and times? But the question is whether the government can afford to do that. Therefore, another approach is through harnessing ICT To support this concept, having right information in the database is important so that specialists can provide accurate diagnosis based on the stored information about the patient during virtual consultation.'
(Interview_4_div_B_BT)

The above statement describes the approach that the MoHM uses to provide equitable access to medical resources using ICT. It also suggests two things prior to the implementation of EHR. The first thing is sufficient ICT infrastructure to support this notion, especially in rural areas. The first proposition discussed this issue in detail. The second thing is to have stored information in a central database so that specialists can access patient medical data regardless of the place and time. Nevertheless, a few studies suggest the unsuitability of a centralised database to support EHR implementation. Commenting on the current design of the EHR system, Raghupathi and Kesh (2009, p. 64, 74) lament the weakness of the existing EHR system. According to them, the existing EHR system is just a simple relational database that functions to store data and generate reports. The best model for them is to adopt banking technology that permits transactions to be made in a variety of locations, because they share the same standards and rules. Comparing EHR implementation methods in the United Kingdom and the United States, Charette (2006, p. 120) identifies some factors that contribute to the failure. One of the factors is the effort required to store patients' data in a central database, which is not feasible.

The second perception is to upgrade the existing model of HIS in an effort to provide more access to medical resources. This view was suggested by one head of an IT department:

'Nevertheless, the health information systems that we are using are able to facilitate health service delivery from the time a patient registers until

he or she is discharged. For the new module to be used together in our HIS, an integration process is required. As an IT official, I always see the new module that needs to be integrated into our HIS as part of improvement that ICT can offer to health care. This is because the new module enables patients to receive new treatment based on new technology. This is an example of improvement in providing better access to medical support. Since all patients' health data are digitised, if in future interoperability across different hospitals can be achieved then it is easy for doctors to access patients' records all the time.'
(Interview_5_HIS_A_HDIT

The above statement suggests that the HTIS and EHR enable equitable access to medical resources. The suggestion is based on two notions. Firstly, HTIS-hospitals use ICT in both clinical and non-clinical operations. In those hospitals, patients' health data can be easily accessible. Secondly, digital data stored in the HTIS database can be used as preparation for future interoperability projects.

5.8.2.3 Medical data exchange

The ability to exchange medical data is another benefit of EHR and HTIS. Data exchange refers to the ability of HTIS to send, receive and act on data that is sent by either departments in the same hospital or external departments. The quotations on the theme suggest two issues under this subject. Table 5.8.2.3 lists the issues and number of occurrences in the quotations. One question forms the basis of the discussion: what are the perceptions of physicians and ICT administrators of inter-departmental data exchange?

Table 5.8.2.3: Issues in medical data exchange

| Categories | Number of occurrences in all interviews |
|--------------------------------------|--|
| Permissible data to exchange | Five times |
| The ability of HTIS to exchange data | Seven times |

A) Permissible data to exchange

This section explains the type of permissible data that Malaysian laws permit to be exchanged and shared. The patients' health data can be categorised into two categories. The first category is the details of patients' health records. This type of record is not permissible to be shared and exchanged without consent from the patients, management of the hospital and the MoHM. This is because the records belong to the Malaysian government. This is according to the National Archive Act 2003 and the 2010 MoHM Circular on managing medical records. The second type is the summaries of patient records. The Malaysian laws permit the sharing of this record.

A plan to use ICT for sharing medical records started in the Seventh Malaysian Plan (1996–2000) to support programmes under the Multimedia Super Corridor (MSC). The MSC is a plan that aimed to transform Malaysia into a hub for ICT for Asian countries (Economic Planning Unit, 1995, p. 548; Mohan & Razali, 2004, p. 218). An example of the plan is the Telemedicine project (The Ministry of Health of Malaysia, 1997). In the Eighth Malaysian Plan (2001–2005), eight hospitals were developed together with Total Hospital Information Systems (THIS) and 25 ICT projects for hospitals. After the failure of the Lifetime Health Records (LHR) and Lifetime Health Plan (LHP) in 1997, the Ninth Malaysian Plan (2006–2010) once again included these two pilot projects in two state capitals of Malaysia. The projects aimed to provide a test bed for the MoHM in implementing interoperated EHR and HTIS (Economic Planning Unit, 2006, p. 433).

The reason that sharing medical records is beneficial is because it permits patients to receive medical treatment in all places without any constraint. This notion was highlighted by Tony Blair in 1998, who said:

'If I live in Bradford and fall ill in Birmingham, then I want the doctor treating me to have access to the information he needs to treat me' (Tony Blair, 1998, as reported in NHS Confederation, 2004).

The majority of interviewees agree on the benefits of EHR. However, the prohibition of laws becomes a challenge to implementing interoperable EHR across Malaysian hospitals. One senior IT official said:

'To implement interoperable EMR is not an easy task in Malaysia. Malaysian legal system does not allow sharing the medical records. The Ministry has done research on this matter, and it is decided that no details of patient medical records can be shared across the information system, except the summaries of the EMR. The summaries will include discharge, visit, encounter, episode and other summaries from EMR. If there is a need to share the details, formal applications must be made to the patient and doctors. Therefore, the Ministry has come out with a project which aims to share the summaries of EMR. The MoHM aims to gather all summaries of individual medical records and store them in national repositories.' (Interview_4_DIV_B_BT)

The Telemedicine Blueprint (1997, p. 39) also acknowledges the challenges from a law perspective to supporting medical data exchange. The document suggests modifications of certain clauses in laws to enable EHR to be stored in central database and be retrievable by medical doctors.

To initiate the sharing of medical record project, the MoHM proposed a pilot ICT project known as MYHIX. This project aims to share the summaries of medical records across six agencies in different locations and to identify technical and non-technical problems in implementing interoperable EHR. One senior IT official who is in charge in this project said:

'Among the problems that are faced now is the variety of information systems being procured or developed by those hospitals. All of them could not communicate with other hospitals' information systems. The data communication can only be done among their own departments, which is internal data communication. For example, the hospital information system in Selayang hospital can only communicate with its own departments. The integration process will enable different

information systems in various hospitals to access data from MyHIX system as their mother system, where it will connect directly to the central database, which is located at the MoHM. The data accessibility however is only in form of discharge summary and not the details of patient health records. Any patient then can receive treatment from any hospital, and doctors will be able to access the summary of his or her health records based on the discharge summary, which will assist the doctors in their treatment and diagnosis. The equipment for MyHIX project will be procured by MDEC.’ (Interview_3_DIV_B_BM)

The above statement illustrates the preparation that the MoHM aims to have in the process of sharing medical records. The requirements to conduct the pilot project to test the feasibility and technical requirements of the project are mentioned in the Telemedicine Blueprint document (1997, pp. 2. 33–36). But after the failure of the project in 1999, no pilot project was conducted until 2009 with the introduction of MYHIX. Based on the latest information from the MoHM, the MYHIX project was cancelled because of resistance from the top management of the MoHM.

B) The ability of HTIS to exchange data

This section discusses the current ability of HTIS to exchange medical data. One question forms the basis of the discussion: does the configuration of HTIS in Malaysian hospitals support data exchange?

The ability to exchange data was confirmed by one head of a department of medical records, who said:

‘So far it has not been a problem to exchange data between the departments through HIS that we use. For example, if a doctor at one department needs an output to be sent from other departments, he would use one menu on the HIS to request the data, and the concerned department will receive the request and the output will be sent via the HIS.’ (Interview_7_HIS_B_HDRM)

Data Analysis

A clear specification of the agreement determines the functionality of HTIS to exchange data. The ability for data exchange is configured during the installation process. One head of an IT department acknowledged this by saying:

'The CERNER HIS was set up for internal use only. But there is a possibility for this system to be configured so it will be able to communicate with external parties. However, it still could not achieve that. The compatibility issue is also important if the Malaysian government has the intention to create inter-hospital data exchange. For the time being, various hospitals are using different technologies under different vendors like KOMPAKAR, Systematic Conglomerate, etc. Legal factors are among the main factors that hamper inter-hospital relationships. Inter-hospital relations are not only related to technology but also other factors as well, for example regulations, security and privacy of patients. All of these things must be properly planned and executed.' (Interview_6_HIS_B_HDIT)

The above quotation describes two situations that occur during the installation process in that hospital. Firstly, there must be a clear specification in the agreement between the vendors and the MoHM. It was apparent that the specification for the CERNER HIS only permitted an inter-departmental relationship. Secondly, the vendor configured the software for installation, which determined the ability of HTIS to exchange data.

Any new procurement of a medical device or third-party software requires interaction with the existing HTIS. Interaction requires data exchange between the various systems. The importance of standardised interfaces is appreciated - one head of an IT department stated:

'Third party applications require a standard interface. For example, Selayang hospital is using ILMS system for their laboratory system. The data capture process by ILMS is configured to enable HIS server to recognise the input and output. The configuration is for the integration.'

Here, the role of standards such as HL7 and DICOM are needed.'

(Interview_5_HIS_A_HDIT)

The above statement describes the requirements to enable interaction with third-party software, which is through a standard interface. The server requires standards (HL7 and DICOM) to understand any input and output from the third-party software.

In his research Rada (2008, pp. 75-77) considered three departments, radiology, pathology, and pharmacy, and found that they normally have separate computer systems because their functions are based on medical devices. The interaction with the main HTIS requires configuration and setting up. One head of an IT department confirmed this condition:

'Since the current system is quite stable, upgrading requires a whole new processes to revamp the whole thing. This hospital has just procured a new pharmacy information system. The new system is connected directly to our HIS. Previously, there is no direct process between our HIS and pharmacy information system. With the new system, prescription will appear on the screen in the pharmacy department, which is time-saving. The patient can just confirm his ID and get his medicine.'

(Interview_6_HIS_B_HDIT)

The above statement describes two circumstances. Firstly, integrating third-party software such as a pharmacy information system requires thorough configuration and setting up of HTIS. Secondly, medical data exchange improves health service delivery.

5.8.2.4 Reduction of mistakes

The reduction of mistakes refers to the ability of EHR to assist physicians to make the right decisions in their diagnosis and prescribing medicine. The National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP, 2011) defines medication errors as follows:

'A medication error is any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing; order communication; product labelling, packaging, and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use.'

A number of studies and papers show the positive contribution of EHR to reducing errors in treating patients (Waegemann, 2003; Leape & Berwick, 2011; Lorenzi et al., 2009). This research contributes to other research done in Malaysia with regard to medical errors, for example a study by Mohd and Mohammad (2005, p. 86). The theme only offers four relevant quotations that highlight this issue. Nevertheless, they still have a significant contribution to the proposition.

Managing information is an example of the benefits of EHR that can reduce the tendency for errors to happen. One head of an IT department suggested this benefit:

'If we make a comparison between a hospital that still uses a manual system in its operation and working process with a hospital that uses HIS, we will come across many mistakes done by doctors in the manual-based system compared to the HIS-based hospital. The doctors in HIS-based hospitals are controlled in their working processes, because everything is managed by the system.'

(Interview_5_HIS_A_HDIT)

Examples of managing information in medical procedures include providing updated information to physicians for their diagnosis, presenting previous diagnoses by other doctors and displaying results from various departments such as X-rays from the radiology department.

However, the scepticism about the feasibility of EHR is displayed in some literature, for example a scepticism about security issues in protecting the patients' records from being forged or stolen. A study by Anciaux et al. (2008, pp. 133–136) suggests an insecure element of EHR to maintain the privacy of the patient, which might lead to forged health data if someone is able to hack into the main server.

Two studies in Malaysian hospitals suggest that medication errors occur in HTIS hospitals not because HTIS fails to perform, but because of the unwillingness of medical staff (doctors and nurses) use HTIS (Chua, Chua & Omar, 2010, p. 606; Chua, Tea & Rahman, 2009, p. 221). The findings of these two studies also show that the minimal use of HTIS limits its benefits in health service delivery.

In relation to the proposition, the reduction of errors should be a motivation for physicians to accept the implementation of EHR in Malaysian health care.

5.9 Eighth proposition

This proposition suggests, 'Successful interoperable EHR implementation in Malaysian public hospitals will depend on the ability to accommodate the current barriers faced by the hospitals into a manageable ICT procurement plan'.

The proposition seeks answers to the following questions:

1. What are the current barriers faced by public hospitals that affect interoperable EHR implementation?
2. What is a manageable ICT procurement plan?

In seeking the answers, the following sections related to the theme BARRIERS IN EHR IMPLEMENTATION conceptualise the discussion.

According to the Telemedicine blueprint 1997, five issues were identified that might hamper the LHR project (Ministry of Health of Malaysia, 1997, p. 39).

Those barriers are:

1. Health care organisation
2. Process re-engineering

3. People
4. Health care financing
5. Laws and regulations

Abd. Ghani et al. (2008, p. 91), in their comparative study on five South-east Asian countries (Malaysia, Japan, Hong Kong, Singapore and Taiwan) regarding EHR initiatives, also quote these barriers. Table 5.9 describes their findings.

Table 5.9: The level of EHR barriers in Malaysia (adapted from Abd. Ghani et al. (2008, p. 91))

| Barriers | |
|-----------------------|------------|
| Integration efforts | Moderate |
| Process reengineering | Complex |
| People | Moderate |
| Funding | Government |
| Laws and regulations | Moderate |

The findings from this proposition will add a new dimension to these five barriers. Two categories of barriers have been identified that affect the implementation of interoperable EHR and HTIS in Malaysia. These categories are extracted from the theme. The categories are intangible and tangible barriers.

5.9.1 Intangible barriers

This section discusses the current barriers that Malaysian public hospitals face in the implementation of interoperable EHR. The intangible barriers refer to the hindrances that are caused by non-technical factors, organisational policies, administrative defects, human error and situations. The results of this discussion will be transformed into a manageable ICT procurement plan. Five intangible barriers are identified from the theme. Table 5.9.1 describes the classification process.

Table 5.9.1: The classification of quotations about intangible barriers

| The subjects | Number of occurrences in all interviews |
|---------------------|--|
| Change management | Three times from the same interviewee |

Data Analysis

| | |
|---|-----------------|
| The perception of ICT administrators of the ICT programme | Two times |
| External factors | Ten times |
| Legality issues of EHR | Seventeen times |
| Non-technical challenges | Five times |

5.9.1.1 The issue of change management

Change management refers to the new environment and conditions that occurs as a result of new technology used in hospital operations. A remark by an interviewee initiates this discussion:

'In other words, to implement EHR requires more than health information systems; there must be changes in the human mindset, work processes, organisation and legal systems.' (Interview_4_div_B_BT)

The above statement suggests three changes to support HTIS and EHR systems: changes in staff perception, working processes and legal systems. In the literature analysis of HTIS adoption in seven countries, Ludwick and Doucette (2009, p. 28) acknowledge that the adoption of HTIS and EHR systems is not just a technical project but also requires other factors such as leadership, changes in organisational cultures, training and the standardisation of terminology.

The same interviewee then added:

'Another issue is related with the obstacles in implementing HIS. It is not an easy task. For example, to ask a person who has been years writing something with a pen to use a keyboard is not easy. Therefore, for those who are going to be change management in any hospitals or health care agencies must have a strong determination.' (Interview_4_div_B_BT)

The above statement suggests another component of change management, which is resistance from the physicians to change their working style. In their case study, Ludwick and Doucette (2009b, p. 6) suggest factors that cause most physicians to be resistant to ICT. These include a lack of computer skills, requirements to do

four things at the same time (listening, talking, typing and analysing), and being unfamiliar with HTIS products.

The MoHM initiated this change management programme in 2010. Three phases have been formulated to extend this technique to all hospitals that have already adopted HTIS or EHR systems. The document analysis from MoHM's circular (2010b) suggests five themes to promote change management across public hospitals and health agencies. Those themes are awareness, desire, knowledge, ability and reinforcement (Ministry of Health of Malaysia, 2010b).

With regard to the effort made by the MoHM to create awareness of change management, does the MoHM allocate enough money to support this programme? This question is a response to another remark made by a interviewee who was concerned about the financial allocation for change management:

'In my opinion, if one HIS project costs around RM10 millions, then it should be another RM5 millions for a change management programme. It is because HIS is just a mechanism and if humans refuse to use the mechanism, then the project is going to fail.' (Interview_4_div_B_BT)

Manageable action plans, according to the above statements, require the following support:

- Continuous training and awareness programmes to change the mindset of all health staff towards ICT.
- The enforcement of rules and a reward system to make sure that all physicians and other health care staff use HTIS.

5.9.1.2 The outsourcing of ICT programmes and integration

This issue was discussed in section 4.2.3.1 regarding the third proposition. The researcher puts it forward again due to its relevancy to this section. The topic reflects the barriers of reactions and mindsets to administering ICT in health care. One senior officer raised this issue when he was asked about the mindset of ICT administrators in ICT adoption:

Data Analysis

'We are also well known as those who like to blindly follow anything that comes from developed countries, and view whatever technologies they offer as the best. This perception might be due to our ambition, which is too much ahead than reality; for example, rather than focusing on the domestic health data exchange among Malaysian hospitals, we want to give more focus on international health data exchange, on how health data in Malaysian hospitals can be exchanged to other hospitals outside Malaysia. We always feel that in order to accomplish the task, we must follow any suggestion given by developed countries.'
(Interview_4_div_B_BT)

The above statement describes the mindset of ICT administrators who imitate everything done or produced in developed countries. The announcement made by IBA Health Limited or ISOFT Group Limited in 2006 on the contract to equip ten hospitals with HIS verifies this statement. The project was done through its subsidiary, which was a local company known as Solutions Protocol. IBA Health Limited is an Australian company and has the experience of providing HIS to more than 5,000 health care providers (Cohen, 2006). In other words, the contract was to use ICT solutions developed by an international company (IBA Health Limited) with installation by a Malaysian company, Solution Protocols Sdn Bhd.

Currently, there is no complaint from the MoHM on these HIS. According to one senior official of the IT division of the MoHM, the HIS used in those hospitals is usable and stable:

'Even with no integration across different hospitals, this division does not receive any complaint from those hospitals with HIS whether in terms of instability or technical drawbacks. For me, it shows those systems are stable and usable.' (Interview_1_div_A_AM)

Yalaho (2006, p.1) names this approach as *International outsourcing of software production* (IOSOP), or offshore outsourcing of software production. In another

Data Analysis

study, Yalaho and Nahar (2008, p. 2) identify twenty risks of employing this approach to both clients and service providers:

1. Strategy
2. Managerial considerations
3. Financial instability
4. Project management skills
5. Company size and other facilities
6. Productivity challenges
7. Culture
8. Communication
9. Language
10. Complexity
11. Legal and contractual problem
12. Geo-political risks
13. Specific technological skills
14. Infrastructure challenges
15. Government restrictions
16. Time-zone differences
17. Security
18. Hidden cost
19. Supplier specific
20. Economic issues

Despite these risks, outsourcing is the preferred method of procuring ICT software and hardware for the Malaysian government, and in the case mentioned above these risks do not appear to have materialised. The MoHM sets the requirements and specifications of the software, and the vendor complies with the requirements. One senior ICT official acknowledges this practice:

‘One more thing, it has been the preferred practice for all government agencies to outsource ICT to vendors. We will determine the requirements of the software, the flow, the process and the outputs, and the vendor programmes the software according to our requests. We have special teams that monitor the development and final result. If the software is compliant with all our requirements then the payment will be released. If not, there will be a long story. It also applies to hardware, where we are the one who determine to accept or reject. That’s why a legal document or contract is very important.’ (Interview_4_div_B_BT)

Based on the above discussion, a manageable action plan to improve the outsourcing approach in ICT procurement requires the following efforts:

- Interoperability should become the first requirement for any health solution outsourced through vendors.
- To assign one ICT officer to be involved in the vendor's development team for technology transfer. The assignment must be part of the legal agreement between the government and vendors.

5.9.1.3 External factors

Intangible barriers in the form of external factors can be defined as influences or forces that determine the flow of ICT programmes in Malaysian health care, and most of them are based on political forces. When the interviewees were asked about the problems in the ICT adoption programme, ten remarks pointed to this issue. The remarks can be categorised into two categories. The first category is external factors that link to decisions about the ICT project. This has been discussed in section 5.2.2.3 under direct negotiation. The second category is external factors that occur because of other factors, for example economic instability, policy or political changes. Table 5.9.1.3 describes these two categories.

Table 5.9.1.3: The categories of external influences as highlighted by the interviewees

| The categories | Number of occurrences |
|--|------------------------------|
| External factors on decision-makers | Eight times |
| External factors that occur because of other factors | Two times |

A senior official who has been handling ICT procurement for decades gives his opinions on the second category. When he was asked about factors that caused the Malaysian government to discontinue the LHR project in 1997, he responded:

'That's why if someone asks me about the achievement of Telehealth since 1997 until now, I can frankly answer that nothing has been fully achieved. For example, four projects under LHR which were having a lot of coverage, were not delivered even though RM100 million was

allocated by the government. After the budget was approved, two contractors were appointed by the top authority to carry out the work. But the Ministry had come out with a policy that the payment for any project is made after the project is delivered. Then, those companies could not continue with the project and were declared bankrupt, which affected the whole project. I think the total loss was not more than RM20 million, and the rest of the money was retrieved by the treasury. The perception of the public was that the Ministry had spent all the amount, which was not true.' (Interview_4_div_B_BT)

The above statement suggests that the retrieval of the financial allocation was an example of an intangible barrier.

He also suggests that the career path system in Malaysian public administration is an example of an external factor:

'Another problem is government officers. There are some spaces in their career path into the higher posts that requires a favour from some people at the top, in addition to the merits. As a result, those who have power to determine other's career path sometimes tend to interfere in administrative decisions. Therefore, it is almost impossible for Ministry administrators to execute any plan because there is a possibility the plan will be overruled by people at the top. These are unavoidable issues and nothing has been done for it, and normally procurements that are politically driven are much higher than normal procurement.' (Interview_4_div_B_BT)

The above statement suggests that the career path of public administrators promotes favouritism. Promotion to a higher post requires not only merit but also favours from politicians. Consequently, public administrators have no choice except to allow interference from politicians in the planning and decisions they make. Interference to any planning is another barrier to ICT adoption in Malaysian health care.

The findings from the literature also support the above interpretation. Ernstmann et al. (2009, p. 187), in their quantitative study, suggest the ability of external factors to influence the success of ICT adoption programmes in health care. The influence happens because those factors influence the central belief of users and providers. Central beliefs comprise control, motivation, emotion, cognitive absorption, self-efficacy and psychological ownership. Cancellation of a project by revoking the financial allocation also happened in a Norwegian EHR project in 1999. Boulus and Bjorn (2010, p. 99) consider the cancellation to be an example of external barriers in EHR projects.

The points from the above discussion suggest three manageable plans to control the involvement of the second type of external forces:

- To introduce a ‘financial silo’ that functions to hold temporarily the financial allocation for ICT projects that cannot be delivered by vendors. This money will be used again to support the same project when a new vendor is appointed.
- Interference in decisions causes a variety of ICT solutions in Malaysian health care. To make sure interoperability of HTIS can be achieved through a variety of vendors, all registered ICT vendors must sign a Memorandum of Understanding (MOU). The MOU will make it compulsory for all vendors to enable their software to be integrated with others.
- To minimise interference by politicians, the career path of public officials should not be determined by ministers or politicians, but rather be based on merits and performance.

5.9.1.4 Legal issues

Seventeen responses from the interviews highlight legal issues. The foci of discussion can be categorised into three categories. The first category is the provision of Malaysian laws on patient records. The second category is the accessibility of the records, which involves confidentiality and security issues. The final category is the validity of EHR documents to be used in a court of law. Table 5.9.1.4 describes the categories.

Data Analysis

Table 5.9.1.4: The categories of legal issues from the interviews

| Categories | Number of occurrences |
|--|-----------------------|
| The provision of Malaysian laws on patient records | Eight times |
| The right to access patient records (confidentiality and security) | Seven time |

A) The provision of Malaysian laws on patient records

The intangible barriers for this category are related to the provision of laws which prohibit the sharing of patient records across health agencies. It is apparent that all interviewees know that the Malaysian legal system does not permit patients' records to be shared across hospitals. The discussions will emphasise the reasons for prohibition, ownership of the records and exceptions to the law.

The reasons behind the prohibition are ownership of the records and confidentiality issues. A senior official in the IT department of the MoHM said:

'Firstly, our laws do not permit sharing the patient records without consent from the patient and Malaysian government. As you are aware, any formal documents that are written by public servants during working hours belong to the government. There are many categories of those documents. Patient records are classified as confidential documents, which require clearance from Malaysian government before they can be released. The Malaysian government in this case is MoHM, which delegates to the respective management of health agencies.'
(Interview_2_div_A_AT)

From document analysis of various government documents, the researcher identifies at least seven Acts in Malaysian law that protect patients' health data from being shared without the consent of the government and the patient. They are the Telemedicine Act 1997, Medical Act 1997, Computer Crime Act 1997, Digital Signature Act 1997, Communication and Multimedia Act 1998, General

Data Analysis

Consumer Code 2003 and the Insurance Act 1996. Patient records are considered public records according to Malaysian laws. According to the National Archive Act, all documents produced in any government agencies in any format are considered to be public records (Malaysian Laws under Act 629 of National Archive Act 2003, p. 9). A circular from the MoHM classifies all patient records as confidential (Ministry of Health of Malaysia, 2010a).

Another quotation adds a new owner of patient records. According to one medical doctor, a patient's record belongs to the hospital and the patient:

'If I am not mistaken, laws do not permit patient records to be shared without consent from individual patients and also the government of Malaysia. What I mean, the government of Malaysia refers to the director of the hospital or MoHM. So it is not easy to implement data exchange across hospitals.' (Interview_12_HIS_A_DOC)

According to the MoHM, the physical structure of the records belongs to the hospital that does the treatment and the MoHM, but the patient owns the information in the record (Ministry of Health of Malaysia, 2010a).

One quotation also defines the type of records that can be shared. One head of a department of medical records commented on this:

'The only permitted documents for data exchange are medical report summaries. Unless for court cases; then we will make the printout from the HIS. If the court only requires the reference from the medical records then we will only send a summary. But the request must be in written form and signed by the authorised official, because medical records are classified as confidential.' (Interview_7_HIS_B_HDRM)

The extract from the document analysis suggests that the MoHM (2010a) has provided guidelines on the type of information that must be included in the summary. The information must include the discharge, treatment and prescription

summaries (Ministry of Health of Malaysia, 2010a). This practice is also applied in other developed countries such as the United Kingdom under the services of Summary Care Records (NHS Connecting for Health, 2011).

B) The right to access patient records (confidentiality and security)

The intangible barrier under this category is related to operational procedures. The procedure delays integration because its establishment is to ensure that the confidentiality of medical records is not violated. All seven remarks by the interviewees focused on either procedures that delay integration or the technical ability of HTIS to support the security of medical records.

One senior official sees the current procedure as delaying the integration process:

'Nowadays, all applications to access the summary of patient records needs to be done in written applications, unless there is a need to have access to the details of the records, then the doctor will call via phone the record units, but if the request could not be entertained than a letter will be written to request formally the access. This process does take a long time and the MyHIX system may shorten the time for the referral cases.' (Interview_3_div_B_BM)

The above statement acknowledges the limitation of the current procedure in sharing the contents of medical records, and suggests that the solution is through ICT. It is also evidence of the absence of inter-hospital relations in Malaysia. Much of the literature agrees about the ability of ICT to remove procedural barriers to enable integration while maintaining the confidentiality of medical records. Linden, Kalra and Talmon (2009, p.155) report seven requirements to ensure that confidentiality can be maintained through this: authentication, integrity of data, author responsibility, confidentiality, consent, audit and archiving.

The ability to support confidentiality through ICT was acknowledged by another interviewee:

'This HIS is using an audit trail for security purposes. This functionality will control access to any health records, where the access report will be sent to IT division for further investigation. This is to ensure data will not be accessed by irresponsible people.' (Interview_5_HIS_A_HDIT)

The use of an audit trail is an example of the technical function of HIS in Malaysia to maintain the security of electronic medical records.

5.9.2 Tangible barriers

This section deals with the tangible barriers that affect the implementation of interoperable EHR. Tangible barriers in this context refer to a lack of physical facilities and infrastructure in Malaysian public hospitals. The discussions will emphasise the development of a manageable ICT procurement plan. The quotations on the theme classify tangible barriers into two categories. Table 5.9.2 describes the classification process.

Table 5.9.2: Classification of quotations regarding tangible barriers

| The subjects | Number of occurrences in all interviews |
|---|--|
| The manageable plan for electricity infrastructure issues | Ten times |
| The manageable plan for ICT infrastructure (networking and computers) | Fourteen times |

5.9.2.1 A manageable procurement plan for addressing electricity infrastructure issues

The first proposition discussed the limitations of electricity infrastructure that hamper the implementation of interoperable EHR and HTIS in Malaysia. The discussion of this proposition will focus on a manageable ICT procurement plan to curb electricity infrastructure issues. Developing an ICT procurement plan requires the researcher to classify reasons behind the limitations in the electricity

Data Analysis

infrastructure, as suggested by the interviewees. Two reasons are extracted from all quotations. Table 5.9.2.1 describes the reasons.

Table 5.9.2.1: Classification of the reasons for insufficient electricity infrastructure

| Reasons | Number of occurrences in all interviews |
|---|---|
| The gap between rural and urban areas | Six times |
| The identification of priorities in managing ICT projects | Four times |

One senior official of ICT made a statement that stressed the infrastructure gap between rural and urban areas:

'In my opinion, there is a need to give more emphasis on basic infrastructure such as electricity, especially in rural areas, and also communication infrastructure. This upgrade should become a national priority. There was one incident when I would like to install a clinical system at a government clinic; there were about ten electricity shutdowns. In order to make sure the system could be running for 24 hours a day, an electricity generator was procured to support the flow of electricity to that area. This demonstrated the limitation in our electricity infrastructure, which could not support health information systems in some areas.' (Interview_4_div_B_BT)

The above statement suggests that there are too many interruptions in the electricity supply to support the running of HTIS in rural clinics. This issue is also acknowledged by WHO in its manual to implement EHR for developing countries. Environmental issues such as electricity are a major problem in developing countries for EHR implementation (World Health Organisation, 2006, p. 27). Kawasumi (2000, p. 143) characterises rural areas as places that have a scarcity of nine elements, one of which is a sufficient electricity supply.

The action plan to improve electricity infrastructure in rural areas has become one of the National Key Resulting Areas (NKRA) for the Ministry of Rural and Regional Development for 2010 and 2011. Phases of infrastructural development have been completed and are in –progress; for example, in 2010, the Ministry managed to accomplish its target 100%, and 20% in 2011 (Ministry of Rural and Regional Development, 2010).

The setting of appropriate priorities determines the success of EHR projects. One medical doctor lamented that the 1997 project failed to set the right priority:

'Based on previous experiences, for example, a project in 1997 to integrate all health records across Malaysia failed because there were many things not being planned properly. For example, electricity infrastructure; even now ... there are still many places that are not having sufficient electricity supplies, especially in rural areas. So focusing solely on development of the information systems to produce EHR without considering supporting factors was not a good approach.'

(Interview_13_HSP_C_DOC)

Setting the right priority is important in EHR implementation. This requirement is not only applicable for developing countries but also developed countries. Rawabdeh (2007, p. 526) suggests that the emphasis on the correct infrastructural priority determines successful implementation in developing countries. His study is based on a case study of e-health implementation in Jordan. Developed countries also require infrastructural priorities to be set correctly. Blobel (2007, p. 455) considers that the correct setting of infrastructural priorities, including security, determines the success of EHR implementation in developed countries.

The MoHM has proposed two action plans known as ICT strategic planning (ISP) to create the right direction in adopting ICT into health care. The first ISP was from 2006 until 2010 and the second ISP is from 2011 until 2015. Among the objectives of both ISPs is to identify technologies and infrastructures that support ICT programmes under the MoHM (Ministry of Health of Malaysia, 2010a).

5.9.2.2 Communication and networking infrastructure

Other tangible barriers that require a manageable action plan are communication and networking infrastructures. The first proposition discusses how inadequacies in infrastructure affect EHR implementation. This section suggests how to transform the inadequacies of these two infrastructures into manageable action plans. The suggestion is extracted from the interview outputs and the literature.

Out of 14 statements, nine clearly mention the inadequacy of communication and networking infrastructures. The researcher identified two issues from those nine which represent tangible barriers to EHR implementation. Table 5.9.2.2 describes those issues.

Table 5.9.2.2: Issues in ICT infrastructure

| Issues | Number of occurrences in all interviews |
|---------------------------------|---|
| Mismatched technologies | Three times |
| Data transactions and bandwidth | Six times |

One example of mismatched technology is a matching between new and old technology, for example an ISDN switch with an old version of copper wire. One senior official in ICT reported his experience of handling this case:

'Second thing is communication infrastructure. There was one case where an ISDN switch was installed at a health agency in Kuala Lumpur, but when I examined the wire under the ground, apparently they were still using the old copper wire.' (Interview_4_div_B_BT)

Integrated Service Digital Network or ISDN is a transmission medium for data transaction in a switch telephone network. Although ISDN switches can be paired with copper wire for normal data transactions, it is often preferable to pair them with fibre-optic cable (Kapor & Weirzner, 2010, p. 397, p. 402). to support data intensive applications.

One medical doctor reported the impact of mismatched technology, i.e. insufficient bandwidth to support data transaction:

'The networking infrastructures also need to be upgraded; I think our HIS handles almost 1,000 to 2,500 data transaction every day. The server needs to be upgraded so that more data could be stored and managed.' (Interview_10_HIS_A_DOC)

The above quotation highlights the second issue, the issue of data transaction with insufficient networking bandwidth. Insufficient bandwidth to support data transaction is among the challenges to EHR implementation in developing countries (Rawabdeh, 2007, p. 526).

The National ICT Strategic Roadmap established action plans to cater for insufficient networking infrastructures from 2007 until 2011 and further years. The plan incorporates all the efforts of eight government agencies to make sure that bandwidth and networking capacity can be improved. The wireless network is among the technology that is going to be promoted as a solution to the inadequacy of cabling technology (Ministry of Science, Technology and Innovation, 2007, p.162).

5.10 Ninth proposition

This proposition suggests, 'The management of interoperable HTIS and EHR implementation requires leadership by an external agency that is independent and authoritative in its decisions'.

The proposition seeks answers to the following questions:

1. Is employing an external agency feasible for ICT adoption in Malaysian health care?
2. How will external leadership improve the management of interoperable EHR and HTIS?
3. What are the key performance indicators to assess this agency?

In seeking the answers, the following sections related to the theme THE AUTHORITY TO MANAGE EHR conceptualise the discussion.

5.10.1 The current administration of ICT by the MoHM

This section aims to seek answers to whether it is feasible to employ an external agency to administer the implementation of interoperable EHR. The discussion provides both positive and negative achievements by the MoHM in administering ICT.

Under this section, there are 18 quotations on the theme that discuss the current role of the MoHM to manage ICT in Malaysian health care. Three current roles are extracted from these 18 quotations. Table 5.10.1 describes the classification process.

The discussion assists the researcher to decide whether the findings support the proposition in theme-matching data analysis.

Table 5.10.1: The classification of quotations regarding intangible barriers

| The subjects | Number of occurrences in all interviews |
|---|---|
| The managerial role of the MoHM for ICT | Seven times |
| A failure to execute the plan | Seven times |
| The absence of a policy for standardisation | Four times |

5.10.1.1 The managerial role of MoHM for ICT

The MoHM functions as a secretariat for the central committee for any procurement of ICT in Malaysian health care. The role aims to make sure the proposal is according to the available financial resources. One interviewee confirmed this role when she was asked about the layers involved before a project can be implemented:

‘Under the procurement process for ICT, this division acts as a secretariat for ICT Steering Committee at the ministerial level. All proposals related to ICT need to be endorsed by this division first before they are tabled in an ICT Steering Committee meeting. Normally, in

Data Analysis

every meeting there are many proposals being tabled and discussed. However, everything will depend on the financial allocation from the Ministry for ICT procurement. Then, every approved proposal should be referred to MAMPU (Malaysian Administrative Modernisation and Management Planning Unit) for ICT coordination and planning.'
(Interview_2_div_A_AT)

The above statement portrays the filtering role of the MoHM before the proposal is tabled to the central committee. This practice is according to the government circular issued by MAMPU (2010c). The circular clearly mentions the functions of the secretariat and the committee. Other countries such as the United Kingdom also apply the same means to deliver a national programme for IT but with a bigger organisation, known as NHS Connecting for Health (NHS Connecting for Health, 2011). The centralisation of decision-making for ICT programmes in health care is also applied in other countries such as Australia, Germany, Canada and the United States but with different mechanisms and approaches (Anderson et al., 2008, p. 825).

In Malaysia, only a government organisation can administer public affairs. Theoretically, an external and independent agency should be a statutory organisation that is under the jurisdiction of the MoHM. It has its own managerial teams who are accountable for making sure that all ICT strategic planning is accomplished. It will receive its own financial allocation from the Malaysian government. Other countries have also employed this type of organisation to manage their ICT in health care. Table 5.10.1.1 illustrates this practice.

Table 5.10.1.1: Managerial organisation of EHR in other countries (Anderson et al., 2008, p. 825)

| | Australia | Canada | UK |
|-------------------------------|---|--|---------------------------|
| Committee | National Health Information Group (NEHTA) | Office of Health and Information Highway (Infoway) | NHS Connecting for Health |
| Name of initiative | Health Connect | Canada Health Infoway | National Programme for IT |
| Initial year of IT initiative | 2000 | 1997 | 2002 |

Data Analysis

| | Australia | Canada | UK |
|--------------------------------|--|---|--|
| Expected year of completion | Undefined | 50% by 2009 | 2014 |
| Providers participating in EHR | Hospitals/ERS/GPs/specialists/nurses/pharmacists/labs/nursing homes/optometrists | Hospitals/ERS/GPs/specialists/nurses/pharmacists/labs | Hospitals/ERS/GPs/specialists/nurses/pharmacists/labs/dentists |
| Total investment as of 2005 | \$97.9 million US | \$1.0 billion US | \$11.58 billion US |

The same interviewee also highlighted the function to monitor and evaluate ICT products from vendors:

'Our division also is responsible to monitor, evaluate and advise any health agency that would like to procure new health solutions. We provide advice with regard to technological specifications, requirements, but sometimes their officials already include the specifications in their proposals. We also must make sure vendors are following those requirements, otherwise we will refer the case to our legal division as breach of contract if the vendor failed to follow our specifications and requirements.' (Interview_2_div_A_AT)

The above statement concerns two issues: the ability to deliver the project by a vendor and the failure to comply with requirements. These two concerns are also underlined by another circular, which specifies in detail the mechanisms for monitoring and managing ICT solutions (Department of Malaysian Prime Minister, 30th April 2009). Wetter (2007, p. 256) names this situation a phenomenon of decay in adoption of HTIS into health agencies. He suggests that close monitoring of any development in the vendor's company such as its financial strengths will minimise the loss on the customer's side.

5.10.1.2 A failure to execute the plan

A failure to execute plan was discussed under proposition three but in a different context. The previous section discusses the failure of individual administrators

and this section discusses failure as an organisation. The same officer above commented:

'Malaysia had planned something which was ahead from other countries but due to some hindrances, Malaysia was unable to continue with the planning. Then the concept was developed and successfully implemented in other countries. I assumed that the idea was imitated from Malaysia.'

(Interview_2_div_A_AT)

Two other quotations provide reasons why the MoHM failed to execute the plan. These two quotations were expressed by one senior ICT manager who was involved in the 1997 LHR project:

'Among the problems related with policy is that whenever any blueprint or planning was drafted and gazetted, it should be adopted by all hospitals. But in the implementation, every hospital does not follow the policy which has been set up by the Ministry. For example, in procurement of health information systems, most of the systems are not compatible with the blueprint and proposed architecture which the Ministry wanted all hospitals to follow. As a result, the variety of health information systems could not be integrated and communicate.'

'The problem that we are facing now is that there are plans set up by the government to enhance the use of ICT in health care, but insufficient money was allocated. Whenever the Ministry of Health of Malaysia proposed the budget for ICT procurement to support EHR, the authority will consider the cost is too high. Of course, it is costly, if we want to achieve proper implementation of EHR. The dispute about the cost also happened in the case of MyKAD or Computerised ID card. This card should be able to store health data. But when the plan could not be implemented, the government questioned the Ministry of Health why it could not be implemented.' **(Interview_4_div_B_BT)**

A trivial reaction to policies and financial constraints are identified as reasons why the MoHM failed to achieve the ICT adoption planning. Realising the importance for government and hospital managers to maintain ICT policy in health care, Dzenowagis (2009) considers that the success and failure of ICT adoption depends on the level of acceptance by all parties to the ICT health policy. His suggestion is based on his analysis of the World Health Organisation's (WHO) data over the use of ICT in developing countries. Edirippulige et al. (2009) links financial constraints with the ability of the governments of developing countries to proceed with ICT programmes in health care. However, this study is not based on empirical data, as they depended on the literature and data from WHO. Their study does also not include any study from Malaysia. Based on a formal report by the Malaysian government for ICT allocation for the MoHM in 2011, there was a 10% increment from 2010. Table 5.10.1.2 describes the total allocation for ICT in the MoHM.

Table 5.10.1.2: Financial allocation for ICT in the MoHM for 2010 and 2011.

| | 2010 | 2011 |
|----------------------------------|--------------|--------------|
| Budget for services and supplies | RM61,480,400 | RM99,156,000 |

Source: The Ministry of Finance

Based on the remark given by one senior official in section 5.2.3.2 B, this amount is still not enough for the MoHM to roll out HTIS or EHR systems in all public hospitals across Malaysia.

5.10.1.3 The absence of a policy for standardisation

The importance of a policy in the implementation of ICT is acknowledged by many researchers and WHO itself. In its manual for implementing EHR in developing countries, WHO clearly states the importance of having policies including standardisation policies among different hospitals (WHO, 2006, pp. 24–25). When asked about the policy for standardisation in Malaysian public hospitals, the same senior official voiced his concern about the lack of synchronisation of policies for standardisation:

Data Analysis

'A policy must be gazetted and synchronised. For example, the use of codes must be standardised, for example drug codes and diagnostic codes, and this includes the types of procedures to be used. We would not want to see a medical facility describe something but get a different meaning. All of these processes are to avoid problems in health data management. All of these things are related with the structure and also the data. The synchronisation is needed from the presentation layer until the data layer.' (Interview_4_div_B_BT)

The validity of the above statement needs to be assessed through evidence and the literature. The MoHM proposed a blueprint Telehealth in 1997 for all health agencies. The document contains standardisation policies for the managerial to the technical framework (Ministry of Health of Malaysia, 1997). However, after the project was cancelled, the document was still available on the MoHM website, which shows that the policy is still employable. The above quotation may refer to the current situation among HTIS in Malaysian public hospitals, based on the interviewee's interpretation. Figure 5.10.1.3 C confirms that a policy for standardisation has existed since 1997.

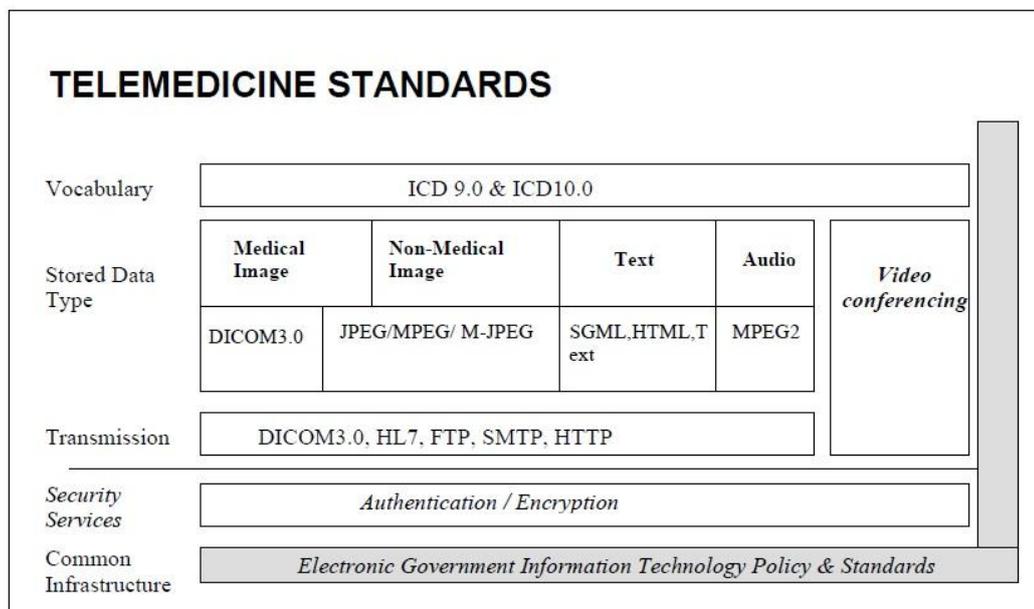


Figure 5.10.1.3: The recommended standards for integration.

Source: Malaysia's Telemedicine Blueprint: Leading Health care into the Information Age (1997 p. 36).

The coding used in MoHM hospitals for the classification of diseases, diagnosis and health records is ICD-10. The use of this code is confirmed by two sources, the interviewees and a circular from the MoHM. Two heads of IT departments and two heads of medical records departments confirm the use of ICD 10 in structuring the medical records in Malaysia. Guidelines from the MoHM on how to manage patient records also specify this coding system as a formal reference for both paper-based and IT systems (Ministry of Health of Malaysia, 2010a, p. 5).

The existence of such a policy is also acknowledged by the head of the IT department in hospital A:

'Third-party applications require a standard interface. For example, Selayang hospital is using ILMS system for their laboratory system. The data capture process by ILMS must be configured so that HIS server will be able to recognise the input and output. The configuration is for the integration. Here, the role of standards such as HL7 and DICOM are needed. That's why the Ministry of Health of Malaysia has stipulated any ICT application procured for hospitals must be HL7 compliant.'
(Interview_5_HIS_A_HDIT)

The above discussion shows the ability of the MoHM to act as manager and administrator for all ICT adoption in health care. The problems that happened were not because the MoHM failed to function but were due to the failure of health agencies and hospitals to comply with directives and policies.

5.10.2 The administrative issues of managing ICT for health care

This section discusses the administrative issues in managing ICT in Malaysian health care and tries to find out whether those issues would occur if an independent agency manages the ICT sector for the MoHM. Eight quotations on the theme highlight the issue. Table 5.10.2 describes these issues with the number of occurrences in the interviews. The discussion assists the researcher to decide whether the findings support the proposition in theme-matching data analysis.

Data Analysis

Table 5.10.2: Issues in the administration of ICT in health care

| The subjects | Number of occurrences in all interviews |
|--------------|---|
| Inspection | Three times |
| Bureaucracy | Five times |

5.10.2.1 Inspection

An inspection is done from time to time to make sure that all health agencies under the MoHM are following the policy and directives from the MoHM. One head of division confirmed this when he was asked about the efforts of the MoHM to ensure that every health agency is following the ICT policy:

‘The monitoring is done by this division. From time to time, this division will conduct an inspectorate of all health care under MoHM to explain about current policies and directives related with ICT strategic planning of MoHM. The meetings will allow direct and transparent communication with the members of MoHM who are attached at the implementer agencies. Normally, the members are more keen to listen directly from the officers who are coming from the headquarters. So that’s the flow that is used to handle issues related with ICT procurements and also ICT strategic planning.’

(Interview_1_div_A_AM)

During an inspection, the inspectors are aware of the diversity of HTIS being used across public hospitals. They are also aware of the violation of procedures in ICT procurement. A senior official of the MoHM reported this situation based on his experience of inspecting public hospitals:

‘Every hospital does not follow the policy which has been set up by the Ministry. For example, in procurement of health information systems, most of the systems are not compatible with the blueprint and proposed architecture which the Ministry wanted all hospitals to follow. As a result, the variety of health information systems could not be integrated and communicate.’ **(Interview_4_div_B_BT)**

The above statement suggests discrepancy between the practice in the MoHM's policies and actual practice in hospitals. Other countries that already employ a statutory agency to manage ICT for health care also face conflicts between the central management of health care and the local management of hospitals. Sambrook (2006, pp. 53–55), in her case study at two trusts and the Department of Health, reports the occurrence of conflict between NHS headquarters and the management of units on many issues, even with clear documented guidelines and procedures.

According to Malaysian law (1957) the statutory body needs to be supervised by a respective minister, even if it receives separate financial allocation from the government. Based on that document, there is no legal allocation that empowers that agency to be totally independent in its actions to enforce ICT policy on health agencies under the MoHM. Based on the above discussion, the administrative issues of inspection would still be unresolved if an external agency replaces the MoHM to manage ICT.

5.10.2.2 Bureaucracy

Bureaucracy in this section refers to the layers of approval that each ICT proposal must go through before final approval is given. This section tries to analyse how an external agency could reduce bureaucracy based on the interview input and findings from the literature.

One medical doctor acknowledged that the current process involving ICT procurement is time-consuming, because each proposal requires approval from groups of committees:

'For the rest of the procurements which are following, the normal policies normally shall take months before final approval is given. As a medical practitioner, I understand if there were complaints from doctors on the delay, because it really affects their work. I also understand the hurdles faced by MoHM to endorse the project, because everything must be according to the procedures.' (**Interview_13_HSP_C_DOC**)

This medical doctor realised the problem in the current working process, as it is too dependent on layers of approval. However, there is no guarantee that employing an external agency will solve the bureaucracy problem or reduce the time needed for project delivery to the customers. Normally, in an IT project, only a small part of ICT determines the flow of the project, even in complex IT projects (Juciute, 2009, p. 132). According to Juciute (2009), the engagement of stakeholders is the dominant factor that determines the smooth running of IT projects in health care. A report by the Parliamentary Office of Science and Technology of the UK (2003) also suggested that managerial factors contribute more to the slow delivery of NHS IT projects. These two findings correct the perception that bureaucracy rarely occurs in developed countries, as suggested by this interviewee:

'The bureaucracy factor might contribute, because if we look to other developed countries, they are more transparent and well planned in managing ICT projects in health care. At the same time, the role of a specialised independent agency which is accountable to plan and execute the implementation of ICT in health care seems to appear to be effective. For example, in Hong Kong there is one agency to handle ICT adoption in health care; in Australia, one agency known as NEHTA; in Canada they have Infoway; and in United Kingdom they have NHS Connecting for Health.' (Interview_2_div_A_AT)

Based on the above suggestions, it appears that employing an external agency does not guarantee that bureaucracy in ICT projects can be reduced or contribute to the shortening of the approval process.

5.10.3 The potential problem of using an external agency to manage ICT in Malaysian health care

This section suggests problems that might occur when employing an external agency to manage ICT in Malaysian health care. The discussion assists the researcher to decide whether the findings support the proposition in theme-

matching data analysis. Five quotations on the theme highlight the potential problems of using an external agency to manage ICT in Malaysian health care. Table 5.10.3 describes the problems and the frequency of quotation occurrence regarding the theme.

Table 5.10.3: The potential problems regarding intangible barriers

| The subjects | Number of occurrences in all interviews |
|--|---|
| The authority of an independent agency | Three times |
| Security and confidentiality issues | Two times |

5.10.3.1 The authority of independent agency

Authority in this section refers to the recognised power of an external agency to plan, enforce, execute, manage, direct, allocate and cancel any matter related to ICT in health care. The recognition should come from the cabinet and all the staff of Malaysian health agencies.

Eleven relevant quotations on the theme mention specifically the possibility of assigning an independent agency to manage ICT in Malaysian health care. The subjects from those quotations can be classified into two categories. The first category is the authority to manage ICT. The second category is leadership and chain of command in ICT management, which has been discussed in section 5.2.3.2.

One medical official questioned the idea of assigning an independent agency to manage ICT in Malaysian health care. This is an example of concern over the authority issue.

‘For me, managing ICT for all public health agencies requires recognised authority by all. Currently, everybody recognises MoHM as a main ministry that handles everything related to health care in Malaysia including ICT for health care. If external agency is assigned with a task to manage ICT on behalf of MoHM, I do not think health agencies will comply to any directive, orders, circulars or policy from that agency.’
(Interview_11_HIS_A_DOC)

Data Analysis

The management of ICT in health agencies such as hospitals requires a clear definition of authority and leadership, because there is a strong relationship between technology and organisational structure (Barley, 1990, p. 98). The Malaysian government is a hierarchical organisation. The MoHM has been managing all aspects of technology in health care for almost 30 years since the 1980s (Ministry of Health of Malaysia, 2011). Therefore, to assign an independent agency to manage ICT just for health care is not feasible, since the chain of authority has already been synonymous with the MoHM. A remark from an interviewee supports this notion:

'If ... MoHM authorises the management of ICT to independent organisation, so what about the security and confidentiality of patient records? There are a few questions that should be asked about this proposal. In Malaysia, there are many categories of government agencies, such as ministry, department, statutory organisation, centres, etc. So which type of organisation will manage the EHR and HTIS implementation? One more thing, what is wrong with the current administration by MoHM? I do not see any defect or wrong doing, because MoHM holds the authority over all health agencies in Malaysia, except for those under different ministries. Another thing, who is going to monitor or control this agency if we put it under MoHM? What is the purpose doing that? It is just the same with current management. I do not think management of respective hospitals will listen and obey any directives given by this agency. Why should they? They are under MoHM jurisdiction.' (Interview_8_HSP_C_HDRM)

The above statement shows concerns about the possibility of health agencies rejecting any directives or decisions made by an independent agency, since it is not directly linked to the MoHM. It also suggests redundancy of authority if the agency is linked to the MoHM, because currently there are two divisions of the MoHM that directly manage ICT for health care.

5.10.3.2 Security and confidentiality issues

The issues of security and confidentiality are significant under this proposition. One medical doctor who is currently working in a hospital with HIS anticipates problems from this approach:

'Can we trust an external agency with patient data? I do not know how they will manage it, but I think as administrators of EHR implementation, they will have access to the systems for configuration or data administration, so how to guarantee patient's health data will not be disclosed or exposed? As a doctor, I understand patient data is very sensitive.' (Interview_10_HIS_A_DOC)

The above statement raises a concern over the security of patient data if an independent agency is assigned to manage ICT for Malaysian health care. According to a MoHM circular (no. 17/2010) on patient record management, all information related to patients is confidential and can only be accessed with the authorisation of the Malaysian government that is represented by the MoHM. This circular has disabled all the potential of an independent agency to manage ICT on behalf of the MoHM.

The circular can be considered as a reaction to a concern raised by Mohan and Yaacob in 2004 (pp. 225–226.) They identified loopholes in the 1997 LHR projects regarding security issues. The management of patient data by a third party including contractors requires monitoring mechanisms to ensure that the confidentiality of patients' data is not breached.

5.11 The findings from the propositions

This section summarises all the key findings from the nine propositions.

5.11.1 The findings from the first proposition

In general, the findings from the first proposition suggest that only limitations in ICT infrastructure hamper the implementation of interoperable EHR, and not electricity infrastructure. Theme matching has produced findings that differentiate the infrastructural issues into two categories. The first category is the implementation of interoperable EHR across the nation, which includes both rural and urban areas. This category includes not only public hospitals in urban areas but also government clinics in rural areas. The second category is the implementation of interoperable EHR in public hospitals located in urban areas. A summary of the findings is given below:

1. There is no direct relationship between the inadequacy of electricity infrastructure and problems implementing interoperable EHR across Malaysian public hospitals.
 - a. It is apparent that many interviewees seem to relate the inadequacy of electricity infrastructure with rural areas, but there are no public hospitals in rural areas in Malaysia because all hospitals are located in urban areas.
 - b. It is apparent from the findings that all public hospitals are located in urban areas where the basic infrastructure is adequate and available on a permanent basis.
2. It is apparent that the interviewees agree on inadequacy of ICT infrastructure to support interoperable EHR implementation.
3. The findings also suggest two reasons that contribute to the inadequacy of ICT infrastructure: financial limitations and human intervention.
4. The findings also suggest two types of ICT infrastructure that are insufficient to support the implementation of interoperable EHR and HTIS: computer hardware and networking equipment.
5. It is apparent from the quotations that no interviewee directly believes that software inadequacy affects interoperable EHR and HTIS implementation.
6. It is clear from the findings that the MoHM's current infrastructure is able to support Patient Management Systems (PMS) as an alternative solution to HTIS, but it may not support the range of functionality required in EHR.

7. The findings confirm the ability of various hospital departments (same hospital) to exchange data between them, even with different health solutions attached to the HIS. The findings also suggest however, that there is an inability of different hospitals to exchange data between them, even when there is the possibility of the same technology being used by the vendors.

5.11.2 The findings from the second proposition

The findings from the second proposition acknowledge that department-based ICT procurement causes diversity and hampers the interoperability of HTIS and EHR. A summary of the findings is given below:

1. It is apparent from the findings that there is a lack of coordination between ‘what has been planned’ and ‘what is required’ in the procurement of ICT by the MoHM and health agencies.
2. The findings indicate that the flexibility of decision-making by the central committee to approve urgent and unplanned ICT projects has increased the number of unplanned and segregated HTIS in public hospitals.
3. There is an indicator from the findings that unplanned ICT procurement is contributing to the issue of technological obsolescence, which adversely affects the adoption of interoperable HTIS and EHR.
4. The findings suggest that vendors favour department-based ICT procurements because these approaches provide more projects for them. Therefore, the findings recommend proper management of the vendors as a controlling mechanism.
5. It can be concluded from the findings that most unplanned and department-based ICT projects are based on direct negotiations that surpass normal procurement procedures.
6. It is observed from the findings that department-based ICT procurements might lead to an issue of intellectual property, because the software is procured specifically to cater for specific departmental needs.

7. The findings suggest that the use of HTIS that is totally owned by the MoHM can help solve the problems of department-based ICT procurements.

5.11.3 The findings from the third proposition

The findings from the third proposition show that there is a link between the competency and understanding of people who administer ICT with success in implementing interoperable EHR and HTIS. A summary of the findings is given below:

1. It is apparent from the findings that there is a lack of innovative culture among ICT administrators at the MoHM, as they are keen to imitate and accept any ICT solutions offered and used by developed countries.
2. There is evidence from the findings that the nature of the working environment at the MoHM contributes to the imitative behaviours of those administrators, which is hierarchical in nature.
3. It is observed from the findings that the cancellation of any approved plan indicates internal problems with ICT administrators such as weak leadership and management.
4. The findings suggest that a failure to plan which leads to the discontinuity of an approved plan is an indicator of the competency gap among administrators of the MoHM.
5. There is evidence from the findings that suggests a knowledge gap among ICT administrators in terms of proficiency to link medical subjects with ICT, because both subjects are different and difficult to link.
6. The findings suggest that the knowledge gap among ICT administrators happens due to the inflexibility of post establishment that specifies computer science and information technology graduates for jobs related to ICT, and medical graduates for the medical profession.
7. An indicator from the findings suggests that a low level of research in Malaysian health informatics is a sign of a knowledge gap among ICT administrators.

5.11.4 The findings from the fourth proposition

The findings from the fourth proposition show that there is an opportunity for external parties to interfere in the decision-making in ICT procurement because of the hierarchical administrative systems. A summary of the findings is given below:

1. The findings present indicators that the processes and procedures set by Malaysian central agencies for any government procurement aim to make sure that no external interference influences the decision-making process.
2. The evidence from the findings shows that the chain of command in normal ICT procurement of the MoHM is very formal and strict and limits external interference in the process.
3. It is clear from the findings that interference of external parties only occurs for procurements that are directly endorsed by the top management of the MoHM because they do not follow the procedures.
4. It is apparent from the findings that vendors try to use indirect influence on specifications or system requirements even though those things are under the jurisdiction of the MoHM.
5. The findings also identify the lack of restrictions set by the MoHM in selecting the type of technologies to be used as long they are compliant with the requirements and system specifications of the MoHM.
6. Politicians' interference in decision-making is done through the direct negotiation of ICT procurements.
7. The findings also associate external interference with political mileage, because politicians need it to support their popularity among supporters.
8. The findings suggest four positive implications of external interference in the ICT procurement processes. The benefits from external interference include shortening processing times, reducing the workloads of administrators and reducing dependency on technical committees from the MoHM.
9. The findings also identify four negative implications from external interference in the decision-making of ICT procurements. The negative outcomes are meddling in ICT strategic planning, bypassing the agreed procedures in procuring ICT for health care, overspending taxpayers'

money and promoting favouritism among government officials by the top management.

5.11.5 The findings from the fifth proposition

The findings from the fifth proposition suggest that the selection of certain standards does not guarantee interoperability across different hospitals. A summary of the findings is given below:

1. It is apparent from the findings that the MoHM has already specified two main standards (HL7 and DICOM) for vendors to comply with in HTIS and EHR systems.
2. The findings suggest that compliance with the standards is not the sole factor that determines the interoperability of HTIS and EHR.
3. There is evidence from the findings that shows that HTIS and EHR systems used in different hospitals with the same standards still cannot interoperate and exchange health data.
4. The findings also suggest that as well as of technical limitations that hamper interoperability, political and security factors also hamper the interoperability of HTIS and EHR systems.
5. The findings also suggest that technical configuration during HTIS installation determines its potential to interoperate. As a result, inter-departmental data exchange occurs from this configuration. The vendor normally configures the HTIS during installation. Therefore, it suggests other factors caused the absence of interoperability.
6. The findings also acknowledge that the absence of a national Master Patient Index in technical specification across Malaysian public hospitals contributes to the non-integration of HIS.
7. It is clear from the findings that the Malaysian legal system does not permit patients' health records to be shared outside the health agency where he or she receives the treatment without written consent from the authorities.

8. There is suggestion from the findings that the only permissible health documents to be shared are a summary of the medical records.
9. The findings also highlight that collaboration with other agencies in pilot projects will technically test suitable standards for interoperability of HTIS and EHR.
10. There is suggestion from the findings that admit the absence of any specific policy to support interoperability across different HTIS and EHR systems.

5.11.6 The findings from the sixth proposition

The findings from the sixth proposition identify the existence of variables and the dependency of open-source software on those variables before it is relevant for Malaysian health care. A summary of the findings is presented below:

1. Many interviewees acknowledged that the use of open-source software is to provide an alternative solution that is not bound under a proprietary licence.
2. There is evidence of a clash between the recommendations made by MAMPU (Malaysian Administrative Modernisation and Planning Unit) as the central agency for the Malaysian government and the preferences and practices of the MoHM concerning open-source technology in ICT procurement.
3. It is suggested that a transformation from proprietary to open-source technology is done through modification of HTIS and EHR systems source codes. The transformation can be done because all procured HTIS and EHR systems are belonged to the Malaysian government.
4. There is no clear evidence (in Malaysian health care) from empirical research that by using open-source technology the cost will be reduced. In fact, based on the interviewees' past experiences, sometimes it costs more.
5. The use of open-source technology is not in accordance with the real concept of open-source software due to the limitation in technical expertise and attitudes.
6. The variables that support open-source technology if the MoHM would like to consider using it in future are:

- a. Transforming all proprietary HTIS and EHR systems into open source through modification of source codes and changes to the licensing status to a GNU public licence.
- b. Aligning the directives between MAMPU and MoHM to promote the use of open-source technology in health care.
- c. Conducting more empirical studies on the economic benefits of open-source technology for Malaysian health care.
- d. Enhancing the technical expertise of ICT administrators of the MoHM to suit the requirement for technical skills in open-source technology.

5.11.7 The findings from the seventh proposition

The findings from the seventh proposition show that there is a link between the acceptance and rejection of EHR/HTIS by physicians and the successful implementation of interoperable EHR and HTIS. A summary of the findings is given below:

1. The findings suggest that resistance among physicians is caused by unwillingness to change their working methods, especially among senior doctors.
2. There is a discrepancy among junior doctors compared to senior doctors in perceiving the benefits of HTIS. The perception is due to early exposure to ICT in their medical careers.
3. There is a concern from doctors regarding the possibility of doubling their workload by using HTIS and EHR systems, because in addition to diagnosing the patients they also need to key the data into the systems.
4. There is an indicator from the findings that training could improve the level of acceptance by the end users (physicians) of HTIS and EHR systems.
5. The findings portray that the negative perception by physicians of HTIS and EHR systems is caused by their frustrations over incomplete ICT

procurement. Incomplete procurements affect their motivation to use the systems because it might increase their workload.

- a. However there was suggestion that frustration over incomplete HTIS procurements can be alleviated if end users understand the reasons behind the delay.
6. Technical disturbance because of system breakdown affects perceptions of the feasibility of HTIS among medical professionals and administrators.
7. Technological obsolescence is another factor that diminishes the positive reaction towards the benefits of HTIS in Malaysian health care.
8. The perception of the inadequacy of resources to completely equip all hospitals with HTIS affects the level of acceptance by physicians of the benefits of HTIS.

5.11.8 The findings from the eighth proposition

The findings from the eighth proposition suggest that the success of interoperable EHR and HTIS, and the ability of the MoHM and health agencies to resolve the current barriers, depend on a manageable plan to tackle those barriers. A summary of the findings is given below:

1. It is clear from the findings that intangible barriers affect HTIS and EHR implementation more than tangible barriers.
2. There is evidence from the findings that intangible barriers are more difficult to handle than tangible barriers.
3. There is evidence suggesting that effective change management would be a contributing factor that would affect the adoption of HTIS and EHR in Malaysian public hospitals.
4. The findings also provide an indication that the competency gap of ICT administrators contributes to the non-technical barriers that hamper HTIS and EHR adoption.
5. There is one indicator that links technical barriers, such as ..., as a contributing factor that hampers HTIS and EHR adoption.

6. For tangible barriers, there are indicators that portray the level of readiness to harness ICT in Malaysian health care:
 - There is still a wide digital divide between rural and urban areas, which need to be resolved to implement interoperable EHR.
 - There are still unresolved issues of the networking infrastructure and broadband network to ensure smooth data transaction across the regions.
 - The plan to have interoperable EHR across Malaysian public hospitals requires financial commitment from the Malaysian government.

5.11.9 The findings from the ninth proposition

The findings from the ninth proposition show the irrelevancy of an independent agency to lead and manage the implementation of interoperable EHR and HTIS.

A summary of the findings is presented below:

1. It is apparent from the findings that the MoHM is a gatekeeper for any new ICT projects between health agencies and the top management of the MoHM, which requires it to review the proposal and amend it if necessary before it can be tabled to the central committee.
2. The finding also recognises the role of the MoHM as an inspection team to monitor and report the use of ICT across health agencies, but with limited power to act except in cases involving vendors.
3. The findings also provide indicators of the inconsistency and steadfastness of the MoHM to execute the approved plan because of certain hindrances.
4. It can be concluded from the findings that ‘a policy with less enforcement’ is common in ICT adoption projects under the MoHM.
5. There is evidence from the findings that leadership is a determining factor in the success of any ICT adoption projects in the MoHM, because the leader has absolute power either to proceed with the approved projects or to cancel them.
6. The findings suggest that bureaucracy and lack of transparency in the current ICT administration of the MoHM justifies the notion of using an

independent agency to manage ICT adoption projects in health care. However, the findings failed to guarantee whether an external agency would be totally independent and transparent in administering ICT.

The findings identify three major benefits if the MoHM applies this approach. The benefits are:

- The anticipation for an external agency to be impartial in policy enforcement and inspection because its officials are not members of the MoHM
- The expectation for an external agency to be impervious to any influences from external parties in managing ICT projects, because the career paths of the officials of an external agency would be independent of a government scheme.
- The expectation for an external agency to perform based on the outcomes and with less bureaucracy in managing ICT for health care

However, the findings also suggest three problems that may arise if the MoHM is not prudent in implementing this approach:

- The problem of enforcing directives and orders to public hospitals because of the issue of authority.
- The problem of financial resources, because there is no guarantee that the Malaysian government will modify its method of financial allocation.
- The problem with regard to the security and confidentiality of patient health records, because only authorised government officers are allowed access to those data.

5.12 Conclusion

To sum up this chapter, the outputs from interviews have highlighted numbers of relevant patterns under the nine propositions. To test their validity, the patterns were triangulated with contents of government documents and discussed in context with relevant academic literature.

Data Analysis

The impact of the findings discussed in this chapter are considered in Chapter 6, where models that aim to overcome many of the barriers and negative factors influencing interoperable HTIS will be created and explained.

CHAPTER SIX

DISCUSSION: MODELS TO ADDRESS THE FACTORS AFFECTING THE INTEROPERABILITY OF HTIS/EHR IN MALAYSIA

6.1 Introduction

In the preceding chapter, the data analysis was framed around nine propositions. Those nine propositions were created based on the nine issues that are highlighted in section 1.3.1 that are the focus of this research. The propositions have generated patterns that explain all nine issues. The patterns were then summarised and formalised into the findings. Those summaries were listed in section 5.11 that explain the reasons why interoperability of different HTIS and EHR has not been achieved in Malaysian healthcare.

To discuss the relevancy of the findings (in the section 5.11) to the reality of HTIS and EHR implementation in Malaysia, those findings were validated by discussing the findings and acquiring feedback from the interviewees. As outlined in the methodology chapter (Section 4.6.5), the issues discussed in the previous chapter were discussed with officials by telephone conversations from the five case study organisations during February 2012. The researcher had also attended a series of meetings with those officials on June 2012 to seek their additional opinions on the findings. The main question during those meetings was:

- How relevant are those findings to the reality of implementation of EHR and HTIS in Malaysian healthcare?

All of them agreed on the findings, but made additional remarks.

This feedback was then used to generate seven major factors that represent enablers and barriers for interoperability of HTIS in Malaysian healthcare. In this research, 'factors' refers to determinants and contributors from both technical and non-technical aspects that influence the successful implementation of interoperable EHR and HTIS in Malaysian public hospitals.

6.2 Infrastructural management

This factor defines the importance to identify required infrastructures and manage them before and after the implementation of interoperable EHR and HTIS. One of the most significant discussions in the literature is how the existing infrastructures affect an ICT project and how to ensure the ICT infrastructure is robust enough to support the complexity of HTIS (Rodrigues and Vadya 2010).

The outcomes of this research as illustrated in section 5.2 also suggested that the loose control by MoHM over the ICT infrastructures affects in a negative way HTIS and EHR implementation. Infrastructural governance should be treated as a foundation of strategic governance of ICT infrastructures for Malaysian healthcare. The feedback from the case study organisations suggest the absence of this element, especially in the inability to identify required ICT infrastructures during pre-implementation of HTIS. Furthermore, the MoHM also failed to computerise the 115 non-HTIS hospitals by using the existing ICT infrastructures, which suggests the absence of efficient governance of the resources. The consequence of this did not only affect the delivery of HTIS but also the success of HTIS projects.

The feedback from the case organisations in February and June 2012 supported the preliminary findings in the previous chapter (Chapter Five) regarding the poor management and coordination of ICT infrastructures to support the HTIS and EHR projects, which decreases the potential for interoperability. They also provided guidelines that are used to develop a new model to manage ICT infrastructures in HTIS projects as preparation for interoperability (see Fig 6.2.1.2 in Sec 6.2.2). The following section proposes solutions to overcome the issue.

6.2.1 Changes in managing the ICT infrastructures

The working processes that were mentioned in the feedback and shown in Figure 5.3.1.1A suggest the current management of ICT infrastructures during HTIS procurement is more towards reactive management. Reactive management in this

Discussion

context refers to a segregated managerial approach in tackling the infrastructural issues in both planning and executing stages. The reactive management of ICT infrastructures is illustrated in Figure 6.2.1A

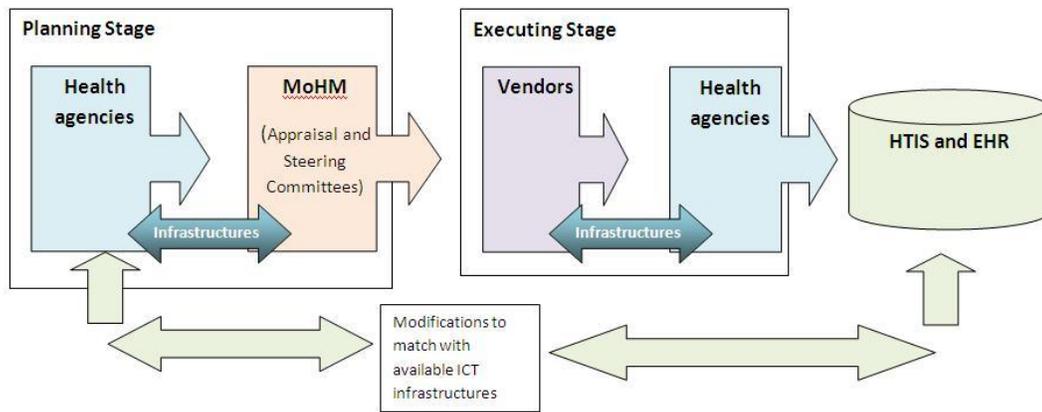


Figure 6.2.1.A: Current model of ICT infrastructural management

The above figure suggests how the issues of ICT infrastructures are not treated as main components in HTIS projects. They are managed in isolation for each stage of HTIS procurement with no underlying plan that covers all stages. To counter this limitation, changes are required to include infrastructural governance as major parts in HTIS and EHR projects. Figure 6.2.1B below proposes a new model to manage ICT infrastructures in HTIS procurements.

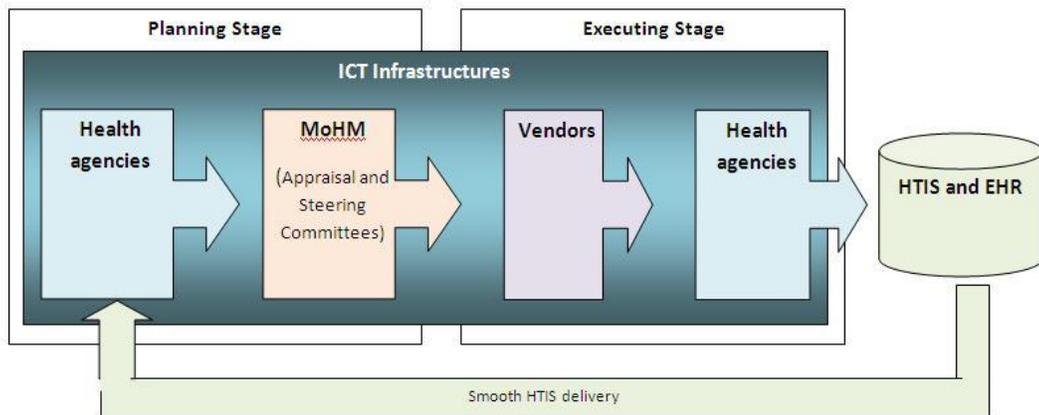


Figure 6.2.1B: New model for ICT infrastructural management

6.2.2 Managing the existing ICT infrastructures

It is also recommended by the literature that the most feasible and cost-efficient method to implement a HTIS project is through slotting the HTIS into existing ICT infrastructures rather than building them from scratch (Spil et al. 2010, p. 97). The ability to use the existing ICT infrastructures is another possible approach that can solve insufficient ICT infrastructures to support new HTIS projects in Malaysia. All hospitals (either HTIS or non-HTIS hospitals) are equipped with the same ICT infrastructures such LAN, WAN and computer hardware.

Currently, the MoHM has improved all nine modules of the Patient Management System (PMS) to be equally functioning as a proprietary hospital information system (HIS). Those nine modules were mentioned in the section 3.4.1. According to the feedback from the case organisations, this software is suitable to be used in all hospitals including non-HTIS hospitals because it is designed to support the physical infrastructures of those hospitals. However, due to reluctance by the hospital management the software is only used for registration and billing purposes. This situation requires the policy makers of MoHM to issue strict directives over the use of PMS to all non-HTIS hospitals and to consider the application of PMS as one of their key performance indicators (KPI). The policy makers in MoHM refer to the Minister, Secretary General and his deputies, and Director General of Health and his deputies.

The necessity to migrate legacy systems into HTIS was acknowledged in the feedback. However, it appears that most officials do not have a thorough knowledge of how migration can be accomplished. The only knowledge they have about the legacy-system migration is by using the third-party application. However, when they were briefed about the Distributed Object (see below for a brief discussion of Distributed Object) by the researcher, the majority of them were agreed on the potential of this method to migrate the legacy systems into PMS. With the latest technology (such as “Distributed Object” under the “Distributed Computing Architecture”) many stand-alone legacy systems from various departments can be migrated into the HTIS. The possibility to migrate legacy systems into new HTIS by

Discussion

using the ‘Distributed Object’ was proven by Dwivedi et al. (2010, p. 895) who successfully collaborated the old legacy system into the latest version of HTIS. The ‘Distributed Object’ is an Object Oriented Technology in form of independent piece of created code that can be made visible to other systems irrespective of the language and compiler used to create it (Dwivedi et al. 2010, p. 895).

As a suggestion, Figure 6.2.2 proposes a new model to optimise the existing ICT infrastructures, which can bring all Malaysian public hospitals to the right track for interoperability.

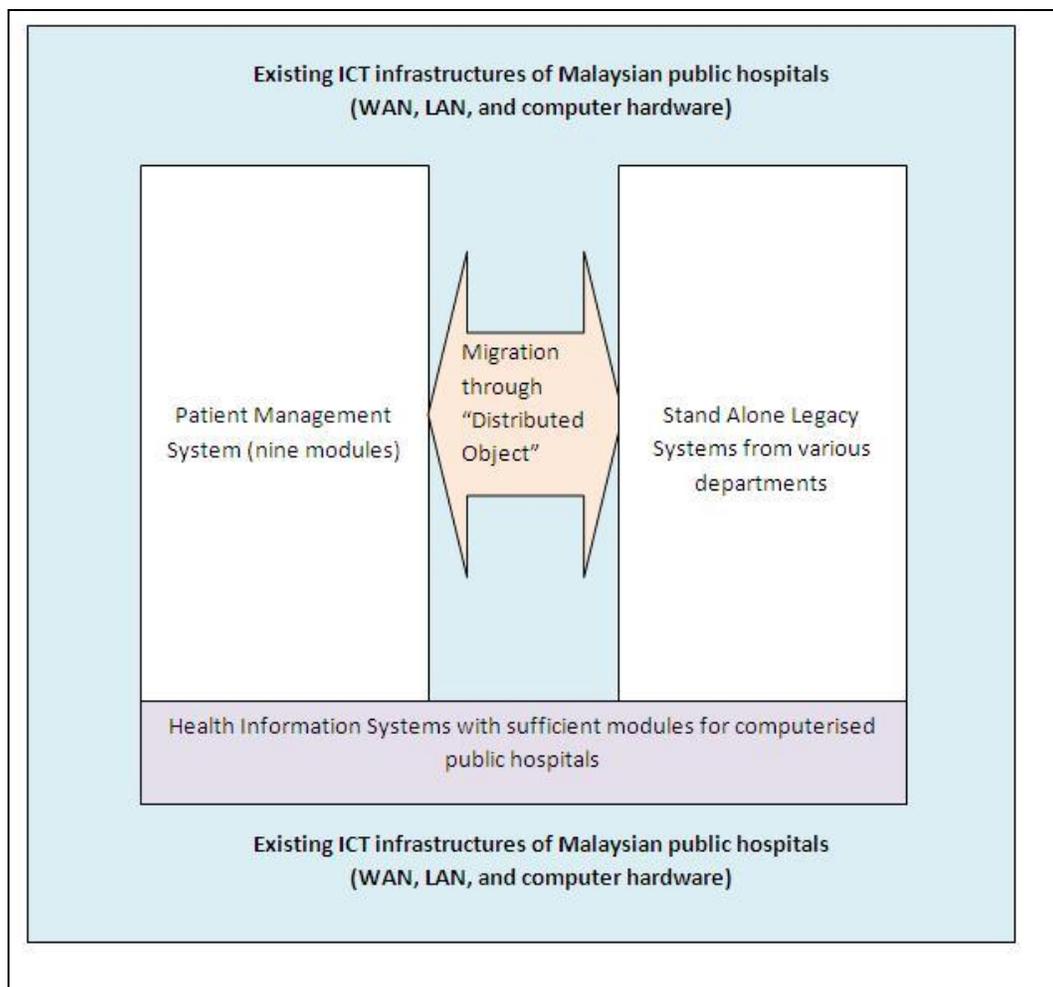


Figure 6.2.2: New model for migration and usability of existing ICT infrastructures

The figure above not only describes a new model to solve the mismatching technology, but also gives directions for MoHM to completely computerise public

hospitals as a national project. It also enables the possibility to integrate the legacy systems into Patient Management System because both of these systems are operating under the same ICT infrastructures.

6.3 Workflow management of administrators and users

Workflow management in this section refers to the definition by Breas and Guah (2010, p. 1329) who consider it as:

“Workflow is an abstraction of a business process. Normally a workflow comprises a number of logical steps, known as tasks. These tasks consist of dependencies among tasks, routing rules and participants.”

This factor defines one important requirement in workflow management, which is an importance to manage inputs from different portfolios of people. Several groups have been identified in Chapter 5 and by the literature, whose outputs are crucial in determining the success of EHR and HTIS adoption in health care. Those groups include doctors, nurses, medical support staff, administrators, patients, caregivers, technology support staff, policymakers and members of the community (Mackert et al. 2010, p. 542). Those groups represent the administrators and users who are involved in HTIS and EHR projects. The administrators for HTIS projects in Malaysian healthcare were discussed in section 5.3.1.1 and the users were outlined in section 5.3.1.2.

Furthermore, outputs from the data analysis in Chapter 5, especially under the second, third, fourth and fifth propositions, illustrate the inactive participation between those groups in project management of HTIS and EHR. Inactive participation is another contributor that inhibits ideas for interoperability because it discourages stakeholders and users to expand the usability of the project into a distributed system environment.

The feedback from the case organisations agreed with the findings of the previous chapter on the issue of participation among administrators and users in HTIS projects.

Discussion

To optimise the workflow management for HTIS projects, two issues need to be improved. They include active participation of stakeholders and improving the diversity of professions to bridge the knowledge gap.

6.3.1 Participation of stakeholders and users in the HTIS and EHR project

Currently, the involvement of administrators and users in HTIS and EHR projects appears only to meet the basic requirements by MAMPU with no intention to expand the usability of the project into a distributed environment with other hospitals. Figure 6.3.1A describes the current participation of these people..

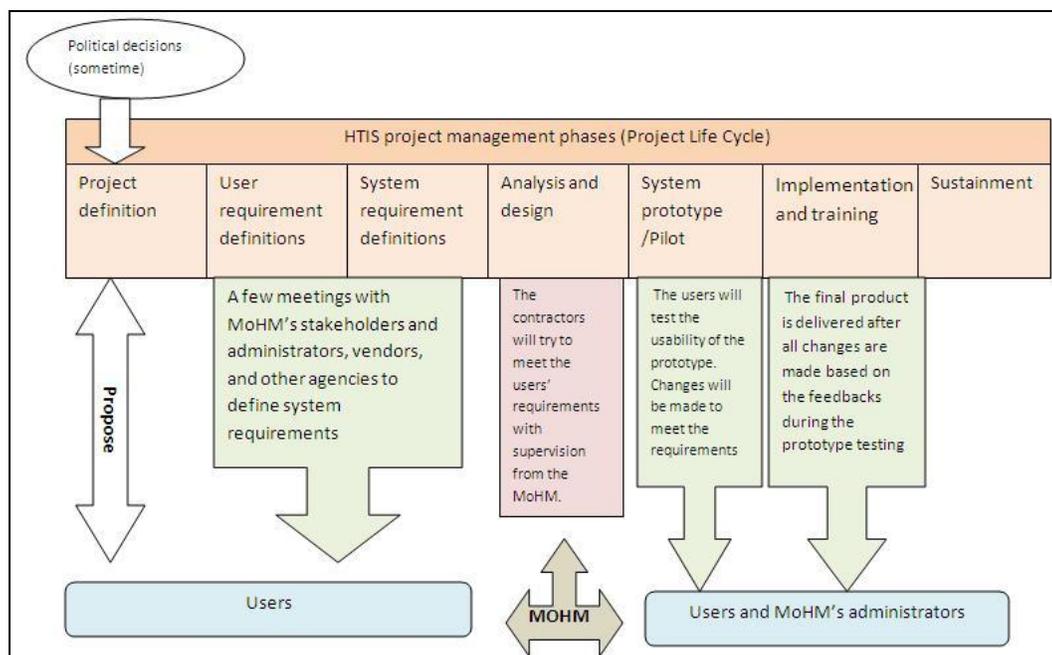


Figure 6.3.1A: Current participation of stakeholders and users in HTIS projects

The figure suggests that participation of administrators and users in HTIS project management is for specific HTIS projects only and not for a distributed environment for the systems. Most of the systems are developed to cater to specific departmental requirements with no intention for interoperability. As a result, most vendors prefer to design HTIS outside the loosely coupled architecture so that they can monopolise the

Discussion

other projects as well. This reaction by vendors was highlighted in the section 5.5.2.1, on the issue of vendor interference to monopolise the HTIS projects.

During the prototype testing, users and administrators are given chances to request that contractors modify the software if there is a fault in its functionality, however, most of the time, the administrators try to avoid requesting modifications, except for serious faults, because it will delay the delivery of the system.

To improve this situation, any involvement of administrators and users in HTIS project management must be based on the intention to enable all HTIS to function in a distributed system environment for future interoperability. Figure 6.3.1A proposes a new model for workflow management.

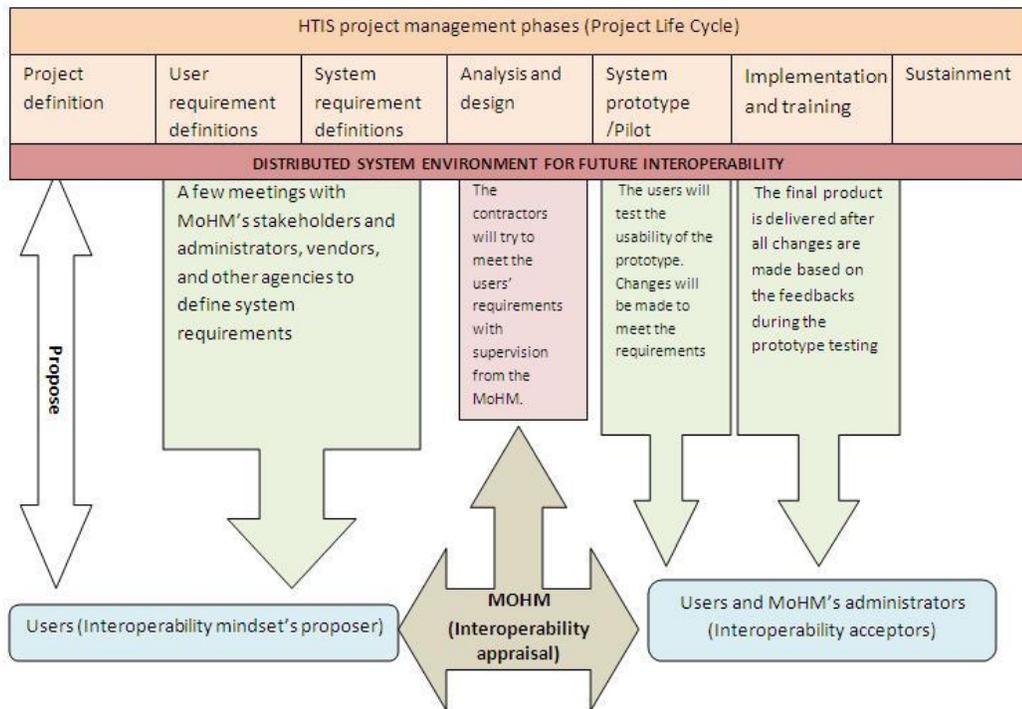


Figure 6.3.1B: New model of HTIS workflow management

It may be concluded that, the distributed system environment should become the main priority for all stakeholders in their participation in HTIS project. Their inputs should represent the idea of enabling for future interoperability. The idea of a

distributed system environment should start at the first phase of HTIS project management under the project definition. The idea then should be formalised in all phases of project management.

6.3.2 Diversity of professions and knowledge gap

It has been acknowledged by some researchers that health services are defined by groups of people who come from different disciplines and pursue different goals (Alvarez, 2003; Connell & Young, 2007; Ray and Mukharjee, 2007, p. 479). The diversity permits different specialisations of professionals to work in health services together with medical professionals. In Malaysian hospitals, the composition of professionals seems to resemble those studies. They include physicians, allied health professionals, IT officials, administrators and supporting staff. Furthermore, the dynamism and complexity of medical disciplines requires those who are involved in managing the HTIS and EHR to understand the processes and latest technology in this field. The knowledge gap between medical and IT professionals can create incorrect translation of medical requirements into system requirements (Fitch 2004; Halim and Sarmad 2010, p. 10). The incorrect translation of medical requirements subsequently affects the functionalities of the HTIS.

Several sections in section 5.4 of the third proposition were dedicated to discussing the issue of knowledge and skill efficiency among ICT administrators. In addition, the feedback from the case organisations supported the preliminary findings from the previous chapter on the need to redesign a model of knowledge and skill management among ICT administrators.

Currently, the post establishments of ICT administrators for HTIS projects are specified for graduates whose tertiary background is a Bachelor degree in Computer Sciences and Information Technology. The majority of them are unskilled in any medical disciplines. Their understanding about medical functionalities are grasped while managing HTIS projects. The Malaysian public servant schemes do not permit

Discussion

medical graduates to enter specialisms other than medical professions because of a shortage of doctors in Malaysian healthcare (e.g. they cannot enter as administrators, systems developers or consultants). Further details about this issue can be found in section 5.4.1.1.B.

To improve this situation, the Malaysian government should introduce a flexible scheme to permit medical professionals to be attached as ICT administrators for MoHM. This scheme would enable knowledge sharing among medical and IT professionals and close the knowledge gap between these two disciplines. It would also assist the MoHM to develop templates for HTIS system requirements, which can be applied to all new HTIS projects. Figure 6.3.2 proposes a new model to improve the knowledge gap among ICT administrators and avoid incorrect translation of HTIS' system requirements.

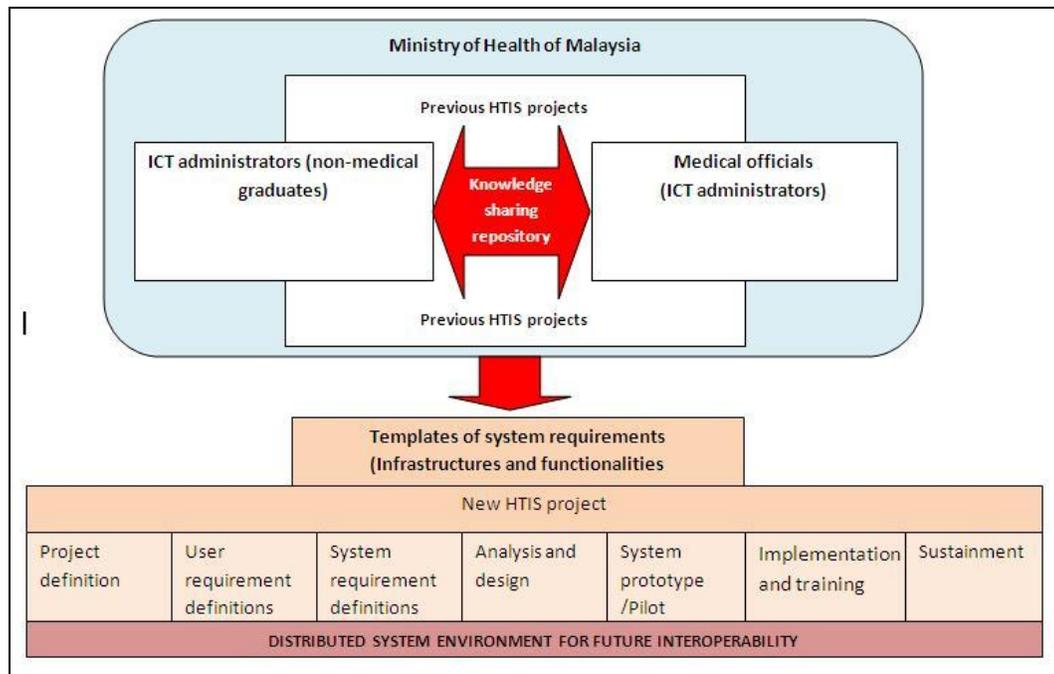


Figure 6.3.2: A new model to bridge knowledge gaps in HTIS projects

6.4 Innovative culture

This factor defines the importance of innovative culture among members of MoHM as a foundation before interoperability can be implemented. The type of innovation

that this section aims to emphasise is the Programmed Innovative culture. A term that is outlined by Zaltman and et al. (1973, p. 17) and refers to innovation that is scheduled in advance. The latest feedback from the interviewees agreed that the absence of an innovative culture may lead to an environment that discourages risk taking and experimentation especially when it involves new ideas, for example, interoperability.

The feedback from the case organisations therefore agreed with the findings presented in the previous chapter about the lack of innovative culture among members of MoHM concerning the use of HTIS and EHR. They also highlighted issues that were essential in developing a new model for innovation as preparation for MoHM members to embrace the concept of interoperability.

6.4. 1 Instilling the innovative culture among MoHM members

It appears from the feedback and data analysis chapter, which a barrier to new ideas occurs among the middle and operational staff of MoHM. From their perspective, new ideas appear to add a new burden into their workloads. This can be seen by their reactions over the suggestion to interoperate different HTIS from different public hospitals, which a majority of them feel is not necessary. That perception is an outcome of the fact that they have been doing the same routines over the years. The campaign to instil the importance of innovation was only begun in the last two years by the top management, and requires more time duration to convince the operational staff.

Innovation in organisation is not something that can be achieved overnight as it requires awareness and support from all level of organisational members (Zaltman et al. 1973, p. 53). To promote innovation, it requires introduction of new reward systems for new ideas that can improve current working systems for its staff, including HTIS. Promotion of HTIS must also be applied to the non-HTIS hospitals to motivate members of those hospitals to agree on the idea of computerisation of healthcare.

To instil innovation, the policy makers of MoHM must permit changes in working procedures and processes, so that staff will be able to explore new best practices of doing thing. For example, the current procedures inhibit health data exchange among different hospitals, hamper many efforts to create interoperable HTIS environment. Figure 6.4.1 proposes one model for how an innovative culture could be diffused into MoHM’s operational staff.

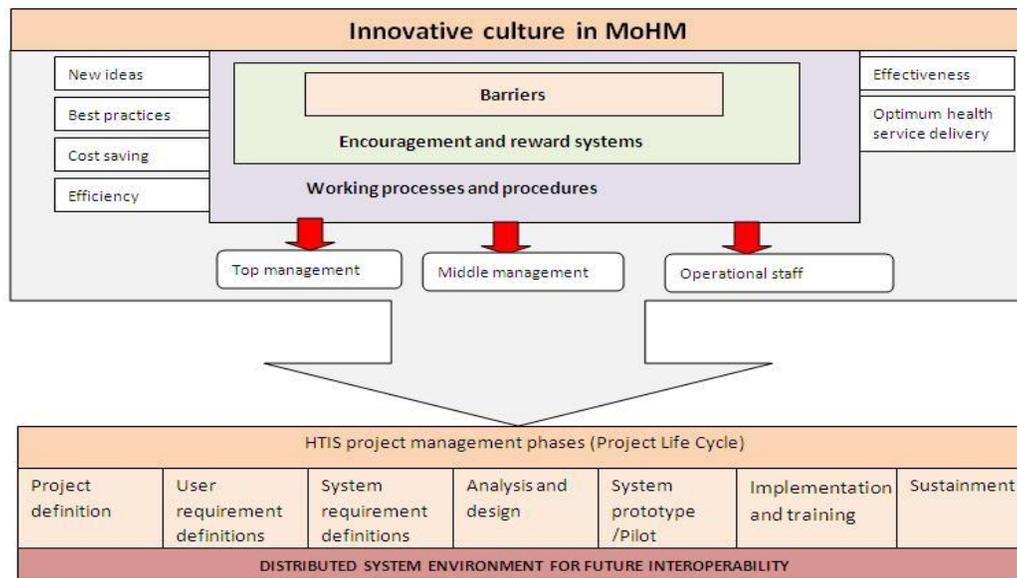


Figure 6.4.1: New model of innovative culture

6.5 Leadership

This factor emphasises the roles of leadership in optimising the use of ICT in Malaysian healthcare. In hierarchical organisations such as MoHM, the continuity of ICT projects depends on the commitment of a leader who leads the ministry. Failure of an ICT project can occur for example, when newly appointed leaders change direction from their predecessors. A recent exploratory study by Luna-Reyes, and Gil-Garcia (2011, p. 344) into the adoption of ICT in the government sector suggests that strong leadership in the project implementation phases contributes to the success of the implementation.

Some sections in the second, fourth, eighth and ninth propositions discuss this issue in length, and conclude the important role of leadership (top and middle management) in ICT programmes for Malaysian health care. The top management includes the Minister of MoHM, Secretary General and his deputies, whereas middle management refers to all administrators from the two divisions (A and B) who took part in this research. Conflicts of power between top and middle leadership is a main issue that affects the implementation of interoperable HTIS and EHR.

The feedback from the case organisations agreed with the findings from the previous chapters (under the second and fourth propositions) on the importance of leadership in dealing with planning to implement HTIS and EHR in Malaysia. To enable interoperability, leaders of MoHM must try to resolve three issues that are the barriers in any HTIS and EHR projects. Those issues, which will be discussed in the coming sections, include establishing new models for division of power, MoHM-vendor relation and proper management of intellectual property.

6.5.1 Division of power

Division of power refers to efforts to avoid conflict of interest in making the decisions concerning ICT projects between top and middle management of MoHM. Ideally, the top management is supposed to be concerned about strategic directions of MoHM to improve health service delivery to Malaysian population, whereas middle management is supposed to manifest that direction into action plans. The strategic directions for example, include the blueprints and decisions to optimise health service delivery by using ICT in Malaysia. To support the blueprints and decisions, middle management will propose series of operational programmes based on the allocated budgets.

Currently, there is no clear distinction of power between these two portfolios, which sometime causes overlap between their jurisdictions. In the previous chapter, there

Discussion

were many complaints from middle management over the interferences by the top management on the action plans. The interferences included for example, the selection of vendors for some of HTIS projects, which bypassed the decisions and plans made by the middle management.

Interferences and overlapping between these two jurisdictions can be avoided through mutual understanding between top and middle management and arbitration by a third party. Figure 6.5.1 proposes a new model to improve issues relating to the balance of power between these two leaderships.

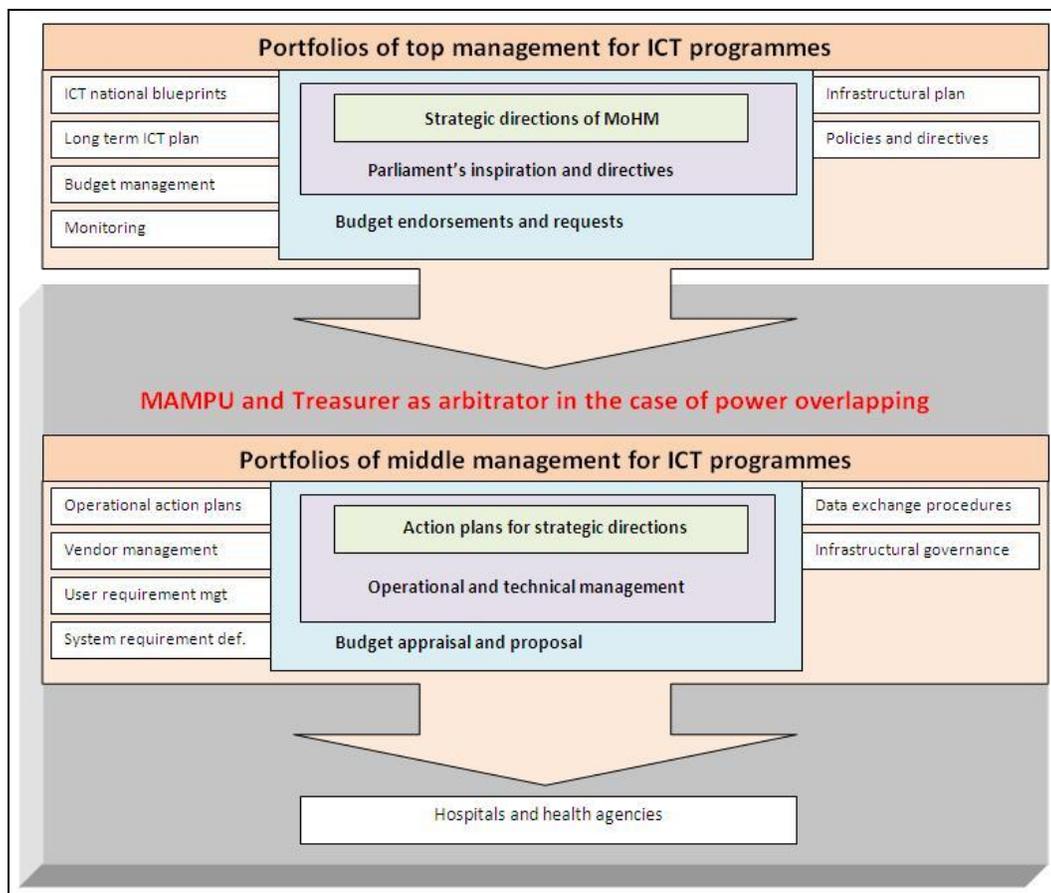


Figure 6.5.1: New model of division of power for top and middle management

This figure illustrates division of power between two portfolios for the better running of HTIS projects in Malaysia. For years, no arbitrator has been appointed to resolve issues over the interferences by the top management of MoHM. Without interference,

middle management can continue to plan future interoperability for the existing 16 HTIS hospitals and propose best mechanisms to computerise the rest of 115 non-HTIS hospitals. It would seem sensible for MAMPU to take this role of third party arbiter.

Clear division of power between the top and middle management provides a managerial blueprint (section 5.10.1.1) to offer solution for administrative problems in managing HTIS and EHR. Those problems include failure to execute the plan (section 5.10.1.2) and absence of policy for standardisation (section 5.10.1.3).

6.5. 2 Changes in MoHM-vendor relations

The findings suggest that vendor management is one critical phase in project management that can contribute to the failure of ICT projects. For example, the HTIS and EHR implementations in two countries (United Kingdom and New Zealand) suggest that failure will occur if there is insufficient mechanism to manage the vendors (National Audit Office 2011, pp. 4-6; UMR, 2008, p. 78). The current situation from ICT outsourcing through vendors in Malaysia also supports the implications that occur in those countries (Arshad et al. 2008, p. 121).

Management of vendors requires strong leadership at all levels in MoHM and clear division of power between all managerial levels. Among the hurdles outlined in the previous chapters, are issues related to project timeframes and quality of the deliverables. Managing these two is a process that requires cooperation from top and middle management of MoHM because it implies legal and financial consequences. The top management of MoHM must issue circulars and strong directives to all registered vendors on the consequences of breach of contracts.

Realising the problem of vendor-purchaser contractual agreements, a study by Goodman et al. (2011, p. 81) recommends fair clauses in the contracts that can protect the purchaser and indemnify the vendors for errors found after the system is

Discussion

delivered. Currently, any breach of contract is not effectively penalised by the MoHM. One of the reasons that lead to this situation is enforcement and legal issues. It is not a simple process to sue the vendors and get compensation for the loss, because it requires legal procedures and it is time consuming. To avoid getting into these long procedures, normally, MoHM will cancel the project without receiving indemnity from the vendors. According to the latest feedback from the case organisations (15th June 2012), solution to this issue requires amendment to the existing legal procedure from the central agencies such as Treasurer and MAMPU because it involves contracts with the external parties outside the government.

The top management of MoHM also should include more clauses within the contractual agreement that support the notion of interoperability. This will require vendors to design the system structures that cope with interoperability requirement, to avoid any breach of contract. To illustrate this improvement, Figure 6.5.2 presents elements in a new model of MoHM-vendor relation.

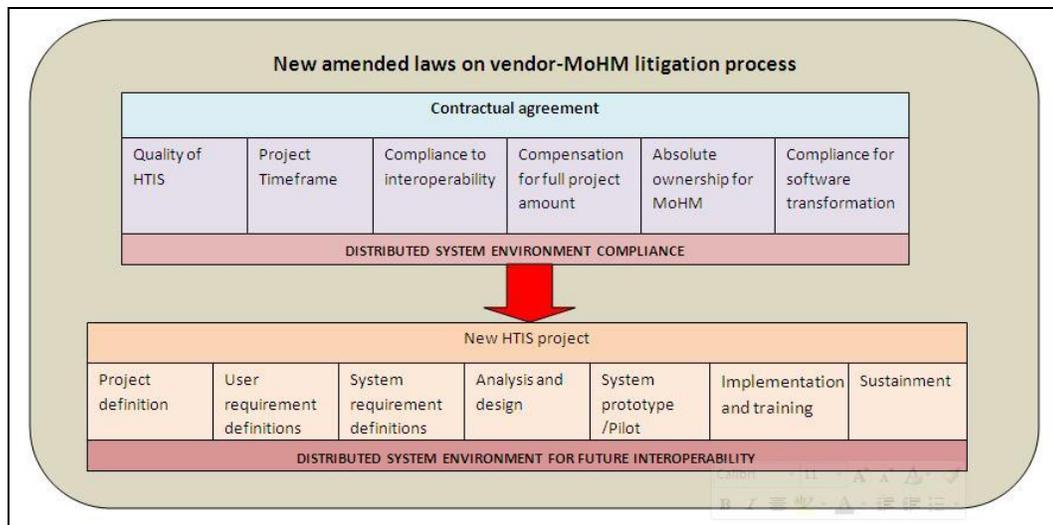


Figure 6.5.2: New model of MoHM-vendor relations

6.5.3 Intellectual property management

It appears from the previous chapter (section 5.3.3), that the current model of intellectual property restricts the possibility of interoperability. The ownership of any procured HTIS does not give a total right for MoHM to freely use the software

beyond the restricted locations. It is actually, a contradiction between the laws (Copyright Act 1987, Section 11 (1) and Section 26 (3)) and the reality of implementation. The ownership of software, according to Malaysian law, is with the government and not to the company who develops it. However, the practice by MoHM does not appear to take this act into account. Therefore, it is apparent that strong leadership and new model of implementation is required to define the existing clause for ownership. To achieve interoperability, top and middle management of MoHM must issue strong directives to all contractors over freedom of the software ownership. Any clause in the agreement that limits the MoHM's freedom to use the software must be removed.

A new model for intellectual property must be based on the notion of a distributed system environment as proposed in the Figure 6.5.2. The leadership of MoHM must be creative in proposing new ideas to resolve this issue. A recent study by Spiegel et al. (2012) also suggests that policy-makers improvise innovative solution to mitigate the barriers that are imposed by proprietary ownership of HTIS. In their study, they introduce *Creative Common licensing* as an alternative licensing model that permits open-distribution and knowledge sharing of proprietary HTIS across different organisations. This new model of licensing is similar to the Open-Source Software (OSS) but with less requirements because it does not require users to participate in improving the software.

6.5.4 The internal and external setup

Apart from improving the chain of command (section 6.5.1), MoHM-vendor relationship (section 6.5.2) and resolving the issues of intellectual property (section 6.5.3), the leadership of MoHM also must propose to the Malaysian Parliament new amendments to existing laws and regulations concerning exchanging patient data online. There are nine acts in the Malaysian laws that require amendment to allow data exchange across public hospitals. They include Telemedicine Act 1997, Medical Act 1997, Computer Crime Act 1997, Digital Signature Act 1997, Communication

and Multimedia Act 1998, General Consumer Code 2003, Insurance Act 1996, National Archive Act 2003, and MoHM Circular of 2010. In the beginning, these laws were billed to protect the right of patients and their confidentiality from being exploited by other people. This issue was discussed in the previous chapter under section 5.9.1.4.

The proposal to amend these laws is a central issue that determines the achievability of HTIS interoperability. The amendments should not however, violate the confidentiality and rights of the patients but to allow some spaces for online data exchange. The practice in other countries such as UK and India, is that similar laws are supported by technological measures such as removal of patient identifiers, covering faces on photographs and limiting who can access patient information stored online (Saliba et al. 2012). Some of these measures are already applied in some of HTIS hospitals in Malaysia, for example, audit trails to control level of accessibility, however this needs to be more widespread.

6.5.5 Independent agencies to manage HTIS

Compared with some countries such as UK and Canada, Malaysia is still centralising the power to manage ICT adoption in healthcare through its ministry. By assigning an independent agency, those countries are already on track to implement interoperable HTIS across their countries. The ninth proposition (section 5.10) was dedicated to examining whether the idea to assign an independent agency to manage ICT adoption is workable for Malaysia. Some benefits were discovered from that idea but the overall findings suggest that the idea is not suitable because of limitations. Three limitations were identified in the previous chapter including limitation in authority, finances and security. The feedback from the case organisation also agreed with these findings, which concluded that Malaysian ICT programmes in healthcare should be managed according to the administrative systems in Malaysia.

6.6 Open-source software alternatives

This factor defines Open-Source Software (OSS) as an alternative to proprietary software. The findings of this study indicate that the majority of ICT administrators, because of many unresolved issues, do not favour OSS. These reactions are consistent with those of other studies such as Waring and Maddock (2005, p. 414), Ven et al. (2008, p. 55) and Fitzgerald (2006, p. 592) who suggest that OSS is not well-suited to healthcare projects because there is ambiguity in costs, expertises and licensing.

Subsequent feedback from the case organisations supported these findings on the unsuitability of OSS because the current ICT procurement method contradicts with OSS licensing requirements. Despite this contradiction, MAMPU had directed all government agencies to give priorities on OSS in their ICT projects from proprietary software. As a result, solutions to comply with the MAMPU's directive are therefore regarded unfavourably. Two reasons were identified for this. The first reason is the unavailability of OSS to run medical devices such as in radiology, and laboratory. The software for these machines is proprietary and distributed as a package by the licensed distributor. Secondly, the ICT procurement method through vendors implies no differences between OSS and proprietary licenses because all contracts are based on copyright and not copy-left (a discussion about copy-left licensing was highlighted in the section 5.7.2.1). For the first reason, no possible solution can be offered due to the need to use specific stand-alone proprietary software. For the second reason, there are alternative solutions that can be offered through the transformation of HTIS procurement – see Section 6.6.1.

6.6.1 Transformation in HTIS procurement

This transformation is a process that requires changes in the working culture, intellectual property and vendor management, and improves the level of competency among ICT administrators. Without these changes, this transformation cannot be achieved and OSS will remain unfeasible to MoHM's ICT projects. This requirement corroborates a great deal of the previous work in this field by Katsamakos et al.

Discussion

(2010, p. 271) who suggest that the success of OSS adoption in healthcare is related to organisational factors and technological expertise. The organisational factors according to Katsamakos include licensing issues and sponsorship, and technological expertise exemplified by the ability of programmers to develop software and modify the source code of OSS. A new working culture must value resource-sufficiency, promote in-house ICT projects, and appreciate research & development and lifelong learning. These elements must become embedded within MoHM before the notion of OSS can be embraced.

Concerning the intellectual property, the contractual agreement must have clauses that permit modification of source code and changes to the software patent. The clauses should resolve the limitation of ownership of the software and, at the same time, enable ICT administrators to comply with requirements of OSS. The clauses also must include specification of the license to avoid hidden cost for example by using Permissive Licence or BSD-Style. This issue was discussed in length in the previous section 5.7.2.1.

In addition to that, changes in mindsets from previous working styles in handling the HTIS projects are required by all ICT administrators. They are not just moderators in HTIS project management but also technical experts. They must equip themselves with sufficient technical skills in programming and medical system requirements. A strong relationship between the success of HTIS/EHR and technical proficiency of those involved in managing the project has been reported in the literature, which includes the coordination and cooperation of those skills in HTIS development (Gill and Paranjape 2010, p. 362; Katsamakos et al. 2010, p. 271). To illustrate the new model of this transformation, Figure 6.6.1 presents some elements that are required to accomplish it.

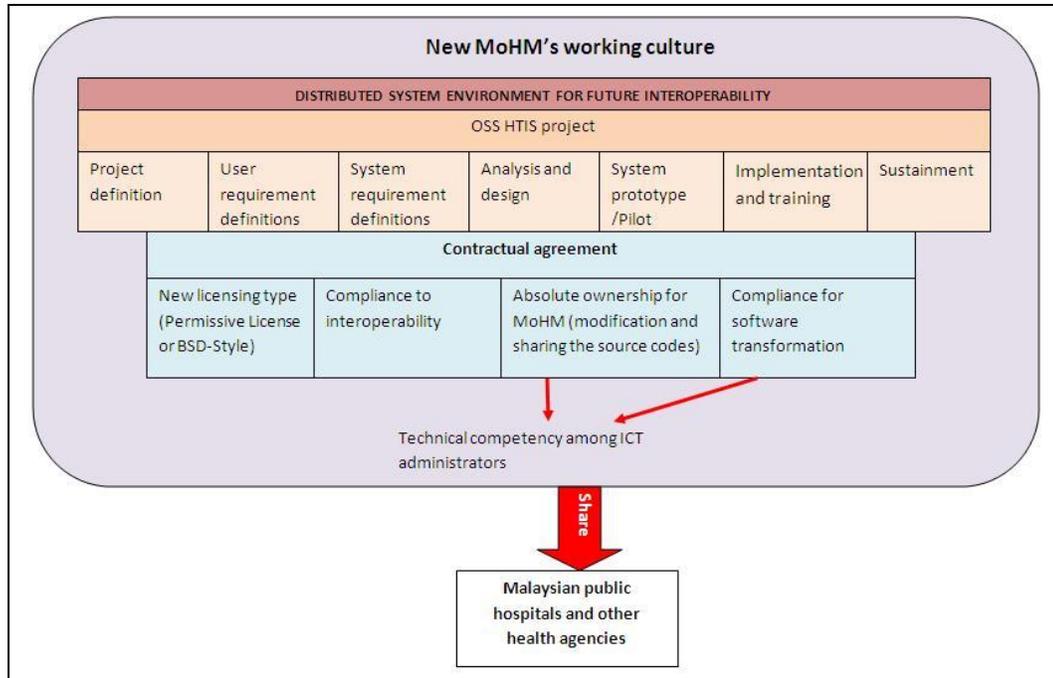


Figure 6.6.1: New model of HTIS procurement using OSS

6.7 Standard appraisal

This factor examines the claim that the interoperability of different HTIS depends solely on the same standard adoption. This ideal integration was examined in the fifth proposition (see Sec 5.6), which indicated that standard compliance is not the sole factor to determine the interoperability of HTIS and EHR. There is evidence from the findings that shows that HTIS and EHR systems used in different hospitals with the same standards still cannot interoperate or exchange health data. The feedback from the case organisations also supported these findings on the limitation of standards to permit data exchanges without support from other factors. This will be discussed in Sec 6.7.1

6.7.1 Supporting factors for standard adoption

The discussions in the section 5.6 and the latest feedback from the case organisations, helped the researcher to understand another three determinants to support standards in interoperability. This section will discuss these determinants and how they can be

Discussion

applied to Malaysian healthcare under the new model of standard adoption. Those determinants include the process of standard adoption, uniformity of medical terminology, and thorough assessment of HTIS compatibility.

The process to adopt standards in HTIS and EHR procurement in Malaysia starts with a directive from MoHM to all vendors on standard compliance (HL7 and DICOM) and it ends with the delivery of HTIS. The process totally relies on vendors' capability to design, analyse, adopt and acquire the standard to the software. However, according to best practice, standard adoption is not that simple. It requires active participation of all stakeholders including the purchaser of the software. The Department of Veterans Affairs (DVA) in United States is an example of a health organisation that succeeded in achieving interoperability with its external agencies. The job of designing and analysing the standards is initiated by the members of DVA and not by vendors (Bouhaddou et al. 2012, p. 814). Figure 6.7.1A illustrates the lifecycle of standard adoption and proposes recommendations to the MoHM.

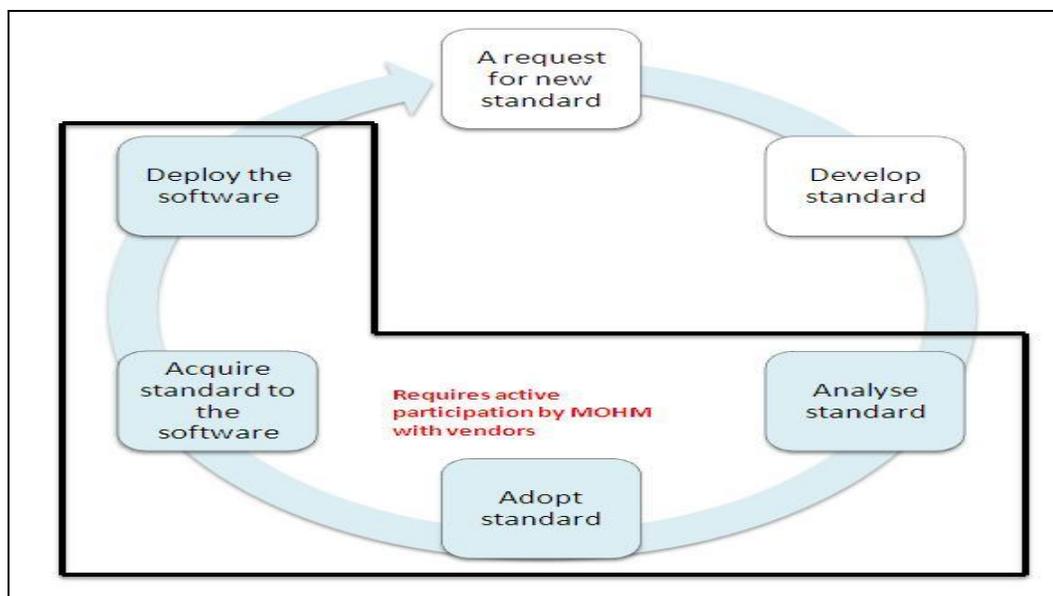


Figure 6.7.1A: Standard adoption lifecycle (adapted from Bouhaddou et al. 2012, p. 814).

Discussion

The figure shows processes used by the DVA in adopting standards into its HTIS. Since the MoHM employs vendors to develop its HTIS, some of those process require participation from MoHM’s ICT administrators and vendors. The requirements to employ technical configuration in standard adoption as suggested in Figure 6.9.1A, corroborates with previous findings in this field (Beier et al. 2001, pp. 884-885; Heathfield, 2007a, p. 4; Hammond (2008, p. 1206).

Another factor that contributes to the successful interoperability is terminology standardisation. This refers to the medical terminology that is used within the HTIS to represent the medical terms. Currently, none of the HTIS-hospitals in Malaysia employ the same terminology to be used in its HTIS. As a result, different terminologies are used in the HTIS, which implies systems cannot comprehend the medical contents during the data exchange. To improve this situation, there must be a directive from the top management of MoHM for all hospitals to standardise their medical terminology. The directives must be supported with Standard Operating Procedures (SOP) on how to handle and assess standard adoption to HTIS. The standardisation must be included as one phase in the HTIS project management. Figure 6.7.1B illustrates the process.

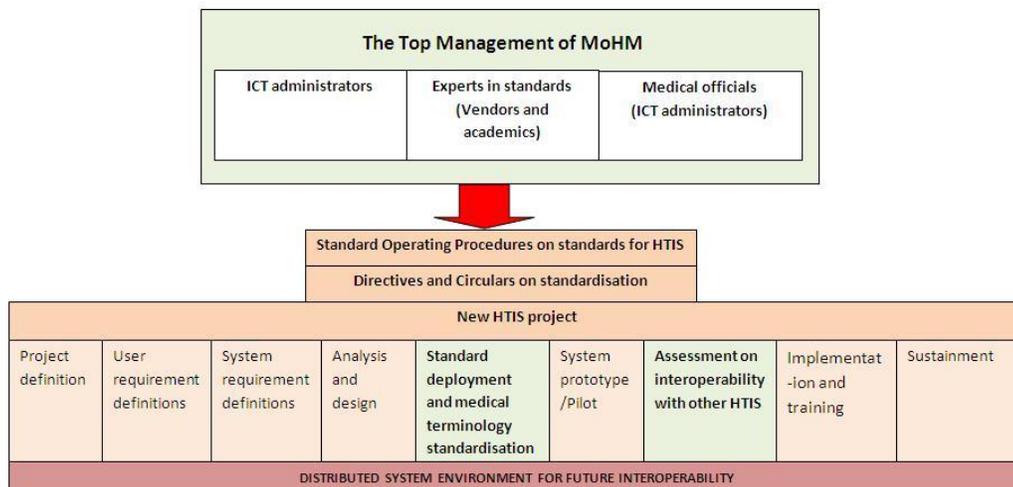


Figure 6.7.1B: A new model for standard adoption in HTIS project management

Before the delivery of HTIS, assessment and system evaluation must be done with other HTIS from other HTIS-hospitals. The current practice only limits the assessment with existing software used in the hospital's departments. The practice must be expanded into other hospitals' HTIS to examine the capability to exchange the data.

6.8 Physicians' acceptance

The physicians' reactions to the HTIS, contribute to the success in interoperability plan. This is because they are users who use the HTIS and experience its functionality. Their acceptance is a sign of the system feasibility and their rejection indicates unfeasibility of the system to improve health service delivery. Section 5.8 of the previous chapter discussed this issue in length, and identified findings that explain reasons and factors that influenced physicians' acceptance. The feedback from the case organisations supported these findings on the reasons and factors that influence physicians' acceptance of HTIS. Therefore, this section aims to propose action plans and initiatives based improving physicians' acceptance .

6.8.1 Change management initiatives

Change management is an initiative that involves various aspects of organisational transformation in MoHM. Introduction of new technology in organisations by replacing the exiting working culture requires more than technological innovation. It requires transformation of organisational culture within the health agencies to accelerate acceptance by its members. This concept of organisational transformation is in agreement with Protti's (2010, p. 414) findings on the necessity for managers and health service providers to reform the organisational culture in the transition from paper-based to electronic medical records. This initiative was discussed in the previous section (Sec 5.9) in length, which showed its relevance to be used as a programme to improve physicians' acceptance.

Discussion

Currently, MoHM has already introduced a change management programme since 2010 to promote ICT adoption in Malaysian healthcare. Five themes form the basis for this programme, which include awareness, desire, knowledge, ability and reinforcement (Ministry of Health of Malaysia, 2010b). These five themes represent a new MoHM's culture towards ICT adoption. The problem however, is that the starting point of this programme is after the HTIS has already been implemented in the respective hospital. This programme must run through all phases of HTIS project management so that vendors and physicians (users) can work together as a team from the beginning. Currently, the relationship between physicians (users) with vendors in current HTIS project management only occurs in a few phases of project management as described in Figure 6.3.1A. Including these themes as a foundation for HTIS project management will create sense of belongingness among the users and vendors, which reduces the tendency of rejection among the users to use the HTIS. The programme also must have supporting mechanisms such as promotions, human resource support and attractive reward system. To propose this new model of change management programme, Figure 6.8.1 illustrates the process.

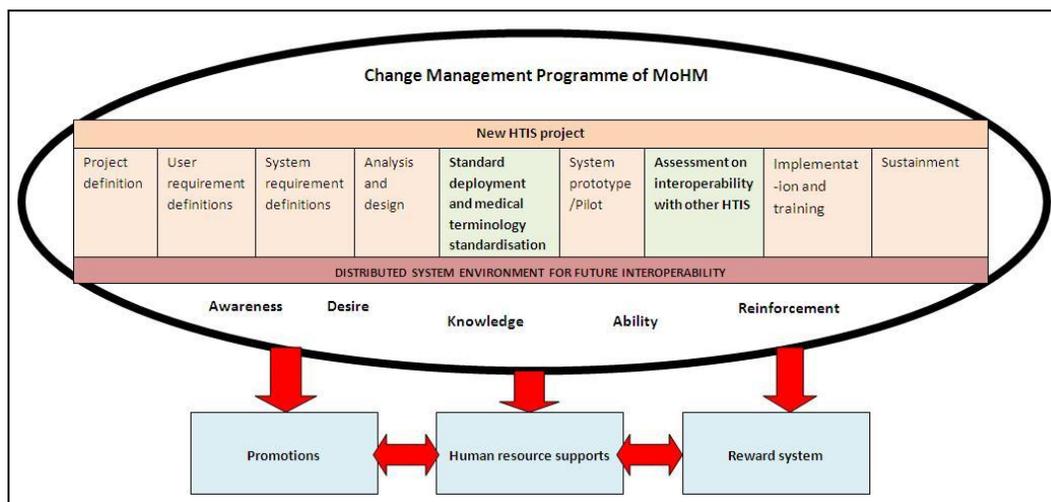


Figure 6.8.1: Change management programme of MoHM

The success of this change management programme can be seen in some HTIS hospitals. In some HTIS-hospitals, awareness programmes and policy are used to implement change management. Awareness programmes include series of training

Discussion

and motivational talks to increase level of awareness among the physicians on the importance of using ICT in their workplaces. A strict policy requires all physicians to key-in all the patients' records into HTIS on the same day after diagnosis. Failure to comply with that policy will result negative appraisal by the head of department. As a result, almost 99% of medical data are keyed-in in those hospitals. Nevertheless, the success rate from this programme is still small compared to the number of public hospitals (HTIS or non-HTIS hospitals).

Another issue that can affect change management programme is the number of non-HTIS hospitals, which is still higher than HTIS-hospitals. The physicians in those hospitals are still using the paper-based records and only small portions of HTIS are used in some departments. They are not familiar with a working in an ICT environment. The problem arises when those physicians are transferred to HTIS-hospitals, which results in their resistance due to unfamiliarity with the environment. This reaction corroborates previous studies on physicians' rejections by (Massaro 2005, p. 256; World Health Organisation, 2006, p. 28; Ludwick and Doucette 2009, p. 6; Abd. Ghani et al., 2008a, p. 90). To resolve this problem, the MoHM must start expanding the use of PMS to all non-HTIS hospitals as recommended in section 6.2.2 to expose the use of HTIS to all physicians.

To support a change management programme, constant promotion by the MoHM is needed to create awareness to all members of health agencies. A numbers of studies suggest that constant promotion from the management of health services can accelerate the level of acceptance by physicians to use EHR and HTIS (Schulman 2010, p. 174; Kitsiou et al. 2010, p. 386). However, this promotion requires other mechanisms to support it. MoHM must identify solutions to assist members from non-HTIS hospitals to start to computerise their medical records into HTIS. Many hospital administrators and doctors from non-HTIS hospitals disagree with computerising paper-based records because it adds new workloads for them. To resolve this issue, it is recommended for MoHM to restructure existing reward systems for those who involve in computerisation of medical data.

CHAPTER SEVEN

ACTORS AND MODEL FOR HTIS AND EHR INTEROPERABILITY

7.1 Introduction

In chapter six, research findings were verified with the latest feedback from the case organisations to see their relevancy and confirm their validity to the implementation of interoperable EHR and HTIS. The outputs from the validations are used to develop models to address the factors affecting the interoperability of HTIS and EHR in Malaysia. This chapter aims to achieve two objectives. The first objective is to propose relevant actors who are accountable to ensure the successful implementation of interoperable EHR and HTIS in Malaysian public hospitals. The second objective is to develop a model of the implementation. This model will comprise all the previous models in chapter six and contain novel elements to align with Malaysian health care structures.

7.2 The actors

This section is about identifying the actors to implement interoperable HTIS and EHR in Malaysia. This will assist the MoHM to delegate the appropriate responsibility to the right people in implementing interoperable EHR and HTIS. To date, there are a limited number of Ph.D. dissertations written to highlight these actors for Malaysian healthcare. The closest studies were by Abd. Ghani (2008) and Mohd Noor (2010) in their Ph.D. dissertations on ICT adoption in Malaysian healthcare. However, their studies did not focus on identifying actors but focused on technical and organisational frameworks in ICT adoption. The majority of studies about actors in ICT adoption refer to HTIS and EHR in countries that already had high percentage of HTIS hospitals.

This section also includes some guidelines from the literature concerning the definition of actor. The inputs from the literature are used to assist the researcher to extract potential actors from the previous chapter six.

7.2.1 Actors from the literature perspectives

Definitions of actors are varied according to the context of research. In his study to integrate diverse application, Chen (2003, p. 271) categorises ‘stakeholder’ as actors who have influence over or been influenced by the adoption of information systems. This definition is redefined by Mantzana et al. (2007, p. 92) in their model by defining actors as refers to “*any human and/or organisation that accepts, provides, supports or controls healthcare services*’. They also propose four criteria to describe actors in HTIS adoption. The criteria include Acceptors, Providers, Supporters and Controllers. These criteria are modified from a study by Houghton (2002). According to Houghton (2002, p. 37), four actors or stakeholders are the players in HTIS adoption. Those actors include payers, providers, practitioners, and patients. A more recent study by Mantzana et al (2010, p. 682) upgrades the composition of actors by emphasising training processes in HTIS and EHR implementation. The actors comprise learner, mentor, tutor and teacher. The learner is the one who accepts the training, mentor who control the trainings, tutor who supports the training, and teacher who provides the trainings.

By combining three studies by Lyytinen & Hirschheim (1987), Pouloudi and Whitley (1997, p. 5) and Mantzana et al. (2007, p. 93), nine guidelines are used to identify and validate the actors who should play pivotal roles in deploying the models from chapter six. Those guidelines are listed below:

1. Actors depend on the specific context and time frame of organisation’s business
2. Actors cannot be viewed in isolation
3. The position of each actor may change over time
4. The nature of the information systems to be adopted
5. Internal vs. external actors
6. Feasible options may differ from the actors’ wishes
7. The type of relationship to the system
8. Depth of impact
9. Level of aggregation

Actors and Model for HTIS and EHR interoperability

The first guideline defines actors according to their functions in organisation's business. This guideline exemplifies actors' identification based on organisation's business and situation, where the actors are attached (Pouloudi and Whitley 1997, p. 5). The second guideline suggests that actors are interrelated and cannot be treated as single entity. This guideline incorporates actors' identification based on their interrelation with other actors in either activities or goals. (Pouloudi and Whiteley 1997, p. 5). The third guideline suggests that the actors' roles are interchangeable and not fixed to one function. The actors may participate in different roles based on the context and situation within the implementation phases of information systems. For example, actors who have different roles in various stage of implementation (Pouloudi and Whiteley 1997, p. 6). The fourth guideline highlights that the relationship between type of actors with type and information systems to be adopted, which also reflects to types of organisations and working culture (Mantzana et al. 2007, p. 93). The fifth guideline outlines that actors are representing both internal and external communities who are involved in HTIS and EHR implementation (Mantzana et al. 2007, p. 93). The sixth guideline suggests that among the criteria of actors they have their own agenda and try to achieve different goals, which may conflict to the goals of other actors (Pouloudi and Whiteley 1997, p. 5). The seventh guideline suggests that actors' roles are defined according to their relationship to the system development phases. The roles include different portfolios such as regulators, producers, or consumers of IS (Lyytinen & Hirschheim 1987, p. 263). In contrast to the first guideline, this guideline emphasizes on the working culture and procedures, and not solely on organisations' core businesses. The eighth guideline defines actors according to level of impacts they can contribute IS projects. The depth of impacts is varied according to their portfolios and job specifications. The impacts can be direct or indirect to the IS projects (Lyytinen & Hirschheim 1987, p. 263). For example, the impacts of policy makers are more depth because they determine the strategic decisions of the projects. The ninth guideline defines actors according to the level of aggregation from one situation to another. The definition includes actors' roles between individuals (one actor as a stakeholder) or groups (multiple actors as a stakeholder) to larger groups such as company or society (Lyytinen & Hirschheim 1987, p. 263).

7.2.2 The proposed actors

The previous discussions in the Chapter Six establish grounds to propose relevant actors who are the main players for EHR and HTIS implementation. Seven factors from the chapter six and nine guidelines are used as grounds to identify the actors.

After thorough analysis, twenty-one potential actors were identified. They are the main players to diffuse the notion of HTIS interoperability across the public hospitals. The actors are listed below:

1. System proposer (officials from health agencies)
2. System or infrastructural evaluators (ICT administrators)
3. System developers (vendors)
4. Technical experts (programmers)
5. Local decision makers
6. Interoperability proposer (officials from health agencies)
7. Interoperability endorsers (appraisal and steering committees)
8. Interoperability examiners (ICT administrators)
9. Users of interoperable HTIS (physicians)
10. Human resource regulator (Public Service Commission)
11. ICT medical professionals (Medical ICT administrators)
12. Information mediator (officials from MoHM)
13. Policy makers (top managers of MoHM)
14. Innovation promoter (middle managers of MoHM)
15. Legal advisors for MoHM
16. Training moderators for OSS
17. OSS enablers (system evaluators and programmers from MoHM)
18. Change management initiator (top management of MoHM)
19. Change management promoter (middle management)
20. Change management adopter (hospital management)
21. Experts in standards (Vendors and academics)

The next section explains in length about each actor and how they are extracted from the factors in Chapter 6.

7.2.2.1 Actors from infrastructural management

Section 6.2.1 recommends a new model to manage ICT infrastructures. Those recommendations include changes from reactive management into holistic considerations in planning the ICT infrastructures for HTIS projects. To illustrate the recommendation, action plans were presented in Figure 6.2.1B. The figure provides a means to identify three actors who would be involved in the changes.

The first actor is system proposer. They are officials from health agencies who request for new HTIS based on their understanding on ICT infrastructural requirements. The second actor is system or infrastructural evaluator. They are present on appraisal and steering committees who will evaluate the feasibility and ICT infrastructural requirements of HTIS projects. Their evaluations will provide vendors with accurate information about ICT infrastructural requirements. The third actor is system developers. They are vendors who will follow recommendations and outputs from the system evaluators. The roles of these actors will avoid discrepancy between ICT infrastructural requirements and technical specifications of HTIS.

Another recommendation is to optimise the use of existing ICT infrastructures for HTIS projects. The recommendation was presented in Figure 6.2.2 and from the figure, three actors were identified. The first actor is a system evaluator. In addition to their previous roles, they are also responsible for managing, upgrading and promoting the PMS to all public hospitals. The second actor is the technical expert. They are programmers either from inside or outside the MoHM who are capable of migrating the legacy systems into PMS. The third actor are local-decision makers. They refer to hospital management who will decide the use of PMS in their hospitals and migration of legacy systems into PMS.

7.2.2.2 Actors from workflow management improvement

Section 6.3.1 recommended changes in the model for workflow management. The changes included different modes of stakeholders and users' participation in perceiving the HTIS projects. Their perceptions and managerial approach should

Actors and Model for HTIS and EHR interoperability

reflect directions for a distributed system environment and for future interoperability. To illustrate the changes, action plans were presented in Figure 6.3.1B. The figure provides a background to extract five actors who will assist MoHM to implement the changes.

The first actor is an interoperability proposer. They should be officials from health agencies who recognise benefits from interoperability. This actor will define the system requirements based on its future ability to interoperate. The second actor is an interoperability endorser. They will form appraisal and steering committees from MoHM who will define all HTIS projects based on distributed system environment. The third actor is an interoperability examiner. They are ICT administrators who will examine whether the vendors are compliant with the notion of interoperability. The fourth actor is user of interoperable HTIS. They are physicians who will use the system and anticipate the interoperability from it. The fifth actor is a system developer. They are vendors who develop the HTIS based on interoperability compliance.

Another recommendation is the need to benefit from the diversity of professionals within the MoHM. The recommendation was presented in Figure 6.3.2 and four actors were identified. The first actor is a human resource regulator. This refers to the people within the institution that set the guidelines to permit flexibility in professional attachment within the MoHM. The detail about this institution was discussed in section 5.4.1.1B. The second actor is an ICT medical professional. These are medical officials who are attached to Division A to assist ICT administrators in HTIS projects. Their involvement in HTIS projects is to reduce the incorrect translation of HTIS specifications from actual medical requirements. The third actor is the system evaluator. Their roles were discussed in section 7.2.2.1 but in addition in this factor, they should also be responsible to match the outputs from ICT medical professionals with HTIS specifications. The fourth actor is information mediator. They are officials from MoHM who are responsible to a develop knowledge repository for all inputs from discussions between ICT medical professionals and system evaluators. The knowledge repository will be transformed into templates of best practices for all future HTIS projects.

7.2.2.3 Actors from innovative culture

Section 6.4.1 recommends innovation to be instilled as internal preparation to embrace the notion of interoperability among members of MoHM. Instilment of innovation in this context will include how HTIS can follow best practice, to operate efficiently and achieve effectiveness in health service delivery. The action plans were presented in Figure 6.4.1, from which four actors were identified. The first actor is policy maker. They are top managers of MoHM who include the Minister, Secretary General and his deputies. Interoperability of different HTIS is one example of innovation that requires support from the top management. Additional actions include amendment of some policies and enforcement of strong directives, which only can be done by the top management. The second actor is innovation promoter. They are middle managers of MoHM who will promote innovation across Malaysian health agencies. The promotion aims to create awareness among the hospital management as a foundation before the notion of interoperability is introduced. The third actor is innovation player. They are individuals who will translate the innovation (the idea of interoperability) into HTIS projects. Their composition consists of several other actors such as interoperability proposer (officials from health agencies), interoperability endorser (appraisal and steering committees), and interoperability examiner (ICT administrators).

7.2.2.4 Actors from leadership

Section 6.5.1 recommends a clear division of power between top and middle management to reduce interference in decision-making concerning HTIS adoption. Previous discussions (sections 5.3.1.2/ 5.9.1.2/ 6.5.1) suggested that the interference from the top management had caused heterogeneity of HTIS procurements in Malaysian public hospitals. The recommendations were presented in Figure 6.5.1 where three actors were identified. The first actor is policy makers who are top managers of MoHM. Their roles were highlighted in previous section 7.2.2.3. Their agreement to the plan (division of power) will enable them to focus at the higher level of managerial functions, which are illustrated in Figure 6.5.1. The second actor is system evaluator. Sections 7.2.2.1

Actors and Model for HTIS and EHR interoperability

and 7.2.2.2 outlined them as ICT administrators and appraisal committees who represent the middle management of MoHM. Division of power will require them to administer the operational decision concerning HTIS projects. The third actor is centralised arbitrator. They are top management of MAMPU and the Treasury who represent the central agencies of Malaysian government. The details about central agency were discussed in section 3.2. Their roles are to arbitrate interference of decisions between the top and middle management concerning HTIS projects.

Other recommendations are to resolve issues concerning MoHM-vendor relations and intellectual property. To describe the solution for these issues, figure 6.5.2 presented the action plans where two actors were identified. The first actor is policy makers who are the top managers of MoHM. Section 7.2.2.3 highlighted some of their roles concerning policy and law amendment. The second actor is legal advisors for MoHM who will draft the contract. The contract should contain six elements that emphasise interoperability of HTIS. Those six elements were presented in the figure 6.5.2. The roles of these two actors extend to other issues such as lobbying for amendment to current laws to remove the legal barriers that disallow data exchange among different hospitals. The third actor is system developers who are vendors that develop the systems. They also need to understand the issues and agree to comply with the requirements in MoHM-vendor relations.

7.2.2.5 Actors from OSS alternatives

Section 6.6.1 suggests that the adoption of OSS is not just technical adoption. It requires transformation of other elements such as changes in working, cultures, improvement in competency level of ICT administrators, and solutions to the issues of vendor relations and intellectual property. The action plans for transformation were presented in Figure 6.6.1 where four actors were identified. The first actor is policy makers who are responsible to introduce new working culture in managing the ICT programmes. In a hierarchical organisation such as MoHM, those tasks must be initiated by the top managers. The second actor is training moderator. They are officials from the training unit of MoHM who need

Actors and Model for HTIS and EHR interoperability

to introduce series of training sessions to increase the level of competency of ICT administrators on OSS-related issues. The third actor is OSS enabler. They consist of officials who are the system evaluators (ICT administrators) and programmers from MoHM. Their responsibility is to initiate developing HTIS based on OSS or modifying the available OSS to match MoHM's technical specifications. The fourth actor is OSS developer. They are vendors who need to follow OSS specifications in the contractual agreement.

7.2.2.6 Actors from standards appraisal

Section 6.7.1 recommends that the transformation in the method to handle standards adoption is required before interoperability can be achieved in Malaysian public hospitals. To illustrate the recommendation, action plans were presented in figure 6.7.1B, from which four actors were identified. The first actor is policy makers who will lead standard committees and issue directives on standard adoption to all agencies under MoHM. The second actor is committee for standards. They consist of groups of officials who are ICT administrators, standard experts and ICT medical officials. They will gather all relevant information about processes, standard medical terminology for HTIS, and produce standard operating procedures (SOP) for standards adoption. This SOP will be used in all HTIS projects. The third actor is system evaluator who will make sure vendors are following the SOP. The fourth actor is system developer who will comply with the SOP for standard adoption in software development.

7.2.2.7 Actors from physicians' acceptance

Section 6.8.1 recommends that action plans under a change management programme will accelerate physicians' acceptance of HTIS and prepare them to embrace the notion of interoperability. To illustrate the recommendation, action plans were presented in Figure 6.8.1, from which three actors were identified. The first actor is change management initiator. They are policy makers who will draft the blueprint to implement a change management programme across public hospitals. The blueprint will include promotional methods, human resource support and new reward systems. Currently, five themes have been identified on which to base the programme. The themes were highlighted in both sections

Actors and Model for HTIS and EHR interoperability

5.9.1.1 and 6.8.1. The second actor is change management facilitator. They are middle management (ICT administrators) who will lead users and vendors to employ those five themes in all HTIS project phases. The third actor is change management adaptor. They are hospital managers who are responsible to introduce this programme at their respective hospitals. The implementation will follow the blueprint by the change management initiator.

7.2.2.8 Verification of actors

In addition to actor identification, verification was done to validate whether those actors are relevant to ICT adoption in MoHM. A series of meetings were conducted with the original interviewees from 27th September until 5th October 2012. During the meeting, each interviewee was given the list of actors and their relationships with the HTIS projects. The interviewees were asked to identify the similarity between those actors and existing establishments/actors in HTIS projects. Surprisingly, all of them gave the almost similar answers except for five interviewees who did not answer a few questions because they felt the irrelevancy of those actors to MoHM's ICT adoption. Their feedbacks are summarised in Table 7.2.2.8. Those interviewees who involved verifying the actors were listed below:

- | | |
|-------------------------------|---------------------------------|
| 1. Interview_1_div_A_AM (1) | 8. Interview_8_HSP_C_HDRM (8) |
| 2. Interview_2_div_A_AT (2) | 9. Interview_9_HIS_A_DOC (9) |
| 3. Interview_3_div_B_BM (3) | 10. Interview_10_HIS_A_DOC (10) |
| 4. Interview_4_div_B_BT (4) | 11. Interview_11_HIS_A_DOC (11) |
| 5. Interview_5_HIS_A_HDIT (5) | 12. Interview_12_HIS_A_DOC (12) |
| 6. Interview_6_HIS_B_HDIT (6) | 13. Interview_13_HSP_C_DOC (13) |
| 7. Interview_7_HIS_B_HDRM (7) | 14. Interview_14_HSP_C_DOC (14) |

Actors and Model for HTIS and EHR interoperability

Table 7.2.2.8: Confirmation of actors by the interviewees

| Actors | Interviewees | | | | | | | | | | | | | |
|--|--------------|---|---|---|---|---|---|---|---|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| System proposer (officials from health agencies) | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| System or infrastructural evaluators (ICT administrators) | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| System developers (vendors) | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Technical experts for OSS (programmers) | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Local decision makers (hospital management) | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Interoperability proposer (officials from health agencies) | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Interoperability endorsers (appraisal and steering committees) | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Interoperability examiners (ICT administrators) | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Experts in standards (Academic and vendors) | A | A | A | A | N | N | N | N | N | N | N | N | N | N |
| Users of interoperable HTIS (physicians) | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Human resource regulator (Public Service Commission) | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| ICT medical professionals (Medical ICT administrators) | A | A | A | A | A | A | A | A | A | A | A | A | A | A |

Actors and Model for HTIS and EHR interoperability

| Actors | Interviewees | | | | | | | | | | | | | |
|--|--------------|---|---|---|---|---|---|---|---|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Information mediator (officials from MoHM) | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Policy makers (top managers of MoHM) | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Innovation promoter (middle managers of MoHM) | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Legal advisors for MoHM | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Training moderators | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| OSS enablers (system evaluators and programmers from MoHM) | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Change management initiator (top management of MoHM) | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Change management promoter (middle management) | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Change management adopter (hospital management) | A | A | A | A | A | A | A | A | A | A | A | A | A | A |

Legends

| | |
|---|------------|
| A | Available |
| N | New actors |
| | No answer |

The feedback suggest that the MoHM already has in place twelve out of twenty-one actors under the different portfolios in HTIS projects whereas nine actors are considered as new. However, there is a discrepancy in opinions in perceiving the novelty of one actor (experts in standards). Those interviewees who are involve in directly managing the ICT projects consider this portfolio already covered by an existing post, but the end-users (doctors and hospital staff), consider this as a new actor. This verification is important because it represents the perspectives of those who involve in ICT adoption in Malaysia. The feedback assures the right direction of this research in its attempt to identify actors and factors for interoperable HTIS implementation.

7.3 Model to implement interoperable EHR in Malaysia

This model presents the outcomes of this research, which represents the answers to the research questions and achievability of research objectives. It is also a blueprint for MoHM to implement interoperable HTIS and EHR. The model illustrates the issues in previous chapters concerning factors and actors that contribute to implement interoperable HTIS and EHR in Malaysian public hospitals. The composition of this model is based on the relationship between eight factors as discussed in the chapter six and the participation of the actors (existing and new actors) in the model. To illustrate the components of the model, figure 7.3 presents the factors and actors for this model.

Two components form this model. The first component presents the lists of actors who are the main players in ICT adoption and interoperability of HTIS and EHR. The composition of these actors is defined according to their roles in each factor. The new actors are outlined with yellow highlights. The second component presents seven factors that contribute to the success and failures of interoperable HTIS and EHR implementation in Malaysia. In addition to those factors, fifteen supporting factors are displayed under each factor, which represent the action plans for each factor.

Actors and Model for HTIS and EHR interoperability

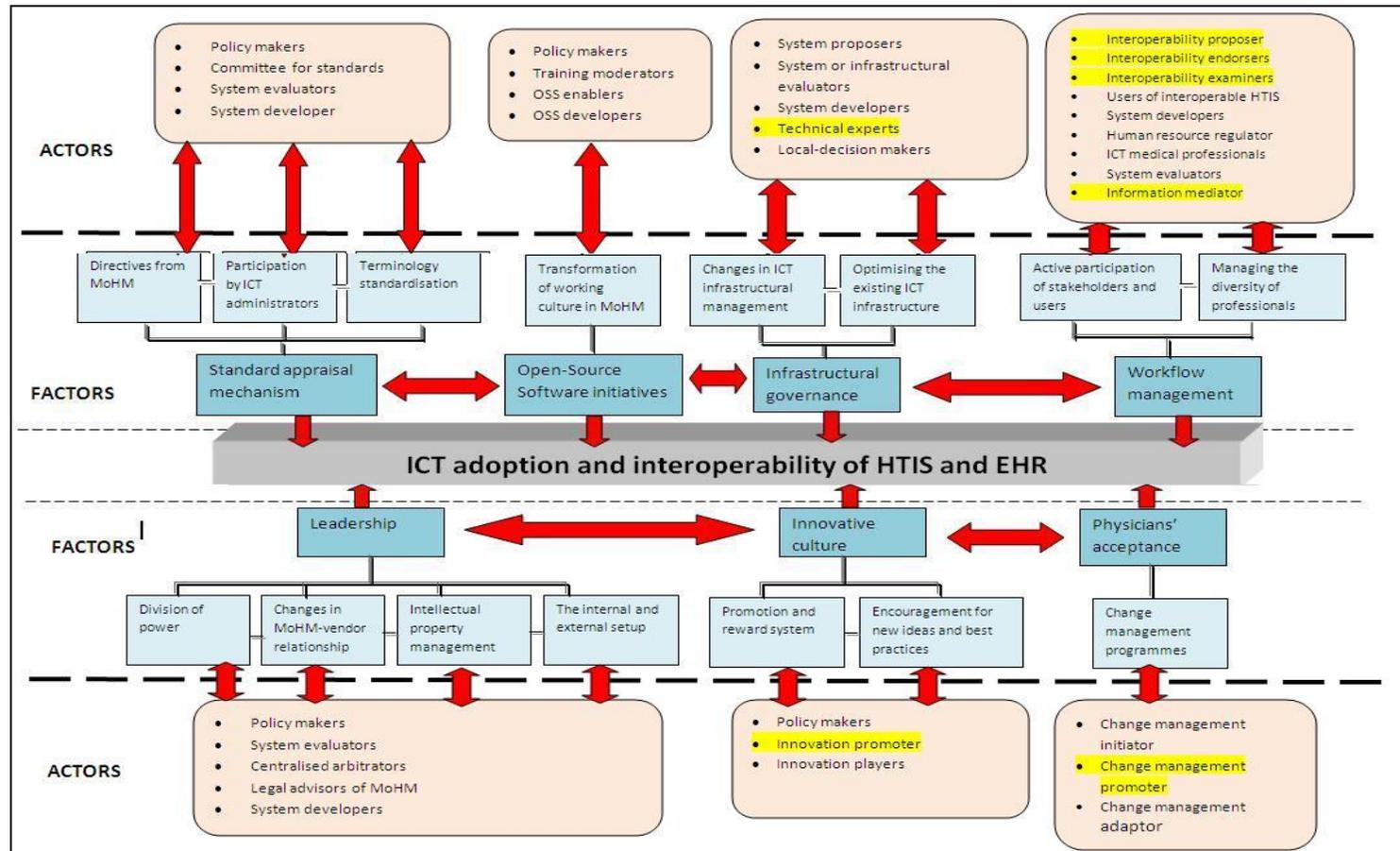


Figure 7.3: Model to implement interoperable HTIS and EHR in Malaysian public hospitals

7.3.1 Lessons from the model

The model, which effectively encompasses the discussion in chapters 6 and 7, suggests a few lessons concerning the implementation of interoperable HTIS and EHR in Malaysia. The first lesson suggests that the implementation of interoperable HTIS and EHR requires identifying the right actors to perform the right tasks. The second lesson proposes that the applicability of those factors depends on how the actors are performing in HTIS projects. The importance of actors' performance to the success of HTIS projects was outlined in section 6.3.1. The third lesson suggests that the method to identify actors should be flexible and appropriate to the administrative situation of a country. The latest feedback from the interviewees on actors suggested the same recommendation. The fourth lesson suggests that reasons behind the lack of interoperability among HTIS that use the same standards are related to the lack of enforcement and organisational inefficiency. Three sub-factors under *Standard appraisal mechanism* justify this view. The fifth lesson explains that the capabilities of HTIS elements in MoHM to support the interoperability of HTIS are still limited by technological innovation and that technical innovation is not supported by strong organisational innovation. This can be seen from the drawbacks in adopting the standards and governing the ICT infrastructures. The sixth lesson suggests that OSS initiatives will only be successful after the transformation of MoHM's working culture. This is because OSS initiatives require a different method of HTIS procurement and a high level of human expertise. The seventh lesson proposes that implementing interoperable HTIS and EHR in Malaysia depends on the efficiency and good governance of MoHM's administration in managing ICT adoption. This recommendation is based on the fact that Malaysian healthcare is highly hierarchical, which includes decisions to implement interoperable HTIS. The eighth lesson illustrates that the barriers to implement interoperable EHR lie with the inability of MoHM to accomplish the positive outcomes from those seven factors.

The model has established the external and internal influences that affect the implementation of interoperable HTIS and EHR in Malaysia. The impacts from external influences were portrayed in three sub-factors under the leadership factor.

Actors and Model for HTIS and EHR interoperability

The details about those sub-factors were discussed in section 6.5. Furthermore, the influences of internal structure within the MoHM are the central issues in this model. Twelve out of fifteen sub-factors outline the internal influences within MoHM and their implications on HTIS projects.

To sum up, the final model is an output of five processes, which are pattern extractions (chapter five), validation of findings (chapter six); formulation of factors from the findings (chapter six); formulation of models for each factor (chapter six) and identification of actors (chapter seven). The evolvement of ideas happened after these five processes, which have exposed the reality of ICT adoption in Malaysian's healthcare. The inputs from these processes were used to formulate a model to implement interoperable EHR in Malaysia. Prior to this, nine points in the conceptual framework (Section 1.5) were derived from the previous studies that highlighted issues of failed HTIS implementation. They were used as a guideline to uncover the research aim, which was to establish factors and actors that influenced the implementation of interoperable EHR in Malaysian public hospitals. The summaries of these five processes are mentioned below:

Pattern Extractions (Chapter Five)

The method to execute this process was elaborated in Chapter Four under the section 4.8. In Chapter Five, the themes arising from the fieldwork were matched with nine theoretical propositions. Each propositions contained a few sub-questions to guide the researcher in conceptualising the findings. This process has generated patterns that explained all nine points. Those patterns were then summarised and formalised into findings, which were used in the next process.

Validations of the findings (Chapter Six)

In order to ensure the findings were transferable and representing the reality of problems in Malaysian healthcare, they required validations. Those who involved during the interviews were contacted and presented with the findings. The summary

Actors and Model for HTIS and EHR interoperability

of the meetings was shown in Table 4.6.2B. The meetings aimed to gather their feedbacks and inputs for the next process.

Formulation of factors from the findings

From the feedback, seven major factors were identified that consisted enablers and barriers to implement interoperable EHR and HTIS in Malaysian healthcare. These seven factors were infrastructural management (section 6.2); workflow management of administrators and users (section 6.3); innovative culture (section 6.4); leadership (section 6.5); open-source software alternatives (section 6.6); standard appraisals (section 6.7); and physicians' acceptance (section 6.8). To ensure the reliability of these factors and their consistency, the researcher had triangulated these factors with other inputs in the previous chapters. As a result, a number of sub-factors were identified.

Formulation of models (Chapter Six)

To address the issues of interoperability of EHR in Malaysian healthcare, a number of models were formulated from each factor. This process aimed to identify the weaknesses in the current practices of managing EHR and HTIS in Malaysian healthcare. From the weaknesses, the researcher was able to propose new models as solutions to the MoHM. New proposed models for each factor were depicted in the following figures:

- Figure 6.2.1B: New model for ICT infrastructural management
- Figure 6.2.2: New model for migration and usability of existing ICT infrastructures
- Figure 6.3.1B: New model of HTIS workflow management
- Figure 6.3.2: New model to bridge knowledge gaps in HTIS projects
- Figure 6.4.1: New model of innovative culture
- Figure 6.5.1: New model of division of power
- Figure 6.5.2: New model of MoHM-vendor relations
- Figure 6.6.1: New model of HTIS procurement using Open-Source Software

Actors and Model for HTIS and EHR interoperability

Identification of actors (Chapter seven)

Another key element of this research is to identify actors or individuals who will act actively in interoperable EHR implementation. Section 7.2.1 was dedicated to elaborate on the definitions, and methods to identify those actors. Finally, twenty-one (21) potential actors were identified. A series of meeting with fourteen (14) interviewees were undertaken to verify the relevancy of those actors. The results of the meetings were presented in Table 7.2.2.8.

CHAPTER EIGHT

CONCLUSION AND RECOMMENDATIONS

8.1 Introduction

This chapter concludes the thesis. It starts with a brief summary of the overall findings of the research, followed by the conclusions drawn from the research. The last section of the chapter presents the limitations of the research and makes recommendations for further research.

This research set out to investigate the implementation of interoperable HTIS and EHR in Malaysian public hospitals. It specifically aimed to examine how the internal context of a HTIS project management and its external context together influenced the implementation of interoperable HTIS and EHR. It also sought to understand how the implementation of the technology in case organisations affected the implementation of the technology in public hospitals.

Guided by the nine propositions, this research has empirically shown that the implementation of interoperable HTIS and EHR in Malaysian public hospitals is shaped by the dynamics of the internal environment particularly by the role and function of the MoHM's administration as well as the external counterparts such as vendors. The outcomes of this research also further indicate that influences from factors of both internal and external contexts have had a substantial impact upon the progress of the interoperability implementation.

In the context of actors and interoperability relationships, the findings suggest that the identification of actors will guide the MoHM to assign right tasks to the right players in HTIS and EHR projects especially for attaining interoperability. Currently, no formula has ever been suggested concerning the right tasks for the right people in all MoHM's projects, which has resulted in the inconsistency of the outcomes.

This chapter is organized as follows. It begins with a brief summary of the lessons learned from this research. Then it elaborates further the contributions of this research and highlights the limitations of the study as well as the opportunities for future research.

8.2 Attainment of research objectives

The aim of this research was to establish factors and actors that influence the implementation of interoperable electronic health records in hospitals of Malaysia. The rationale for undertaking this research is to create a blueprint for MoHM for future interoperable HTIS and EHR projects. The aim was attained through several specific research objectives as discussed in the following sections.

8.2.1 First research objective

The first research objective is to form a model that highlights factors and actors in implementing interoperable electronic health records in Malaysia. This research proposes a model that has identified, reconfigured and proposed improvement on many aspects of current management of EHR and HTIS project management. The intention behind this objective is to disclose those mistakes in previous HTIS projects (section 1.3) and give recommendations for the better governance for future ICT adoption programmes.

The composition of the model comprises of factors and actors. The processes to generate these factors have provided implicit discussions to the six of seven areas (section 1.4 at page of 9) that are not well tackled by many researchers as proposed by Lobach and Detmer (2007, pp. 105-110). Those six areas are listed below:

- The issues related to system development.
- The issues related to system implementation.
- The impact of electronic health records in the clinical setting.

Conclusion and Recommendation

- The policies that will protect patient health information.
- The policies related to access to personal health information.
- The issues related to universal standards.

Concerning the actors, the model has complemented other studies on ICT adoption in Malaysian healthcare. Those studies were mentioned in section 1.3, in which almost none of them mentioned about the actors. Without identifying the right actors, MoHM will not be able to assign the right jobs to the right people, or will fail to identify the right plans to promote the use HTIS among the public hospitals.

To sum up, the attainment of this research objective is depicted by Figure 7.3. The figure shows all relevant factors and actors, which must be established by the MoHM for any plans to implement interoperable EHR and HTIS in Malaysian public hospitals. This model was developed after synchronizing all findings in Chapter 5 and combining them with various models in Chapter 6.

8.2.2 Second research objective

The second research objective aims to identify barriers faced by the Malaysian hospitals when implementing interoperable EHR and HTIS. This study identified a wide range of barriers that affected the implementation of the interoperable EHR and HTIS. Those barriers are shown implicitly in the factors and their sub-factors. In the process to generate those factors, section 5.9 of chapter five has dedicated the whole discussions to discuss both tangible and intangible barriers. These two barriers are considered as part of change management programme, which requires ongoing reactions from the MoHM.

The intention behind this objective is to assist and give recommendations to the MoHM on how to tackle these two barriers under right ministerial programmes such as change management. This objective also adds new barriers to what has been

Conclusion and Recommendation

suggested by Raghupathi and Kesh (2007; 2009) in the section 1.4 of this research. Those barriers were discussed in sections 5.9.1 and 5.9.2.

This research has successfully identified both tangible and intangible barriers, which have been ignored in many HTIS and EHR projects by MoHM. Those barriers are noticeable but most ICT administrators do not realise their importance in EHR and HTIS projects. After those barriers were discussed in Chapter 5, they were used as blueprints to develop various models in addressing factors that affect the interoperability of HTIS and EHR in Malaysian public hospitals.

8.2.3 Third research objective

The third research objective aims to understand the level of managerial and administrative influences in implementing interoperable electronic health records in Malaysia. This study has identified findings that affirm the significant influences of managerial and administrative elements in the programmes to implement interoperable EHR and HTIS for Malaysian healthcare. A majority of the findings in section 5.11 relate to this objective. The intentions behind this objective are to assist the management of MoHM to identify the core managerial issues before making any attempt to initiate the interoperability projects. It also presents how a high level of control of resources and bureaucracy influence the processes to diffuse interoperable EHR and HTIS in Malaysian healthcare. The administrative and managerial elements which contribute to the success of implementing interoperable EHR and HTIS were discussed thoroughly in this research. This objective is depicted in many models outlined in Chapter 6.

8.2.4 Fourth research objective

The fourth research objective aims to establish external and internal influences that affect the implementation of interoperable electronic health records and health information systems in Malaysia. Two chapters (six and seven) are dedicated to this

Conclusion and Recommendation

objective. This study identified a wide range of issues that are related to both internal and external influences in the implementation of the interoperable EHR and HTIS. The relationship is demonstrated in numbers of factors and sub-factors that represent these two influences, which can be seen from the model in section 7.3. The intention behind this objective is to assist MoHM identifying both influences (internal and external) and strengthening them.

8.2.5 Fifth research objective

The fifth research objective intends to present recommendations for implementing interoperable electronic health records to the Ministry of Health of Malaysia based on the findings of this research. Those recommendations are proposed based on the empirical findings, factors, and actors. Three chapters (five, six and seven) are dedicated to accomplishing this objective.

8.3 Statement of Contribution and research novelty

In general, this study makes two important contributions. Firstly, it gives a theoretical contribution on how to study ICT adoption in healthcare especially in developing countries. Secondly, it gives practical dimension to study ICT adoption in Asian countries like Malaysia, a country that has less ICT penetration into its healthcare. This new dimension consists of three aspects that include selection of samples, suitable research method, focuses on the research.

8.3.1 Theoretical contribution

8.3.1.1 The theme matching method of data analysis

As shown in this research, the use of pattern matching (section 4.8) is used to cater to the requirement of research design and data collection and analysis. A few modifications were made to ensure that this model suited the research design, which contained theoretical propositions and their outcomes. The modification adds theoretical proposition and literature (previous studies) as new requirement to form the theoretical realms or patterns. It also simplifies the technique to be used easily for a social science researcher under qualitative research approaches.

8.3.1.2 ICT adoption in healthcare for developing countries of Asian

This research has shown similarities and differences between the practice of ICT adoption in healthcare in some developed countries in Asian and OECD countries. From that, it presents some lessons to be learnt concerning ICT adoption in healthcare in developing Asian countries such as Malaysia. Section 2.3.8 outlines six issues that represent key points that determine the success of interoperable EHR. Those issues were examined with empirical data from the fieldwork guided by nine propositions. As a result, fifteen supporting factors under seven main factors were identified contributing to the success of implementing interoperability of EHR. The majority of these factors are organisational factors, which illustrate the reality of ICT adoption in healthcare in those countries, where technical factors are secondary compared to the organisational factors.

The research's novelty can be seen in the identification of some actors (portfolios or players), who are important but ignored especially in Malaysia in previous HTIS and EHR implementation. Without identifying the right actors, all projects will be managed with no specification of right assignments to the right individuals and expertise.

Conclusion and Recommendation

This research also proposes a foundation for any ICT programmes that aims to attain interoperability in developing Asian countries. The foundation suggests that sufficiency of ICT infrastructures determines the success for different HTIS to interoperate. Unlike other developed countries, ICT infrastructures to support computerisation of healthcare in developing countries are scarce and limited to some urban places. The details of this foundation were discussed in both sections 6.2.1 and 6.2.2.

8.3.2 Practical Contributions in the Malaysian Context

8.3.2.1 Managing HTIS and EHR interoperability in Malaysian public hospitals

In the beginning of this research, the researcher supposed that technical factors were core determinants in ensuring the success of interoperability programmes. This belief was supported by the 1997 paper work by MoHM on Telemedicine project, which emphasised many technical factors. To investigate this belief, three propositions were dedicated to examine the contribution of technical factors in ensuring the success to implement interoperability of HTIS and EHR. However, after analysing the data and proposing the implementation models, the findings do not support this supposition. It appears that interoperability's attainment, especially in Malaysia, is not just merely technical but more related to synchronisation of managerial elements between different managerial portfolios. Much of the content from data analysis support this finding. To justify widening this conclusion to other developed countries such as United Kingdom, the researcher had discussed the significance of managerial elements in NPfIT in section 2.3.1.2, which also alludes to the same outcome.

8.3.2.2 Political determination and change management programme

Reflecting on the findings of this research, whilst the Malaysian government, via the roles and functions of the MoHM is proactive in developing policies, strategies and initiatives to diffuse HTIS and technologies, its bureaucracy and lack of pragmatic

Conclusion and Recommendation

approaches could become a barrier in helping the management of public hospitals to smoothly integrate and adapt to the use technology such as the interoperability of EHR and HTIS. Also whilst political determination to procure technology to support the healthcare sector is undoubtedly important, the government, via the roles and functions of the MoHM must always prioritize resources to provide adequate healthcare service to the public and has to prevent the wastage of resources that results from the appointment of incompetent vendors to build and maintain the complex healthcare infrastructure.

To support this political determination, a change management programme should be enhanced, not only to cover the internal preparation among MoHM's staff to embrace the ICT but also should widen its scope to educate the technology providers such as vendors so that end-users and MoHM could benefit from the technology and prepare Malaysian healthcare for interoperability. This research proposes models to improve the role of top and middle management, and their relationship with external parties so that an undisrupted chain of command can be maintained and the positive outcomes from the HTIS projects can be delivered. These models were proposed in section 6.5 under the leadership factor.

8.3.2.3 The potentials of Patient Management System (PMS)

Reflecting the findings of this research, financial problems are recognised as a major hurdle to computerise the 115 non-HTIS hospitals. The findings from the data analysis chapter (Chapter Five) and section 6.2.2 recognised the feasibility of an existing legacy system, which is the Patient Management System (PMS), to alleviate the financial burdens of computerisation. PMS's compatibility with existing ICT infrastructures and the ability of its modules to meet the ICT requirements for public hospitals mean that this system should be deployed as widely as possible. This research has proposed in those sections some approaches that MoHM can do to optimise the use of PMS for non-HTIS hospitals, as well as outlining the potential problems in its implementation. As part of the recommendations, this research in

Conclusion and Recommendation

section 6.2.2 also recommended a tool to migrate PMS into HTIS, which might resolve the migration process between legacy system and HTIS.

8.3.2.4 The significant roles of actors in ICT adoption in Malaysian healthcare

Currently, the assessment of ICT adoption programmes by the MoHM is process-oriented, and assessed by the same group of committees. Discussions under different parts of section 5.3 have identified some limitations arising from this structure. These limitations for example, are normally caused by inconsistent decisions by those committees, which promote the procurement of segregated and departmental-based HTIS, which limits the potential of those HTIS to interoperate. To minimise the effects from those limitation, this research has proposed that specific expertise must be commensurate with the specific assignments.

Based on that, this research has proposed a number of novel actors required to undertake specific tasks in managing HTIS projects. Details about actors' identifications are highlighted in section 7.2.2.8.

8.3.3 Recommendations to the Ministry of Health of Malaysia

1. MoHM should exert strict division of power between top and middle management to remove the power to endorse projects from the ministry or top management of MoHM and minimise the use of the direct negotiation approach. This research has revealed that uncontrolled direct negotiation has promoted disparity of HTIS, and hampered the interoperability plan.
2. MoHM should widen the use of Patient Management System to non-HTIS hospitals and improve its existing modules for transformation into comprehensive HTIS. This is the first step for interoperability for Malaysian public hospitals, because interoperability of different HTIS is worthless if it is not practiced in all hospitals.

Conclusion and Recommendation

3. MoHM should initiate programmes to migrate various legacy systems used in the public hospitals into PMS. The migration will enhance the functionalities of PMS and resolve the issue of incompatibility of legacy system and HTIS.
4. MoHM should propose some amendments to existing laws to amend the strict restrictions on health data exchange especially among doctors. Those amendments should also include mechanisms to protect individuals' health data confidentiality during the data exchange.
5. MoHM should introduce and appoint specific portfolios (actors) for officials in HTIS projects. This should ensure that the right staff with the right knowledge are assigned to the correct posts . With regard to interoperability, this will enable staff with interoperability knowledge to apply it in HTIS project management.
6. MoHM should synchronise the standards appraisal mechanism by improving the organisational efficiency and enforcement. Without enforcement and strict monitoring, existing regulations ensuring the same standards underpin every HTIS will not be adhered to by the service providers (vendors).
7. MoHM should standardise the use of medical terminological vocabularies among different public hospitals. This effort will create a foundation for all hospitals that are using different medical terminologies in their medical records.
8. MoHM should initiate many ICT-based programmes that expose its staff on how to think and operate innovatively using ICT. These programmes should promote innovative culture among MoHM's staff, and also inspire them to embrace the ideas to interoperate behind ICT adoption in healthcare.
9. MoHM should reward and motivate any innovative efforts by its staff to widen the use of OSS technology. The encouragement will motivate staff to become involved in technology that promotes openness and the sharing of resources.
10. MoHM should optimise its efforts to promote the use of ICT among doctors in non-HTIS hospitals (approximately 115 hospitals) through change

Conclusion and Recommendation

management programmes. Their acceptance and rejections are prominent factors in ensuring the success of interoperability programmes.

11. MoHM should have more control and legal privileges over the licensing rights and ownerships in any contracts between MoHM and vendors. This will entitle MoHM to have more controls over the software ownership and limit the possibility for vendors to be less responsible after the project delivery.
12. MoHM should initiate programmes to transform existing proprietary software into OSS by modification of source codes and licensing patents. The transformation will increase the use of OSS in Malaysian healthcare.
13. MoHM should have guidelines and information over the basic requirement for ICT infrastructures for all public hospitals across the country. The guidelines and information will assist project manager for HTIS projects to define technical specifications according to the capabilities of existing ICT infrastructures.
14. MoHM should set up guidelines that require all HTIS projects to be based on a distributed system environment.
15. MoHM should promote diversity and collaboration of different expertise from both ICT and medical disciplines in project management in HTIS projects.

8.4 Research limitations and recommendations for further works

This research focused on issues behind the adoption of ICT in Malaysian healthcare by investigating the possibility of implementing interoperable EHR and HTIS. After considering many factors, the researcher chose qualitative methodological approaches as the preferable research approach. Realising the strict accessibility to the sample, and other constraints the researcher utilised an interview-based case study approach to investigate the subject. There are numbers of limitations in this research, which require future additional research to complement it.

Conclusion and Recommendation

This research is based around propositions identified in Chapters 1 and 3, and the research techniques adopted were designed to investigate these propositions. However other theories regarding the way in which innovations such as interoperable EHR/HTIS get adopted across organisations could have formed the basis for the investigation. Comparing the results of this work to similar studies that address the problem from differing theoretical backgrounds (such as Roger's Diffusion of Innovation theory (Rogers 2003) would be interesting and, if the findings concur, could help to further validate the findings of this research.

Another limitation is the number of participants who have participated during the interviews. The researcher had tried to contact more than thirty individuals who were either managing or using the HTIS or EHR. However, after series of discussions via telephone, only fourteen of them agreed to be interviewed. The number of participants under the case study, however does not affect the validity of the results, nevertheless, the researcher believes more patterns may have been able to be derived if more interviewees had participated in this research.

A possible limitation is related to the use of single research approach, which is qualitative. This approach does seem appropriate given the complexity of the research aims, however further quantitative approaches may be possible to determine the extent to which the findings and opinions were replicated across a wider range of health professionals.

REFERENCES

ABD GHANI, M.K., BALI, R.K., NAGUIB, R.N.G. and MARSHALL, I.M., 2008a. Electronic health records approaches and challenges: a comparison between Malaysia and four East Asian countries. *International Journal of Electronic Healthcare*, **4**(1), pp. 78-104.

ABD. GHANI, M.K., BALI, R.K., NAGUIB, R.N.G., MARSHALL, I.M., BASKARAN, V., WICKRAMASINGHE, N.S. and PUENTES, J., 2008b. A Flexible Telemedicine Framework for the Continuous Upkeep of Patient Lifetime Health Records (F2U-LHR), AMCIS, ed. In: *Proceedings of the Fourteenth Americas Conference on Information Systems*, August 14-17, 2008 2008b, AMCIS;, pp. 1-12.

ABDUL RAZAK, NAJIB (MALAYSIAN PRIME MINISTER), June 10, 2010, 2010-last update, Speech by Prime Minister in Dewan Rakyat of tenth Malaysian plan 2011-2015 [Homepage of The Prime Minister Office of Malaysia], [Online]. Available: http://www.pmo.gov.my/dokumenattached/speech/files/RMK10_Speech.pdf [May 15, 2011].

ABIDI, S.S., GOH, A. and YUSOFF, Z., 1998. Telemedicine and medical informatics in the multimedia super corridor: the Malaysian vision, MEDINFO, ed. In: *9th World Congress on Medical Informatics*, August 18-22, 1998 1998, Citeseer, pp. 1282-1286.

AHMAD HAMIDY, M., 2010. *The Malaysian health care system*. Presentation edn. Putrajaya: Ministry of Health of Malaysia.

AHMAD, M. and OTHMAN, R.B., 2006. Implementation of electronic government in Malaysia: The status and potential for better service to the public. *Public Sector ICT Management Review*, **1**(1), pp. 1-9.

ALVAREZ, R., 2002. The promise of e-Health - a Canadian perspective. *eHealth Int*, **1**(1), pp. 4.

AMATAYAKUL, M., 2009. Hospitals are selling (EHR)-but will physicians buy? *Healthcare Financial Management*, **63**(9), pp. 124-126.

AMMENWERTH, E., ILLER, C. and MAHLER, C., 2006. IT-adoption and the interaction of task, technology and individuals: a fit framework and a case study. *BMC Medical Informatics and Decision Making*, **6**(1), pp. 3.

ANCI AUX, N., BENZINE, M., BOUGANIM, L., JACQUEMIN, K., PUCHERAL, P. and YIN, S., 2008. Restoring the patient control over her medical history, *Computer-Based Medical Systems, 2008. CBMS'08. 21st IEEE International Symposium on 2008*, IEEE, pp. 132-137.

- ANDERSON, G.F., FROGNER, B.K., JOHNS, R.A. and REINHARDT, U.E., 2006. Health care spending and use of information technology in OECD countries. *Health Affairs*, **25**(3), pp. 819-831.
- ANDERSON, J.G., 2007. Social, ethical and legal barriers to E-health. *International Journal of Medical Informatics*, **76**(5-6), pp. 480-483.
- ANIZA, I., JAMSIAH, M., AMIN, S.A., ALI, M. and MUNIZAM, A.M.:, 2008. The Malaysian health reform in primary health care services. *Journal of community health*, **14**(2), pp. 1-10.
- ANN ROBERTSON, KATHRIN CRESSWELL, AMIRHOSSEIN TAKIAN, DIMITRA PETRAKAKI, SARAH CROWE, TONY CORNFORD, NICHOLAS BARBER, ANTHONY AVERY, BERNARD FERNANDO, ANN JACKLIN, ROBIN PRESCOTT, ELA KLECUN, JAMES PATON, VALENTINA LICHTNER, CASEY QUINN, MARYAM ALI, ZOE MORRISON, YOGINI JANI, JUSTIN WARING, KATE MARSDEN and AZIZ SHEIKH, 2010. Implementation and adoption of nationwide electronic health records in secondary care in England: qualitative analysis of interim results from a prospective national evaluation. *British Medical Journal*, **341**(n.a.), pp. n.a.-n.a.
- ANYANWU, K., SHETH, A., CARDOSO, J., MILLER, J. and KOCHUT, K., 2003. Healthcare Enterprise Process Development and Integration. *Journal of Research and Practice in Information Technology*, **35**(2), pp. 83-98.
- APPARI, A. and JOHNSON, M.E., 2010. Information security and privacy in healthcare: current state of research. *International journal of Internet and enterprise management*, **6**(4), pp. 279-314.
- ARGUELLO, M., DES, J., PEREZ, R., FERNANDEZ-PRIETO, M.J. and PANIAGUA, H., 2009. Electronic Health Records (EHRs) Standards and the Semantic Edge: A Case Study of Visualising Clinical Information from EHRs, *Computer Modelling and Simulation, 2009. UKSIM '09. 11th International Conference on 2009*, pp. 485-490.
- ARIFF, K.M. and TENG, C.L., 2002. Rural health care in Malaysia. *Australian Journal of Rural Health*, **10**(2), pp. 99-103.
- ARSHAD, N.H., MAY-LIN, Y. and MOHAMED, A., 2008. ICT outsourcing: Inherent risks, issues and challenges. *Growth*, **4**(8), pp. 117-125.
- ARSHAD, N.H., MAY-LIN, Y. and MOHAMED, A., 2008. ICT outsourcing: Inherent risks, issues and challenges. *WSEAS Transactions on Business and Economics*, **4**(8), pp. 117-125.
- ASEFZADEH, S. and MORADI, G., 2005. Electronic health record infrastructure. *Noncommunicable Disease Section Malaysia*, **4**(2), pp. 30-36.

- ASH, J.S. and BATES, D.W., 2005. Factors and Forces Affecting EHR System Adoption: Report of a 2004 ACMI Discussion. *Journal of the American Medical Informatics Association*, **12**(1), pp. 8.
- ASH, J.S., BERG, M. and COIERA, E., 2004. Some unintended consequences of information technology in health care: the nature of patient care information system-related errors. *Journal of the American Medical Informatics Association*, **11**(2), pp. 104-112.
- ASSADI, B., 01-10-2004, 2004-last update, Information and Communication Technologies in the Canada health system: An analysis of federally-funded ICT related projects [Homepage of Health Canada], [Online]. Available: <http://www.hc-sc.gc.ca/hcs-sss/pubs/ehealth-esante/2003-ict-tic-analys-proj/index-eng.php> [September 20, 2008].
- ATALAG, K., KINGSFORD, D., PATON, C. and WARREN, J., 2009. *Putting Health Record Interoperability Standards to Work*.
- AUSTRALIAN HEALTH INFORMATION COUNCIL, 2007. *Preliminary Strategic Work Plan for January 2007 - April 2008*. n.a. Canberra: Australian Health Information Council.
- AYATOLLAHI, H., BATH, P.A. and GOODACRE, S., 2010. Factors influencing the use of IT in the emergency department: A qualitative study. *Health Informatics Journal*, **16**(3), pp. 189-200.
- AZIZ SHEIKH, TONY CORNFORD, NICHOLAS BARBER, ANTHONY AVERY, AMIRHOSSEIN TAKIAN, VALENTINA LICHTNER, DIMITRA PETRAKAKI, SARAH CROWE, KATE MARSDEN, ANN ROBERTSON, ZOE MORRISON, ELA KLECUN, ROBIN PRESCOTT, CASEY QUINN, YOGINI JANI, MARYAM FICOCIELLO, KATERINA VOUTSINA, JAMES PATON, BERNARD FERNANDO, ANN JACKLIN and KATHRIN CRESSWELL, 2011. Implementation and adoption of nationwide electronic health records in secondary care in England: final qualitative results from prospective national evaluation in “early adopter” hospitals. *BMJ*, **343**.
- BARLEY, S.R., 1990. The alignment of technology and structure through roles and networks. *Administrative Science Quarterly*, **35**(1), pp. 61-103.
- BASSELLIER, G. and BENBASAT, I., 2004. Business competence of information technology professionals: conceptual development and influence on IT-business partnerships. *MIS quarterly*, **28**(4), pp. 673-694.
- BATES, D.W., EBELL, M., GOTLIEB, E., ZAPP, J. and MULLINS, H.C., 2003. A Proposal for Electronic Medical Records in U.S. Primary Care. *Journal of the American Medical Informatics Association*, **10**(1), pp. 1-10.

BEND, J., 2004. *Public value and e-Health*. 1 edn. United Kingdom: Institute for Public Policy Research.

BERNAMA, June 15, 2010, 2010-last update, Combating corruption for effective delivery [Homepage of Office of Prime Minister of Malaysia], [Online]. Available: http://www.pmo.gov.my/?menu=newslist&news_id=3493&news_cat=62&page=1731&sort_year&sort_month [March 15, 2011].

BERNSTEIN, K., BRUUN-RASMUSSEN, M., VINGTOFT, S., ANDERSEN, S.K. and NØHR, C., 2005. Modelling and implementing electronic health records in Denmark. *International journal of medical informatics*, **74**(2-4), pp. 213-220.

BINDAKHEEL, A. and ROSNAH, N., 2010. Adoption of ICT at hospital: A case study of UMMC, *Electronic Computer Technology (ICECT), 2010 International Conference on 2010*, pp. 157-160.

BLAXTER, L., HUGHES, C. and TIGHT, M., 2001. *How to research*. 3 edn. New York: Open University Press.

BLAZONA, B. and KONCAR, M., 2007. HL7 and DICOM based integration of radiology departments with healthcare enterprise information systems. *International Journal of Medical Informatics*, **76**(Supplement 3), pp. S425-S432.

BLEICH, H.L. and SLACK, W.V., 2010. Reflections on electronic medical records: When doctors will use them and when they will not. *International journal of medical informatics*, **79**(1), pp. 1-4.

BLOBEL, B., 2007. Comparing approaches for advanced e-health security infrastructures. *International Journal of Medical Informatics*, **76**(5-6), pp. 454-459.

BLOBEL, B., 2006. Advanced and secure architectural EHR approaches. *International Journal of Medical Informatics*, **75**(3-4), pp. 185-190.

BLUMENTHAL, D., 2009. Stimulating the Adoption of Health Information Technology. *N Engl J Med*, **360**(15), pp. 1477-1479.

BORHAN, A., 2011. *Innovation centre under Prime Minister Office*. n.a. edn. Kuala Lumpur: n.a.

BOUHADDOU, O., CROMWELL, T., DAVIS, M., MAULDEN, S., HSING, N., CARLSON, D., COCKLE, J., HOANG, C. and FISCHETTI, L., 2012. Translating standards into practice: Experience and lessons learned at the Department of Veterans Affairs. *Journal of Biomedical Informatics*, **45**(4), pp. 813-823.

- BOULUS, N. and BJORN, P., 2010. A cross-case analysis of technology-in-use practices: EPR-adaptation in Canada and Norway. *International journal of medical informatics*, **79**(6), pp. e97-e108.
- BRACEWELL, L., 2006. *NHS ISB-Operational requirement information standard submission*. n.a. London: National Health Services.
- BRADSHAW, K. and URQUHAT, C., 2005. Theory and practice in strategic planning for health information systems, *UK Academy for Information Systems 10th conference 2005*.
- BRAUN, V. and CLARKE, V., 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology*, **3**(2), pp. 77-101.
- BRENDER, J., 2010. Evaluation methods to monitor success and failure factors in health information system's development. In: MEHDI KHOSROW-POUR, STEVE CLARKE, MURRAY E. JENNEY, ANNIE BECKER, ARI-VEIKKO ANTTITOIKO, SHERIF KAMEL, IN LEE, JERZY KISIELNICKI, KENG SIAU, AMAR GUPTA, CRAIG VAN SLYKE, JOHN WANG, AND VISHANTH WEERAKKODY, ed, *Health information systems: Concepts, methodologies, tools, and applications*. 1 edn. New York: Medical Information Science Reference, pp. 605-626.
- BRENNAN, S., 2005. *The NHS IT Project: The biggest computer programme in the world.....ever!* Oxon United Kingdom: Radcliffe.
- BRITISH STANDARDS, 2007. *BS EN 13606-1:2007 Health informatics — Electronic health record communication: Part 1: Reference Information Model*. BS ISO 13606-1:2007 edn. United Kingdom: n.a.
- BRITISH STANDARDS, 2007. *BS EN 13606-2:2007 Health informatics — Electronic health record communication: Part 2: Archetype interchange specification*. BS ISO 13606-2:2007 edn. United Kingdom: n.a.
- BRITISH STANDARDS INSTITUTION, 2006. *PD ISO/TR 16056-1:2004 Health informatics — Interoperability of telehealth systems and networks — Part 1: Introduction and definitions*. PD ISO/TR 16056-1:2004 edn. United Kingdom: ISO/TR 16056-1.
- BULGIBA, A.M., 2004. Information Technology in Health Care - What the Future Holds. *Asia Pacific Journal of Public Health*, **16**(1), pp. 64-71.
- BUNNISS, S. & KELLY, D.R. 2010, "Research paradigms in medical education research", *Medical education*, vol. 44, no. 4, pp. 358-366.
- BURKHARDT, M.E. and BRASS, D.J., 1990. Changing Patterns or Patterns of Change: The Effects of a Change in Technology on Social Network Structure and Power. *Administrative Science Quarterly*, **35**(1), pp. 104-127.

- BURNS, F., 1998. *An information strategy for the modern NHS 1998-2005*. NHS Executive, A1103. Leeds: .
- BUSH, M., LEDERER, A.L., LI, X., PALMISANO, J. and RAO, S., 2009. The alignment of information systems with organizational objectives and strategies in health care. *International journal of medical informatics*, **78**(7), pp. 446-456.
- CALDWELL, D.F., CHATMAN, J., O'REILLY, CHARLES A.,I,II, ORMISTON, M. and LAPIZ, M., 2008. Implementing strategic change in a health care system: The importance of leadership and change readiness. *Health care management review*, **33**(2),.
- CANADA HEALTH INFOWAY, January 2008, 2008-last update, Corporate business plan 2008/09: Paving the way to collaborative care [Homepage of Canada Health Infoway], [Online]. Available: http://www2.infoway-inforoute.ca/Documents/Infoway_Business_Plan_2008-2009_Eng.pdf [March 15, 2008].
- CANADA HEALTH INFOWAY, January 2008, 2008-last update, A newsletter from Canada Health Infoway [Homepage of Canada Health Infoway], [Online]. Available: http://www2.infoway-inforoute.ca/Documents/EHRNews_SS2008_EN.pdf [April 2, 2008].
- CANADA HEALTH INFOWAY, 2008-last update, Vision 2015: Advancing Canada's next generation of healthcare [Homepage of Canada Health Infoway], [Online]. Available: http://www.infoway-inforoute.ca/en/pdf/Vision_2015_Advancing_Canadas_next_generation_of_healthcare.pdf [March 15, 2008].
- CARNALL, D., June 20, 2000, 2000-last update, Open Source Software in Healthcare [Homepage of Douglas Carnall], [Online]. Available: <http://www.informatics-review.com/thoughts/open.html> [September 1, 2011].
- CARTER, S.M. and LITTLE, M., 2007. Justifying knowledge, justifying method, taking action: epistemologies, methodologies, and methods in qualitative research. *Qualitative health research*, **17**(10), pp. 1316-1328.
- CASSELL, M.K., 2010. The Status of Free/Open Source Software among Local Governments: Lessons from Three German Cities, *Conference Proceedings of JITP 2010: The Politics of Open Source 2010*, pp. 220.
- CAULDWELL, M., BEATTIE, C., COX, B., DENBY, W., EDE-GOLIGHTLY, J. and LINTON, F., 2007. The impact of electronic patient records on workflow in general practice. *Health Informatics Journal*, **13**(2), pp. 155-160.
- CHANG, J., 1 April 2011, 2011-last update, Universal Health Care Pros And Cons [Homepage of n.a.], [Online]. Available: <http://www.universalhealthcareprosandcons.com/> [October 1, 2011].

CHARETTE, R., 2006. EHRs: Electronic Health Records or Exceptional Hidden Risks? *Communications of the ACM*, **49**(6), pp. 120-120.

CHEN, M., 2003. Factors affecting the adoption and diffusion of XML and Web services standards for E-business systems. *International Journal of Human-Computer Studies*, **58**(3), pp. 259-279.

CHEN, H., GUO, F., CHEN, C., CHEN, J. and KUO, T., 2001. Review of telemedicine projects in Taiwan. *International journal of medical informatics*, **61**(2-3), pp. 117-129.

CHEW, S., CHENG, H., LAM, D., CHENG, A., LEUNG, A., CHUA, J., YU, C. and BALAKRISHNAN, V., OphthWeb—cost-effective telemedicine for ophthalmology. *Hong Kong Medical Journal*, **4**(3), pp. 300-304.

CHIASSON, M.W. and DAVIDSON, E., 2004. Pushing the contextual envelope: developing and diffusing IS theory for health information systems research. *Information and Organization*, **14**(3), pp. 155-188.

CHO, S., MATHIASSEN, L. and GALLIVAN, M., 2008. From Adoption to Diffusion of a Telehealth Innovation, *Hawaii International Conference on System Sciences, Proceedings of the 41st Annual 2008*, pp. 245-245.

CHO, S., MATHIASSEN, L. and GALLIVAN, M., 2009. Crossing the diffusion chasm: from invention to penetration of a telehealth innovation. *Information Technology & People*, **22**(4), pp. 351-366.

CHUA, S., CHUA, H. and OMAR, A., 2010. Drug administration errors in paediatric wards: a direct observation approach. *European journal of pediatrics*, **169**(5), pp. 603-611.

CLEGG, C., AXTELL, C., DAMADORAN, L., FARBEY, B., HULL, R., LLOYD-JONES, R., NICHOLLS, J., SELL, R. and TOMLINSON, C., 1997. Information technology: a study of performance and the role of human and organisational factors. *Ergonomics*, **40**(9), pp. 851.

COEN, D., 1999. The impact of US lobbying practice on the European business-government relationship. *California management review*, **41**(4), pp. 27.

COHEN, G., 2006. *IBA'a Malaysian business leaps ahead as Joint Venture is given approval for 10 hospitals*. Business Announcement to Australian Security Exchange edn. n.a.: ISOFT Group Limited.

COIERA, E.W., 2007. Lessons from the NHS National Programme for IT. *Medical Journal of Australia*, **186**(1), pp. 3.

COLE, E., PISANO, E.D., CLARY, G.J., ZENG, D., KOOMEN, M., KUZMIAK, C.M., SEO, B.K., LEE, Y. and PAVIC, D., 2006. A comparative study of mobile electronic data entry systems for clinical trials data collection. *International journal of medical informatics*, **75**(10-11), pp. 722-729.

CONNELL, N.A.D. and YOUNG, T.P., 2007. Evaluating healthcare information systems through an “enterprise” perspective. *Information & Management*, **44**(4), pp. 433-440.

COWARD, R., 2010. Educational governance in the NHS: a literature review. *International journal of health care quality assurance*, **23**(8), pp. 708-717.

CRAIK, J., 2005. Dilemmas in Policy Support for the Arts and Cultural Sector. *Australian Journal of Public Administration*, **64**(4), pp. 6-19.

CRESWELL, J.W., 2009. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 3 edn. California: SAGE Publications Inc.

CRISÓSTOMO-ACEVEDO, M.J. and MEDINA-GARRIDO, J.A., 2010. Telemedicine Barriers. In: MEHDI KHOSROW-POUR, STEVE CLARKE, MURRAY E. JENNEX, ANNIE BECKER, ARI-VEIKKO ANTTIROIKO, SHERIF KAMEL, IN LEE, JERZY KISIELNICKI, KENG SIAU, AMAR GUPTA, CRAIG VAN SLYKE, JOHN WANG and VISHANTH WEERAKKODY, eds, *Health information systems: Concepts, methodologies, tools, and applications*. 1 edn. New York: Medical information science reference, pp. 315-322.

CZEKIERDA, L., DAÑDA, J., LOZIAK, K., SIKORA, M. and ZIELIŃSKI, K., 2006. Wireless systems in e-health. In: KRZYSTOF ZIELIŃSKI, ed, *Information technology solutions for healthcare*. 1 edn. London: Springer, pp. 85-109.

DARKE, P., - SHANKS, G. and - BROADBENT, M., - 1998. - *Successfully completing case study research: combining rigour, relevance and pragmatism*. - Blackwell Science Ltd.

DAUD, M.A., December 31, 2007, 2007-last update, HUKM develops own Total Hospital Information System [Homepage of Bernama.com], [Online]. Available: http://www.bernama.com.my/bernama/v3/news_lite.php?id=305217 [December 31, 2007, Business].

DAVIS, F.D., 1989. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, **13**(3), pp. 319-340.

DELONE, W.H. and MCLEAN, E.R., 2003. The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems*, **19**(4), pp. 9-30.

DELONE, W.H. and MCLEAN, E.R., 2004. Measuring e-Commerce Success: Applying the DeLone & McLean Information Systems Success Model. *International Journal of Electronic Commerce*, **9**(1), pp. 31-47.

DELONE, W.H. and MCLEAN, E.R., 1992. Information Systems Success: The Quest for the Dependent Variable. *Information Systems Research*, **3**(1), pp. 60-95.

DEPARTMENT OF FINANCE CANADA, 22 July 2008, 2008-last update, Canada Health Transfer [Homepage of Department of Finance Canada], [Online]. Available: <http://www.fin.gc.ca/FEDPROV/chte.html> [August 15, 2008].

DEPARTMENT OF HEALTH, September 2011, 2011-last update, Dismantling the NHS National Programme for IT. Available: <http://mediacentre.dh.gov.uk/2011/09/22/dismantling-the-nhs-national-programme-for-it> [December 15, 2011].

DEPARTMENT OF HEALTH OF HONG KONG, 28 October, 2011b-last update, Health facts of Hong Kong [Homepage of Department of Health of Hong Kong], [Online]. Available: http://www.dh.gov.hk/english/statistics/statistics_hs/files/Health_Statistics_pamphlet_E.pdf [August 16, 2011].

DEPARTMENT OF HEALTH OF HONG KONG, 28 October, 2011a-last update, Department of Health Annual Report 2008/2009 [Homepage of Department of Health of Hong Kong], [Online]. Available: http://www.dh.gov.hk/english/pub_rec/pub_rec_ar/pub_rec_arpis_0809_html_ar.html [August 16, 2011].

DEPARTMENT OF HEALTH, EXECUTIVE YUAN OF ROC, November, 2011a-last update, Essential Statistical data of National Health Insurance Key Statistics [Homepage of Department of Health, Executive Yuan of ROC], [Online]. Available: http://www.doh.gov.tw/EN2006/DM/DM2.aspx?now_fod_list_no=6464&class_no=390&level_no=3 [October 1, 2011].

DEPHILLIPS, H.A., 2007. Initiatives and Barriers to Adopting Health Information Technology: A US Perspective. *Disease Management Health Outcomes*, **15**(1), pp. 1-6.

DETMER, W.M. and FRIEDMAN, C.P., 1994. Academic physicians' assessment of the effects of computers on health care. N.A., ed. In: *Proceedings of the Annual Symposium on Computer Application in Medical Care*, n.a. 1994, American Medical Informatics Association, pp. 558-562.

DEUTSCH, E., DUFTSCHMID, G. and DORDA, W., 2010. Critical areas of national electronic health record programs—Is our focus correct? *International journal of medical informatics*, **79**(3), pp. 211-222.

DIMAGGIO, P.J. and POWELL, W.W., 1983. The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, **48**(2), pp. 147-160.

DOHERTY, N.F. 2014, "The role of socio-technical principles in leveraging meaningful benefits from IT investments", *Applied Ergonomics*, vol. 45, no. 2, Part A, pp. 181-187.

DOI, K., 2007. Computer-aided diagnosis in medical imaging: Historical review, current status and future potential. *Computerized Medical Imaging and Graphics*, **31**(4-5), pp. 198-211.

DOWLING, A.F., THORNEWILL, J., COX, B. and ESTERHAY, R.J., 2010. Information Infrastructure for Public Health and Health Research: Findings from a Large-Scale HIE Stakeholder Study, *System Sciences (HICSS), 2010 43rd Hawaii International Conference on 2010*, pp. 1-10.

DOWNING, G., BOYLE, S., BRINNER, K. and OSHEROFF, J., 2009. Information management to enable personalized medicine: stakeholder roles in building clinical decision support. *BMC Medical Informatics and Decision Making*, **9**(1), pp. 44.

DWIVEDI, A., BALI, R.K., WICKRAMASINGHE, N. and NAGUIB, R.N.G., 2010. Using Object Oriented Technologies to build collaborative applications in healthcare and medical information systems. In: MEHDI KHOSROW-POUR, STEVE CLARKE, MURRAY E. JENNEX, ANNIE BECKER, ARI-VEIKKO ANTTIROIKO, SHERIF KAMEL, IN LEE, JERZY KISIELNICKI, KENG SIAU, AMAR GUPTA, CRAIG VAN SLYKE, JOHN WANG and VISHANTH WEERAKKODY, eds, *Health information systems: Concepts, methodologies, tools, and applications*. 1 edn. New York: Medical information science reference, pp. 889-902.

DZENOWAGIS, J., 2009. 2 Bridging the digital divide: Linking health and ICT policy. In: R. WOOTTON, N.G. PATIL, R.E. SCOTT and K. HO, eds, *Telehealth in the Developing World*. 1 edn. London: The Royal Society of Medicine Press, pp. n.a.-n.a.

ECONOMIC PLANNING UNIT, 2010. *Tenth Malaysian Plan 2011-2015*. Malaysian National Plan edn. Putrajaya Malaysia: EPU.

ECONOMIC PLANNING UNIT, 2006. *Ninth Malaysian Plan 2006-2010*. Malaysian National Plan edn. Putrajaya Malaysia: EPU.

ECONOMIC PLANNING UNIT, 1996. *Seventh Malaysian Plan 1996-2000*. Malaysian National Plan edn. Kuala Lumpur Malaysia: EPU.

ECONOMIC PLANNING UNIT OF PRIME MINISTER OFFICE, 2009. *First guideline of tenth Malaysian plan, 2011-2015: The economic prospects and strategic directions*. UPE(S)12-10/1 Jld.3. Putrajaya: Prime Minister Office.

EDIRIPPULIGE, S., MARASINGHE, R.B., DISSANAYAKE, V.H.W., ABEYKOON, P. and WOOTTON, R., 2009. Strategies to promote e-health and telemedicine activities in developing countries. In: R. WOOTTON, N.G. PATIL, R.E. SCOTT and K. HO, eds, *Telehealth in the Developing World*. 1 edn. London: The Royal Society of Medicine Press, pp. n.a.-n.a.

EISENHARDT, K.M. 1989, "Building Theories from Case Study Research", *The Academy of Management Review*, vol. 14, no. 4, pp. 532-550.

EGYEDI, T.M., 2007. Standard-compliant, but incompatible?! *Computer Standards & Interfaces*, **29**(6), pp. 605-613.

EHEALTH RECORD OFFICE, 10 November 2011, 2011b-last update, eHR Sharing System Development Roadmap [Homepage of Food and Health Bureau, eHealth Record Office], [Online]. Available: http://www.ehealth.gov.hk/en/development_programme/roadmap.html [September 2011, 2011].

EHEALTH RECORD OFFICE, 10 November 2011, 2011a-last update, History of EHR development [Homepage of Food and Health Bureau, eHealth Record Office], [Online]. Available: http://www.ehealth.gov.hk/en/development_programme/history.html [September 2011, 2011].

EHIKHAMENOR, F.A., 2002. Socio-Economic Factors in the Application of Information and Communication Technologies in Nigerian Print Media. *Journal of the American Society for Information Science & Technology*, **53**(7), pp. 602-611.

EICHELBERG, M., ADEN, T., RIESMEIER, J., DOGAC, A. and LALECI, G.B., 2005. A Survey and Analysis of Electronic Healthcare Record Standards. *ACM Computing Survey*, **37**(4), pp. 277-315.

ENGLAND, I. and STEWART, D., 2007. Executive management and IT innovation in health: identifying the barriers to adoption. *Health Informatics Journal*, **13**(2), pp. 75-87.

FAHEY, D.F. and BURBRIDGE, G., 2008. Application of Diffusion of Innovations Models in Hospital Knowledge Management Systems: Lessons to Be Learned in Complex Organizations. *Hospital topics*, **86**(2), pp. 21-31.

FENDRICK, A. MARK & SCHWARTZ, J. SANFORD, 1994. Physicians' Decisions Regarding the Acquisition of Technology. In: ANNETINE C. GELIJNS & HOLLY V. DAWKINS, ed, *Adopting New Medical Technology*. 1 edn. Washington: National Academy Press, pp. 71-84.

- FITCH, C.J., 2004. Information systems in healthcare: mind the gap, *System Sciences, 2004. Proceedings of the 37th Annual Hawaii International Conference on* 2004, pp. 8 pp.
- FITZGERALD, B., 2006. The transformation of open source software. *Management Information Systems Quarterly*, **30**(3), pp. 587.
- FITZNER, K.A., COUGHLIN, S., TOMORI, C. and BENNETT, C.L., 2000. Health care in Hong Kong and mainland China: one country, two systems? *Health policy*, **53**(3), pp. 147-155.
- FLICK, U., 1956-, 2006. *An introduction to qualitative research*. London: London : SAGE.
- FONTANA, R., KUHN, B.M., MOGLEN, E., NORWOOD, M., RAVICHER, D.B., SANDLER, K., VASILE, J. and WILLIAMSON, A., 2008. *A legal issues primer for open source and free software projects*. Software Freedom Law Center.
- FOO, L.N., LAI, W.K. and ELAMZAZUTHI, C., 2002. NARROWING THE DIGITAL DIVIDE IN MALAYSIA: ISSUES AND INITIATIVES. *ASEAN JOURNAL ON SCIENCE AND TECHNOLOGY FOR DEVELOPMENT*, **19**(2), pp. 97-110.
- FRAMBACH, R.T. and SCHILLEWAERT, N., 2002. Organizational innovation adoption: a multi-level framework of determinants and opportunities for future research. *Journal of Business Research*, **55**(2), pp. 163-176.
- GAGNON, M., DESMARTIS, M., LABRECQUE, M., CAR, J., PAGLIARI, C., PLUYE, P., FRÉCHONT, P., GAGNON, J., TREMBLAY, N. and LÉGARÉ, F., Systematic Review of Factors Influencing the Adoption of Information and Communication Technologies by Healthcare Professionals. *Journal of medical systems*, , pp. 1-37.
- GANESH, A.U.J., 2004. E-health-drivers, applications, challenges ahead and strategies: a conceptual framework. *Industrial Journal of Medical Informatics*, **1**(1), pp. 39-47.
- GENOVA, B.K.L. and GREENBERG, B.S., 1979. Interests in News and the Knowledge Gap. *Public opinion quarterly*, **43**(1), pp. 79.
- GEORGIU, A., AMPT, A., CRESWICK, N., WESTBROOK, J.I. and BRAITHWAITE, J., 2009. Computerized Provider Order Entry—What are health professionals concerned about? A qualitative study in an Australian hospital. *International Journal of Medical Informatics*, **78**(1), pp. 60-70.
- GERBER, T., 2007. Legislative and regulatory considerations for HIT . In: CLAIRE TOPAL AND KALEB BROWNLOW, ed, *Health information technology*

and policy lab: HIT briefing book. 1 edn. Washington: The National Bureau of Asian Research, pp. 43-45.

GHANI, M.K.A., BALI, R.K., NAGUIB, R.N.G., MARSHALL, I.M. and WICKRAMASINGHE, N.S., 2010. Critical analysis of the usage of patient demographic and clinical records during doctor-patient consultations: A Malaysian perspective. *International Journal of Healthcare Technology and Management*, **11**(1-2), pp. 113-130.

GHOSH, B. and SCOTT, J.E., 2005. Comparing knowledge management in health-care and technical support organizations. *Information Technology in Biomedicine, IEEE Transactions on*, **9**(2), pp. 162-168.

GIACOMINI, M.K. and COOK, D.J., 2000. Users' guides to the medical literature: XXIII. Qualitative research in health care A. Are the results of the study valid? *Journal of the American Medical Association*, **284**(3), pp. 357.

GILCHRIST, J., FRIZE, M., BARICIAK, E. and TOWNSEND, D., 2008. Integration of new technology in a legacy system for collecting medical data - challenges and lessons learned, *Engineering in Medicine and Biology Society, 2008. EMBS 2008. 30th Annual International Conference of the IEEE 2008*, pp. 4326-4329.

GILL, S. and PARANJAPPE, R., 2010. A review of recent contribution in agent based healthcare modeling. In: MEHDI KHOSROW-POUR, STEVE CLARKE, MURRAY E. JENNEX, ANNIE BECKER, ARI-VEIKKO ANTTIROIKO, SHERIF KAMEL, IN LEE, JERZY KISIELNICKI, KENG SIAU, AMAR GUPTA, CRAIG VAN SLYKE, JOHN WANG and VISHANTH WEERAKKODY, eds, *Health information systems: Concepts, methodologies, tools, and applications*. 1 edn. New York: Medical information science reference, pp. 356-373.

GLASER, J., 2009. Implementing Electronic Health Records 10 Factors for Success. *hfm (Healthcare Financial Management)*, **63**(1), pp. 50-54.

GORLA, N., SOMERS, T.M. and WONG, B., 2010. Organizational impact of system quality, information quality, and service quality. *The Journal of Strategic Information Systems*, **19**(3), pp. 207-228.

GRANEHEIM, U.H. and LUNDMAN, B., 2004. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse education today*, **24**(2), pp. 105-112.

GRAY, P.S., WILLIAMSON, J.B., KARP, D.A. and DALPHIN, J.R., 2007. *The Research Imagination : An Introduction to Qualitative and Quantitative Methods*. Cambridge: Cambridge University Press.

GREENHALGH, T., ROBERT, G., MACFARLANE, F., BATE, P. and KYRIAKIDOU, O., 2004. Diffusion of Innovations in Service Organizations: Systematic Review and Recommendations. *The Milbank quarterly*, **82**(4), pp. 581-629.

GREENHALGH, T., POTTS, H.W., WONG, G., BARK, P. and SWINGLEHURST, D., 2009. Tensions and Paradoxes in Electronic Patient Record Research: A Systematic Literature Review Using the Meta-narrative Method. *Milbank Quarterly*, **87**(4), pp. 729-788.

GREENHALGH, T., STRAMER, K., BRATAN, T., BYRNE, E., MOHAMMAD, Y. and RUSSELL, J., 2008. Introduction of shared electronic records: multi-site case study using diffusion of innovation theory. *BMJ*, **337**, pp. a1786.

GRIMSON, J., GRIMSON, W. and HASSELBRING, W., 2000. The SI challenge in health care. *Communications of the ACM*, **43**(6), pp. 49.

GUAH, M.W. and CURRIE, W.L., 2007. Managing Vendor Contracts in Public Sector IT: A Case Study on the UK National Health Service, *Proceedings of the 15th European Conference on Information Systems 2007*, St. Gallen, Switzerland, pp. 2147-2160.

GUNDE, R., 30 September, 2004-last update, Healthcare in Taiwan: Opportunities and Success [Homepage of UCLA International Institute], [Online]. Available: <http://www.international.ucla.edu/article.asp?parentid=15333> [October 8, 2011].

HALFORD, S., OBSTFELDER, A. and LOTHERINGTON, A.T., 2009. Beyond implementation and resistance: how the delivery of ICT policy is reshaping healthcare. *Policy & Politics*, **37**(1), pp. 113-128.

HAMID, A. and SARMA, A., 2010. Multi-dimensional criteria for the evaluation of e-Health services. In: MEHDI KHOSROW-POUR, STEVE CLARKE, MURRAY E. JENNEX, ANNIE BECKER, ARI-VEIKKO ANTTIROIKO, SHERIF KAMEL, IN LEE, JERZY KISIELNICKI, KENG SIAU, AMAR GUPTA, CRAIG VAN SLYKE, JOHN WANG and VISHANTH WEERAKKODY, eds, *Health information systems: Concepts, methodologies, tools, and applications*. 1 edn. New York: Medical information science reference, pp. 8-25.

HAMMOND, W., 2005. The making and adoption of health data standards. *Health affairs*, **24**(5), pp. 1205.

HANDEL, D.A. and HACKMAN, J.L., 2010. Implementing Electronic Health Records in the Emergency Department. *The Journal of emergency medicine*, **38**(2), pp. 257-263.

HARRISINTERACTIVE, 2007. Large differences between primary care practices in the United States, Australia, Canada, Germany, New Zealand, the Netherlands and the United Kingdom. *Health Affairs*, **7**(2), pp. 1.

- HART, S.L., 1971. *Axiology--Theory of Values*. University of Buffalo, Inc.
- HAUX, R., 2006. Individualization, globalization and health – about sustainable information technologies and the aim of medical informatics. *International Journal of Medical Informatics*, **75**(12), pp. 795-808.
- HAUX, R., WINTER, A. and BRIGL, B., 2004. Basic concepts. In: REED M. GARDNER, ed, *Strategic information management in hospitals: An introduction to hospital information systems*. 1 edn. n.a.: Springer, pp. 1-42.
- HEALTH LEVEL SEVEN INTERNATIONAL, 2011-last update, Clinical Document Architecture FAQ [Homepage of HL7], [Online]. Available: <http://www.hl7.org/about/FAQs/index.cfm> [September 30, 2011].
- HEATHFIELD, S., 2007. *External Data Transfer (EDT) deployment process for CDS-XML V5*. NPFIT-TO-BAR. London: NHS Connecting for Health.
- HEEKS, R., 2006. Health information systems: Failure, success and improvisation. *International journal of medical informatics*, **75**(2), pp. 125-137.
- HELLER, P.S., 1982. A model of the demand for medical and health services in Peninsular Malaysia. *Social science & medicine*, **16**(3), pp. 267-284.
- HEMPHILL, T.A., 2005. Government technology acquisition policy: the case of proprietary versus open source software. *Bulletin of Science, Technology & Society*, **25**(6), pp. 484.
- HENDERSON, J., BRITT, H. and MILLER, G., 2006. Extent and utilisation of computerisation in Australian general practice. *The Medical Journal of Australia*, **185**(2), pp. 84-87.
- HENDY, J., FULOP, N., REEVES, B.C., HUTCHINGS, A. and COLLIN, S., 2007. Implementing the NHS information technology programme: qualitative study of progress in acute trusts. *BMJ*, **334**(7608), pp. 1360.
- HERBST, M., BUSCH, C., PHAROW, P. and BLOBEL, B., 2008. Empowerment of Health Professionals: How High Level Security Education Can Raise Awareness and Confidence. In: S.K. ANDERSEN, ed, *eHealth Beyond the Horizon – Get IT There*. 1 edn. New York: IOS Press, pp. 673-678.
- HESS, D.R., 2004. How to write an effective discussion. *Respiratory care*, **49**(10), pp. 1238-1241.
- HISAN, A., 20th June 2006, 2006-last update, Malaysia's health: Transforming healthcare services through ICT [Homepage of MoHM], [Online]. Available:

<http://unpan1.un.org/intradoc/groups/public/documents/gaid/unpan033231.pdf> [January 5, 2008, 2008].

HOLDEN, R.J. and KARSH, B., 2009. A theoretical model of health information technology usage behaviour with implications for patient safety. *Behaviour & Information Technology*, **28**(1), pp. 21-38.

HORSLEY, A. and FORSTER, L., 2005. Handheld computers in medicine: the way forward. *Postgraduate medical journal*, **81**(957), pp. 481-482.

HOUGHTON, J., 2002. Information Technology and the Revolution in Healthcare. *Victoria University of Technology*, [Day of Access, 25th August 2004], .

HOVENGA, E.J.S., 2008. Importance of achieving semantic interoperability for national health information systems. *Texto and contexto emfermagem*, , pp. 158-167.

HOVENGA, E.J.S. and GARDE, S., 2010. Electronic Health Records, Semantic Interoperability and Politics. *electronic Journal of Health Informatics*, **5**(1), pp. e2.

HSU, M.H., YEN, J.C., CHIU, W.T., TSAI, S.L., LIU, C.T. and LI, Y.C., 2011. Using health smart cards to check drug allergy history: The perspective from Taiwan's experiences. *J Med Syst*, **35**, pp. 555-558.

HU, P.J.H., CHAU, P.Y.K. and SHENG, O.R.L., 2000. Investigation of factors affecting healthcare organization's adoption of telemedicine technology, IEEE COMPUTER SOCIETY, ed. In: *System Sciences, 2000. Proceedings of the 33rd Annual Hawaii International Conference on*, January 4-7, 2000 2000, IEEE Computer Society, pp. 10.

HU, P.J.H., WEI, C.P. and CHENG, T.H., 2002. Investigating telemedicine developments in Taiwan: Implications for telemedicine program management, *System Sciences, 2002. HICSS. Proceedings of the 35th Annual Hawaii International Conference on 2002*, IEEE, pp. 8 pp.

HU, P.J., CHAU, P.Y.K., LIU SHENG, O.R. and KAR, Y.T., 1999. Examining the Technology Acceptance Model Using Physician Acceptance of Telemedicine Technology. *Journal of Management Information Systems*, **16**(2), pp. 91-112.

HUSSEIN, R., ABDUL KARIM, N.S., MOHAMED, N. and AHLAN, A.R., 2007. The influence of organizational factors on information systems success in e-government agencies in Malaysia. *The Electronic Journal of Information Systems in Developing Countries*, **29**(0),.

IBRAHIM, A.R., 2002. *An integrated performance measurement system of health care services: An empirical study of public and private hospitals in Malaysia*, University of Strathclyde.

- IBRAHIM, L., 2003. Coding of ICD-10 diagnosis and procedure implementation in Malaysia. *NCD Malaysia*, **2**(4), pp. 19-22.
- IRESTIG, M. and TIMPKA, T., 2008. Politics and technology in health information systems development: A discourse analysis of conflicts addressed in a systems design group. *Journal of Biomedical Informatics*, **41**(1), pp. 82-94.
- ISMAIL, A., JAMIL, A.T., RAHMAN, A.F.A., BAKAR, J.M.A., SAAD, N.M. and SAADI, H., 2010. The implementation of hospital information system (HIS) in tertiary hospitals in Malaysia: A qualitative study. *Malaysian Journal of Public Health Medicine*, **10**(2), pp. 16-24.
- ISO/TR 20514, 2005. *Health informatics-electronic health record: Definition, scope and context*. ISO TC 215. Geneva: International Organization for Standardization (ISO).
- JACKSON, J., FOX, S.J. and SCHICK, V., 2011. Negotiating the EHR vendor contract. *American College of Surgeons Bulletin*, **96**(3), pp. 12-17.
- JANAMANCHI, B., KATSAMAKAS, E., RAGHUPATHI, W. and GAO, W., 2009. The State and Profile of Open Source Software Projects in health and medical informatics. *International journal of medical informatics*, **78**(7), pp. 457-472.
- JANCZEWSKI, L. and XINLI SHI, F., 2002. Development of Information Security Baselines for Healthcare Information Systems in New Zealand. *Computers & Security*, **21**(2), pp. 172-192.
- JENNINGS, G.R., 2004. Interviewing: A focus on qualitative techniques. In: B.W. RITCHIE, P. BURNS and C. PALMER, eds, *Tourism Research Methods: Integrating Theory with Practice*. 1 edn. Oxfordshire: CABI Publishing, pp. 99-118.
- JENSEN, T.B. and AANESTAD, M., 2007. How Healthcare Professionals "Make Sense" of an Electronic Patient Record Adoption. *Information Systems Management*, **24**(1), pp. 29.
- JHA, A.K., DOOLAN, D., GRANDT, D., SCOTT, T. and BATES, D.W., 2008. The use of health information technology in seven nations. *International Journal of Medical Informatics*, **77**(12), pp. 848-854.
- JOEL, W., 2003. How open is open enough?: Melding proprietary and open source platform strategies. *Research Policy*, **32**(7), pp. 1259-1285.
- JOHANSSON, A., LINDBERG, M., 2011. *Making a case for gender-inclusive innovation through the concept of creative imitation*. <http://www.innovationandentrepreneurship.net/index.php/aie/article/view/8440> edn. North America: CoAction Publishing.

JUCIUTE, R., 2009. ICT implementation in the health-care sector: effective stakeholders' engagement as the main precondition of change sustainability. *AI & Society*, **23**(1), pp. 131-137.

KALOF, L., DAN, A. and DIETZ, T., 2008. *Essentials of social research*. 1 edn. England: Open University Press.

KALRA, D., 2006. Electronic health record standards. In: HAUX, R. AND KULIKOWSKI, C., ed, *IMIA Yearbook of Medical Informatics 2006*. 1 edn. Stuttgart, Germany: International Medical Informatics Association and Schattauer, pp. 136-144.

KALRA, DIPAK & INGRAM, DAVID, 2006. Electronic health records. In: HANNAH, KATHRYN & BALL, MARION J., ed, *Information technology solutions for healthcare*. 1 edn. London: Springer, pp. 135-176.

KAPLAN, B. and MAXWELL, J.A., 2005. Qualitative research methods for evaluating computer information systems. In: K.J. HANNAH and M.J. AND BALL, eds, *Evaluating the organisational impact of healthcare information systems*. 1 edn. New York: Springer, pp. 30-55.

KAPOR, M. and WEITZNER, D.J., 2010. Developing the national communications and information infrastructure. *Internet Research: Electronic Networking Applications and Policy*, **20**(4), pp. 395-407.

KARIM, N.S.A. and AHMAD, M., 2010. An overview of electronic health record (EHR) implementation framework and impact on health care organizations in malaysia: A case study, *Management of Innovation and Technology (ICMIT), 2010 IEEE International Conference on*, 2-5 June 2010 2010, IEEE, pp. 84-89.

KATSAMAKAS, E., JANAMANCHI, B., RAGHUPATHI, W. and GAO, W., 2010. A classification analysis of success of Open Source health information technology projects. In: MEHDI KHOSROW-POUR, STEVE CLARKE, MURRAY E. JENNEX, ANNIE BECKER, ARI-VEIKKO ANTTIROIKO, SHERIF KAMEL, IN LEE, JERZY KISIELNICKI, KENG SIAU, AMAR GUPTA, CRAIG VAN SLYKE, JOHN WANG and VISHANTH WEERAKKODY, eds, *Health information systems: Concepts, methodologies, tools, and applications*. 1 edn. New York: Medical inforMation science reference, pp. 256-273.

KATSAMAKAS, E., JANAMANCHI, B., RAGHUPATHI, W. and GAO, W., 2010. A Classification Analysis of the Success of Open Source Health Information Technology Projects. In: MEHDI KHOSROW-POUR, STEVE CLARKE, MURRAY E. JENNEX, ANNIE BECKER, ARI-VEIKKO ANTTIROIKO, SHERIF KAMEL, IN LEE, JERZY KISIELNICKI, KENG SIAU, AMAR GUPTA, CRAIG VAN SLYKE, JOHN WANG and VISHANTH WEERAKKODY, eds, *Health information systems: Concepts, methodologies, tools, and applications*. 1 edn. New York: Medical inforMation science reference, pp. 256-273.

KAWASUMI, Y., 2000. Accessibility in rural and remote areas. In: UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION (UNESCO), ed, *Infoethics 2000*. 1 edn. Paris: Citeseer, pp. 143.

KAYE, R., KOKIA, E., SHALEV, V., IDAR, D. and CHINITZ, D., 2010. Barriers and success factors in health information technology: A practitioner's perspective. *Journal of Management & Marketing in Healthcare*, **3**(2), pp. 163-175.

KERSUMA NYATA SDN BHD, 2010. *A contract to supply information system to management division of the Ministry of Energy, Green Technology and Water*. Contractual agreement edn. Kajang Selangor: Kersuma Nyata Sdn Bhd.

KERSUMA NYATA SDN. BHD, 2009. *Contract to supply ICT solution to Malaysian government*. n.a. edn. Kajang Selangor: n.a.

KHOO, E. and RICHARD, K.M., 2002. Primary Health Care and General Practice -- a Comparison between Australia and Malaysia. *Asia Pacific Journal of Public Health*, **14**(2), pp. 59-63.

KHOUMBATI, K. and THEMISTOCLEOUS, M., 2007. Application of fuzzy simulation for the evaluation of enterprise application integration in healthcare organisations. *Transforming Government: People, Process and Policy*, **1**(3), pp. 230-241.

KHOUMBATI, K., THEMISTOCLEOUS, M. and IRANI, Z., 2006. Evaluating the Adoption of Enterprise Application Integration in Health-Care Organizations. *Journal of Management Information Systems*, **22**(4), pp. 69-108.

KIM, K.K. and MICHELMAN, J.E., 1990. An Examination of Factors for the Strategic Use of Information Systems in the Healthcare Industry. *MIS Quarterly*, **14**(2), pp. 201-215.

KIMBERLY, J.R. and EVANISKO, M.J., 1981. Organizational Innovation: The Influence of Individual, Organizational, and Contextual Factors on Hospital Adoption of Technological and Administrative Innovations. *Academy of Management Journal*, **24**(4), pp. 689-713.

KIRBY, M.J.L. and LEBRETON, M., 2002. *The health of Canada- The federal role (Vol. 6, Recommendations for Reform)*. 2. Canada: Standing Senate Committee on Social Affairs, Science and Technology.

KITSIOU, S., MANTHOU, V. and VLACHOPOULOU, M., 2006. A framework for the evaluation of integration technology approaches in healthcare, A. PRENTZA, ed. In: *The International Special Topic Conference on Information Technology in Biomedicine*, 26-28 October 2006 2006, The University of Ioannina, pp. 106-111.

KITSIOU, S., MANTHOU, V. and VLACHOPOULOU MARO, 2010. Overview and Analysis of Electronic Health Record Standards. In: MEHDI KHOSROW-POUR, STEVE CLARKE, MURRAY E. JENNEX, ANNIE BECKER, ARI-VEIKKO ANTTIROIKO, SHERIF KAMEL, IN LEE, JERZY KISIELNICKI, KENG SIAU, AMAR GUPTA, CRAIG VAN SLYKE, JOHN WANG and VISHANTH WEERAKKODY, eds, *Health information systems: Concepts, methodologies, tools, and applications*. 1 edn. New York: Medical inforMation science reference, pp. 374-392.

KLEIN, L. 2014, "What do we actually mean by 'socio-technical'? On values, boundaries and the problems of language", *Applied Ergonomics*, vol. 45, no. 2, Part A, pp. 137-142.

KNAUP, P., BOTT, O., KOHL, C., LOVIS, C. & GARDE, S. 2007, "Electronic patient records: moving from islands and bridges towards electronic health records for continuity of care", *Yearb Med Inform*, pp. 34-46.

KO, P., n.a. 2002-last update, Telemedicine in Hong Kong [Homepage of The Telemedicine today], [Online]. Available: <http://www2.telemedtoday.com/articles/telemedicinehongkong.shtml> [September 9, 2011].

KOBAYASHI, S., YAHATA, K., GOUDGE, M., OKADA, M., NAKAHARA, T. and ISHIHARA, K., 2009. Open Source Software in Medicine and its Implementation in Japan. *The Journal on Information Technology in Healthcare*, , pp. 94.

KOTHARI, A., HOVANEC, N., HASTIE, R. and SIBBALD, S., 2011. Lessons from the business sector for successful knowledge management in health care: A systematic review. *BMC health services research*, **11**(1), pp. 173.

KOVINDHA, O., 2007. *e-Health in Asia and the Pacific: Challenges and opportunities*. n.a. Bangkok: United Nations Economic and Social Commission for Asia and the Pacific.

KRABBEL, A., WETZEL, I. and RATUSKI, S., 1996. Participation of heterogeneous user groups: Providing an integrated hospital information system, J. BLOMBERG, F. KENSING and E. DYKSTRA-ERICKSON, eds. In: *Proceeding of the participatory design conference*, November 1996 1996, Citeseer, pp. 241–249.

KRATHWOHL, D.R., 1977. *How to prepare a research proposal*. 4 edn. New York: Syracuse University Bookstore.

KREPS, D. and RICHARDSON, H., 2007. IS Success and Failure—The Problem of Scale. *Political Quarterly*, **78**(3), pp. 439-446.

KRISHNAMURTHY, S., 2003. A managerial overview of open source software. *Business horizons*, **46**(5), pp. 47-56.

- KVALE, S., 1996. *Interviews : an introduction to qualitative research interviewing*. 1 edn. London: Sage.
- LANGER, S., CHARBONEAU, N. and FRENCH, T., 2010. DCMTB: A Virtual Appliance DICOM Toolbox. *Journal of Digital Imaging*, **23**(6), pp. 681-688.
- LAPOINTE, L., LAMOTHE, L. and FORTIN, J., 2006. The dynamic of IT adoption in a major change process in health care delivery. In: TON A.M. SPIL and ROEL W. SCHURING, eds, *E-health systems diffusion and use: The innovation, the user and the use IT model*. 1 edn. London: Idea Group Publishing, pp. 107-127.
- LEAPE, L.L. and BERWICK, D.M., 2005. Five Years After To Err Is Human. *JAMA: The Journal of the American Medical Association*, **293**(19), pp. 2384-2390.
- LEE, C.E., 2007. Singapore HIT case study. In: CLAIRE TOPAL AND KALEB BROWNLOW, ed, *Health information technology and policy lab: HIT briefing book*. 1 edn. Washington: The National Bureau of Asian Research, pp. 65-70.
- LEE, H.W., RAMAYAH, T. and ZAKARIA, N., External Factors in Hospital Information System (HIS) Adoption Model: A Case on Malaysia. *Journal of medical systems*, , pp. 1-12.
- LI, Y.C., KUO, H.S., JIAN, W.S., TANG, D.D., LIU, C.T., LIU, L., HSU, C.Y., TAN, Y.K. and HU, C.H., 2001. Building a generic architecture for medical information exchange among healthcare providers. *International journal of medical informatics*, **61**(2), pp. 241-246.
- LI, Y.(., 2007. Taiwan HIT case study. In: CLAIRE TOPAL AND KALEB BROWNLOW, ed, *Health information technology and policy lab: HIT briefing book*. 1 edn. Washington: The National Bureau of Asian Research, pp. 71-74.
- LINTHICUM, D.S., 1999. *Enterprise application integration*. 1 edn. New Jersey: Addison-Wesley Professional.
- LITTLEJOHNS, P., WYATT, J.C. and GARVICAN, L., 2003. Evaluating computerised health information systems: hard lessons still to be learnt. *BMJ*, **326**(7394), pp. 860-863.
- LIU CHING-YI, KUO, H.S. and WANG, D., n.a. 2000-last update, Health Information Network in Taiwan -- Now and Future [Homepage of INET 2000], [Online]. Available: <http://www.isoc.org/inet2000/cdproceedings/posters/233/index.htm> [October 15, 2011].
- LIU, Y. and WANG, J., 2011. *PACS and digital medicine: Essential principles and practical guidance*. 1 edn. New York: CRC Press.
- LOBACH, D.F. and DETMER, D.E., 2007. Research Challenges for Electronic Health Records. *American Journal of Preventive Medicine*, **32**(5, Supplement 1), pp. S104-S111.

- LOPEZ, D.M. and BLOBEL, B.G.M.E., 2009. A development framework for semantically interoperable health information systems. *International Journal of Medical Informatics*, **78**(2), pp. 83-103.
- LORENCE, D.P. and CHURCHILL, R., 2005. Clinical knowledge management using computerized patient record systems: is the current infrastructure adequate? *Information Technology in Biomedicine, IEEE Transactions on*, **9**(2), pp. 283-288.
- LORENZI, N., KOUROUBALI, A., DETMER, D. and BLOOMROSEN, M., 2009. How to successfully select and implement electronic health records (EHR) in small ambulatory practice settings. *BMC medical informatics and decision making*, **9**(1), pp. 15.
- LU, R.J. and CHIANG, T., 2011. Evolution of Taiwan's health care system. *Health Economics, Policy and Law*, **6**(01), pp. 85.
- LUCAS, H., 2008. Information and communications technology for future health systems in developing countries. *Social Science & Medicine*, **66**(10), pp. 2122-2132.
- LUDWICK, D. and DOUCETTE, J., 2009b. Primary care physicians' experience with electronic medical records: barriers to implementation in a fee-for-service environment. *International Journal of Telemedicine and Applications*, **2009**, pp. 1-9.
- LUDWICK, D.A. and DOUCETTE, J., 2009. Adopting electronic medical records in primary care: Lessons learned from health information systems implementation experience in seven countries. *International journal of medical informatics*, **78**(1), pp. 22-31.
- LUNA-REYES, L.F. and GIL-GARCIA, J.R., 2011. Using institutional theory and dynamic simulation to understand complex e-Government phenomena. *Government Information Quarterly*, **28**(3), pp. 329-345.
- LUO, N., KOH, W.P., NG, W.Y., YAU, J.W.K., LIM, L.K., SIM, S.S.P. and TAY, E.G., 2009. Acceptance of information and communication technologies for healthcare delivery: a SingHealth Polyclinics study. *Annals of the Acad Medicine Singapore*, **38**, pp. 529-536.
- LYYTINEN, K. and HIRSCHHEIM, R., 1987. Oxford Surveys in Information Technology. In: P. ZORKOCZY, ed, New York, NY, USA: Oxford University Press, Inc, pp. 257-309.
- MACKERT, M., WHITTEN, P. and KROL, E., 2010. Planning successful Telemedicine and e-Health systems. In: MEHDI KHOSROW-POUR, STEVE CLARKE, MURRAY E. JENNEX, ANNIE BECKER, ARI-VEIKKO ANTTIROIKO, SHERIF KAMEL, IN LEE, JERZY KISIELNICKI, KENG SIAU, AMAR GUPTA, CRAIG VAN SLYKE, JOHN WANG and VISHANTH WEERAKKODY, eds, *Health information systems:*

Concepts, methodologies, tools, and applications. 1 edn. New York: Medical information science reference, pp. 540-553.

MACKINNON, W. and WASSERMAN, M., 2009. Integrated Electronic Medical Record Systems: Critical Success Factors for Implementation, *System Sciences, 2009. HICSS '09. 42nd Hawaii International Conference on* 2009, pp. 1-10.

MAGNI, A., DE OLIVEIRA ALBUQUERQUE, R., DE SOUSA JR, R.T., HANS, M.G. and MAGNI, F.G., 2007. Solving incompatibilities between electronic records for orthodontic patients. *American Journal of Orthodontics and Dentofacial Orthopedics*, **132**(1), pp. 116-121.

MAIDIN, S.S. and ARSHAD, N.H., 2010. IT governance practices model in IT project approval and implementation in Malaysian public sector, *Electronics and Information Engineering (ICEIE), 2010 International Conference On Information Engineering* 2010, pp. V1-532-V1-536.

MALAYSIAN ADMINISTRATIVE MODERNISATION AND MANAGEMENT PLANNING UNIT (MAMPU), 2011. *The Malaysian public sector ICT strategic planning 2011-2015*. n.a. Putrajaya: MAMPU.

MALAYSIAN ADMINISTRATIVE MODERNISATION AND MANAGEMENT PLANNING UNIT (MAMPU), 2010d. *Open-source software implementation in Malaysian public sector*. Putrajaya: MAMPU.

MALAYSIAN ADMINISTRATIVE MODERNISATION AND MANAGEMENT PLANNING UNIT (MAMPU), 2010c. *The guideline of ICT projects in Malaysian public sector*. MAMPU.BDPIC700-2/25. Putrajaya: MAMPU.

MALAYSIAN ADMINISTRATIVE MODERNISATION AND MANAGEMENT PLANNING UNIT (MAMPU), 2010b. *The steering committee for ICT procurement in public sector* 1 edn. Putrajaya: MAMPU.

MALAYSIAN ADMINISTRATIVE MODERNISATION AND MANAGEMENT PLANNING UNIT (MAMPU), 2010a. *Open source software (OSS) implementation guidelines*. 1 edn. Putrajaya: OSCC MAMPU.

MALAYSIAN ADMINISTRATIVE MODERNISATION AND MANAGEMENT PLANNING UNIT (MAMPU), 2009. *OSCC Quarterly Newsletter*. 1 edn. Putrajaya: OSCC MAMPU.

MALAYSIAN ADMINISTRATIVE MODERNISATION AND MANAGEMENT PLANNING UNIT (MAMPU), 2007. *Information Technology Instruction*. 1 edn. Putrajaya Malaysia: Malaysian Administrative Modernisation and Management Planning Unit (MAMPU).

MALAYSIAN ADMINISTRATIVE MODERNISATION AND MANAGEMENT PLANNING UNIT (MAMPU), 2006b. *The guideline for ICT outsourcing in public sectors* 1 edn. Putrajaya: MAMPU.

MALAYSIAN ADMINISTRATIVE MODERNISATION AND MANAGEMENT PLANNING UNIT (MAMPU), 2006a. *Malaysian government interoperability framework for open source software (MyGIFOSS)*. 1 edn. Putrajaya: OSCC MAMPU.

MALAYSIAN ADMINISTRATIVE MODERNISATION AND MANAGEMENT PLANNING UNIT (MAMPU), 2003. *Standards, Policies and Guidelines - Malaysian Government Interoperability Framework (MyGIF) Version-1.0* edn. Putrajaya: MAMPU.

MALAYSIAN NATIONAL ARCHIVE, 2003. *The guidelines for electronic records and archive management*. 1 edn. Kuala Lumpur: Malaysian National Archive.

MALAYSIAN PARLIAMENT, 1963. *Federal Constitution of Malaysia*. 42 edn. Kuala Lumpur: Malaysian Government.

MANN, R.J., 2006. Commercializing open source software: do property rights still matter? *Harvard Journal of Law & Technology*, **20**(1),.

MANTZANA, V. and THEMISTOCLEOUS, M., 2005. Towards a conceptual framework of actors and factors affecting the EAI adoption in healthcare organisations, *13th European Conference on Information Systems*, May 26-28 2005, Citeseer, pp. 1.

MANTZANA, V., THEMISTOCLEOUS, M. and MORABITO, V., 2010. Healthcare information systems and older employees' training. *Journal of Enterprise Information Management*, **23**(6), pp. 680-693.

MANTZANA, V.G., 2006. *Investigating the adoption of enterprise application integration in healthcare organisations using an actor oriented approach*, Brunel University.

MANTZANA, V., THEMISTOCLEOUS, M., IRANI, Z. and KHOUMBATI, K., 2008. Information systems and healthcare XXV: Factors and Actors Affecting the EAI Adoption in the Healthcare Sector. *Communications of AIS*, **2008**(22), pp. 103-116.

MANTZANA, V., THEMISTOCLEOUS, M., IRANI, Z. and MORABITO, V., 2007. Identifying healthcare actors involved in the adoption of information systems. *European Journal of Information Systems*, **16**(1), pp. 91.

MARGHERITA, A. and PETTI, C., 2010. ICT-enabled and process-based change: an integrative roadmap. *Business Process Management Journal*, **16**(3), pp. 473-491.

MARTIN, D., 2011. £12bn NHS computer system is scrapped. *Daily Mail*.

MASSARO, T., 2005. Introducing Physician Order Entry at a Major Academic Medical Center: Impact on Organizational Culture and Behavior. *Evaluating the Organizational Impact of Healthcare Information Systems*, , pp. 253-263.

MAT TAIB, M.Z., 2005. *A system inquiry within public health care in Malaysia*. Doctor of Philosophy edn. Loughborough University: Loughborough University.

MATHISON, S., 1988. Why triangulate? *Educational researcher*, **17**(2), pp. 13-17.

MAYER, R.C., DAVIS, J.H. and SCHOORMAN, F.D., 1995. An Integrative Model of Organizational Trust. *The Academy of Management Review*, **20**(3), pp. 709-734.

MCCONNELL, R.R., SHIELDS, T., DRURY, P., KUMEKAWA, J., LOUW, J., FEREDAY, G. and NYAMAI-KISIA, C., 2006. *Improving health, connecting people: the role of ICTs in the health sector of developing countries A framework paper*. 1254 edn. United Kingdom: InfoDev.

MCGRATH, G.M. and MORE, E., 2001. Data integration along the healthcare supply chain: the pharmaceutical extranet gateway project, N.A., ed. In: *The 34th Annual Hawaii International Conference on Systems Sciences, Maui, Hawaii*, January 3-6 2001, Citeseer, pp. n.a.-n.a.

MERICAN, I. and BIN YON, R., 2002. Health Care Reform and Changes: the Malaysian Experience. *Asia Pacific Journal of Public Health*, **14**(1), pp. 17-22.

MERRIAM, S., 1995. What can you tell from an nofl?: Issues of validity and reliability in qualitative research. *PAACE Journal of Lifelong Learning*, **4**, pp. 50-60.

MICHELMAN, J.E. and KYU KIM, K., 1990. An Examination of Factors for the Strategic Use of Information Systems in the Healthcare Industry. *MIS Quarterly*, **14**(2), pp. 201-215.

MILES, M.B. and HUBERMAN, A.M., 1994. *Qualitative data analysis*. Second edn. London: Sage Publications.

MILLER, M., March 3, 2010, 2010-last update, What we can learn from Singapore's healthcare model? [Homepage of The Washington Post], [Online]. Available: <http://www.washingtonpost.com/wp-dyn/content/article/2010/03/03/AR2010030301396.html?hpid=opinionsbox1> [July 17, 2011].

MINISTRY OF FINANCE OF MALAYSIA, 10 November, 2011-last update, The guidelines for direct negotiation for services and procurements [Homepage of Ministry of Finance of Malaysia], [Online]. Available: http://www.treasury.gov.my/index.php?option=com_content&view=article&id=462&Itemid=152&lang=my [October 20, 2011].

MINISTRY OF FINANCE OF MALAYSIA, 2011. *The procurement of ICT and Internet networks*. S/K.KEW/PK/PP/1100/000000/10/31JLD.30 SK 7 (2). Putrajaya: The Ministry of Finance of Malaysia.

MINISTRY OF FINANCE OF MALAYSIA, 2010. *Estimated Budget 2011*. 1 edn. Putrajaya: Ministry of Finance of Malaysia.

MINISTRY OF HEALTH OF MALAYSIA, 2011b. *User access control policy and guidelines*. Circular edn. Putrajaya: Government of Malaysia.

MINISTRY OF HEALTH OF MALAYSIA, 2011a. *MyHIX flyers*. 1 edn. Putrajaya: Telehealth division.

MINISTRY OF HEALTH OF MALAYSIA, 2010c. *Newsletter of Information management division*. 1 edn. Putrajaya: Information management division.

MINISTRY OF HEALTH OF MALAYSIA, 2010b. *Guideline to prepare medical records for public hospitals and health agencies under the Ministry of Health of Malaysia*. MOH/P/PAK/201.10 (GU). Putrajaya: Ministry of Health of Malaysia.

MINISTRY OF HEALTH OF MALAYSIA, 2010b. *Newsletter of information management division*. 2 edn. Putrajaya: Information management division.

MINISTRY OF HEALTH OF MALAYSIA, 2010a. *Guideline for administering and managing the patient records for all public hospitals and health agencies*. MOH/P/PAK/199.10 (GU). Putrajaya: Ministry of Health of Malaysia.

MINISTRY OF HEALTH OF MALAYSIA, 2009e. *Interview with Head of IT of Ministry of Health of Malaysia*. n.a. edn. Putrajaya: n.a.

MINISTRY OF HEALTH OF MALAYSIA, 2009d. *The guidelines for referral cases and movement of patient among public hospitals*. MOH/P/PAK/165/08.GU. Putrajaya: The Ministry of Health of Malaysia.

MINISTRY OF HEALTH OF MALAYSIA, 2009c. *The guidelines on procedures to apply the technical endorsement for ICT projects in government agencies*. KKM/BPM/190/4/6/ Jld 2. Putrajaya: The Ministry of Health of Malaysia.

MINISTRY OF HEALTH OF MALAYSIA, 2 February 2009, 2009b-last update, Health Facts [Homepage of MoHM], [Online]. Available: http://www.moh.gov.my/images/gallery/stats/healthfact_L_2009.pdf [February 1, 2010, 2010].

MINISTRY OF HEALTH OF MALAYSIA, March 2009a, 2009-last update, ICT blog [Homepage of MoHM], [Online]. Available: <http://btmk.moh.gov.my/BlogICT/> [January 1, 2009, 2009].

- MINISTRY OF HEALTH OF MALAYSIA, 2008. *Newsletter of Information management division*. 1 edn. Putrajaya: Information management division.
- MINISTRY OF HEALTH OF MALAYSIA, 2007. *Newsletter of Information management division*. 2 edn. Putrajaya: Information management division.
- MINISTRY OF HEALTH OF MALAYSIA, 1997. *Telemedicine Flagship Application: Lifetime Health Plan (LHP)*. Proposal edn. Putrajaya: Government of Malaysia.
- MINISTRY OF HEALTH OF NEW ZEALAND, 23 March 2011, 2011b-last update, Information sheet. Available: <http://moh.govt.nz/moh.nsf/indexmh/connected-health-ict-research-2009> [July 5, 2011].
- MINISTRY OF HEALTH OF NEW ZEALAND, 23 March 2011, 2011a-last update, Overview of the health system. Available: <http://www.health.govt.nz/new-zealand-health-system/overview-health-system> [July 5, 2011].
- MINISTRY OF RURAL AND REGIONAL DEVELOPMENT, 2010. *Delivering basic infrastructures*. 1 edn. Putrajaya: The Ministry of Rural and Regional Development.
- MINISTRY OF SCIENCE TECHNOLOGY AND INNOVATION, 2007. *National ICT Roadmap*. Ministry Paper Work edn. Putrajaya Malaysia: Ministry of Science Technology and Innovation.
- MINISTRY OF SCIENCE TECHNOLOGY AND INNOVATION, 2007. *The National ICT Roadmap (full report)*. Report edn. Putrajaya Malaysia: MOSTI, MSCTC and IBM.
- MINTZBERG, H. & WATERS, J.A. 1982, "Tracking Strategy in an Entrepreneurial Firm", *Academy of Management Journal*, vol. 25, no. 3, pp. 465-499.
- MOHAN, J. and RAZALI RAJA YAACOB, R., 2004. The Malaysian Telehealth Flagship Application: a national approach to health data protection and utilisation and consumer rights. *International Journal of Medical Informatics*, **73**(3), pp. 217-227.
- MOHD ZAHRI, N.A., 24 April 2008, 2008-last update, ICT initiative in public sector [Homepage of Malaysian Administrative Modernisation and Planning Unit], [Online]. Available: www.mampu.gov.my/pengumuman/25-04-2008-ict%20initiatives%20240408.pdf [October 2, 2008, 2008].
- MOHD, H. and MOHAMAD, S.M.S., 2005. Acceptance model of electronic medical record. *Journal of advancing information and management studies*, **2**(1), pp. 75-92.
- MORTON, M.E. and WIEDENBECK, S., 2011. *EHR acceptance factors in ambulatory care: A survey of physician perceptions*. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2805555/pdf/phim0007-0001c.pdf> edn. n.a.: American Health Information Management Association.

MÜLLER, H., MICHOUX, N., BANDON, D. and GEISSBUHLER, A., 2004. A review of content-based image retrieval systems in medical applications—clinical benefits and future directions. *International Journal of Medical Informatics*, **73**(1), pp. 1-23.

MÜLLER, M.L., ÜCKERT, F., BÜRKLE, T. and PROKOSCH, H., 2005. Cross-institutional data exchange using the clinical document architecture (CDA). *International Journal of Medical Informatics*, **74**(2-4), pp. 245-256.

MURRAY, M., 2003. Strategies for the successful implementation of workflow systems within healthcare: a cross case comparison, *Proceedings of the 36th Annual Hawaii International Conference on System Sciences*, January 6-9, 2003 2003, Citeseer, pp. 166–175-1.

MYKKÄNEN, J.A. and TUOMAINEN, M.P., 2008. An evaluation and selection framework for interoperability standards. *Information and Software Technology*, **50**(3), pp. 176-197.

NARAYANA SAMY, G., AHMAD, R. and ISMAIL, Z., 2010. Security threats categories in healthcare information systems. *Health Informatics Journal*, **16**(3), pp. 201-209.

NATIONAL ARCHIVE OF MALAYSIA, 2003. *The National Archive Act*. Acts 629 edn. Kuala Lumpur: The Malaysian Laws.

NATIONAL AUDIT OFFICE, 2011. *The national programme for IT in the NHS: an update on the delivery of detailed care record systems*. HC 888 Session 2010–2012. London: National Audit Office.

NATIONAL AUDIT OFFICE, 2008. *The National Programme for IT in the NHS: Progress since 2006*. HC 484-I Session 2007-2008. London: COMPTROLLER AND AUDITOR GENERAL.

NATIONAL HEALTH SERVICES, 04 March 2008, 2008-last update, About Us. Available: <http://www.connectingforhealth.nhs.uk/about/history> [May 15, 2008].

NDOU, V., 2004. *E-government for developing countries: opportunities and challenges*. <http://www.ejisdc.org/ojs2/index.php/ejisdc> edn. Hong Kong: The City University of Hong Kong.

NHS CONFEDERATION, 2004. *The NHS care record service (briefing 105)*. London: NHS Confederation.

NHS CONNECTING FOR HEALTH, 2009, 2009-last update, Spine Factsheet [Homepage of NHS Connecting for Health], [Online]. Available: <http://www.connectingforhealth.nhs.uk/resources/systserv/spine-factsheet> [June 15, 2009].

NHS CONNECTING FOR HEALTH, 2008. *SNOMED CT - the language of the NHS Care Records Service: A guide for NHS staff in England*. n.a. London: NHS Connecting for Health.

NIAZKHANI, Z., VAN DER SIJS, H., PIRNEJAD, H., REDEKOP, W.K. and AARTS, J., 2009. Same system, different outcomes: Comparing the transitions from two paper-based systems to the same computerized physician order entry system. *International journal of medical informatics*, **78**(3), pp. 170-181.

NICHOLSON, L., VAKHARIA, A.J. and SELCUK ERENGUC, S., 2004. Outsourcing inventory management decisions in healthcare: Models and application. *European Journal of Operational Research*, **154**(1), pp. 271-290.

NIELSEN, A., 1998. *A study into levels of, and attitudes towards information technology in general practice*. S2587/QG 2132. New South Wales: Department of Health and Family Service.

NOOR GHANI, S. and YADAV, H., 2008. *Healthcare in Malaysia*. 1 edn. Kuala Lumpur: University of Malaya Press.

OFFICE OF HEALTH AND THE INFORMATION HIGHWAY, 2001. *Towards electronic health records*. Ottawa: Office of Health and the Information Highway (OHII).

ORAM, A., 2011. Promoting Open Source Software in Government: The Challenges of Motivation and Follow-Through. *Journal of Information Technology & Politics*, **8**(3), pp. 240-252.

OSCC MAMPU, n.a. 2011-last update, Open source software [Homepage of OSCC], [Online]. Available: <http://www.oscc.org.my//content/view/99/255/> [July 12, 2011].

OUSBORNE, J.A. and CLARKE, M., 2008. Factors motivating the acceptance of new information and communication technologies in UK healthcare: A test of three models. In: J. TAN, ed, *Healthcare information systems and informatics: Research and practices*. 1 edn. New York: Medical Information Science Reference, pp. 25-39.

PAI, F. and HUANG, K., 2011. Applying the Technology Acceptance Model to the introduction of healthcare information systems. *Technological Forecasting and Social Change*, **78**(4), pp. 650-660.

PAPASTATHOPOULOU, P., AVLONITIS, G.J. and GOUNARIS, S., 2006. Information and communication technologies' adoption: Scenarios for success and failure. In: DHRUV GREWAL, MICHAEL LEVY and R. KRISHNAN, eds, *Enhancing Knowledge Development in Marketing*. Citeseer, pp. 20-29.

PARÉ, G., WYBO, M. and DELANNOY, C., 2009. Barriers to Open Source Software Adoption in Quebec's Health Care Organizations. *Journal of medical systems*, **33**(1), pp. 1-7.

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY, 2003. *Government of IT projects*. 200. London: POST.

PATTON, M., Q., 2002. *Qualitative research and evaluation method*. 3 edn. London: Sage Publication.

PICKARD, A.J., 2007. *Research methods in information*. 1 edn. London: Facet Publishing.

POULOUDI, A. and WHITLEY, E.A., 1997. Stakeholder identification in inter-organizational systems: gaining insights for drug use management systems. *European journal of information systems*, **6**(1), pp. 1-14.

PROTTI, D., JOHANSEN, I. & PEREZ-TORRES, F. 2009, "Comparing the application of Health Information Technology in primary care in Denmark and Andalucía, Spain", *International journal of medical informatics*, vol. 78, no. 4, pp. 270-283.

PROTTI, D., 2010. A comparison of how Canada, England, and Denmark are managing their Electronic Health Record journeys. In: MEHDI KHOSROW-POUR, STEVE CLARKE, MURRAY E. JENNEX, ANNIE BECKER, ARI-VEIKKO ANTTIROIKO, SHERIF KAMEL, IN LEE, JERZY KISIELNICKI, KENG SIAU, AMAR GUPTA, CRAIG VAN SLYKE, JOHN WANG and VISHANTH WEERAKKODY, eds, *Health information systems: Concepts, methodologies, tools, and applications*. 1 edn. New York: Medical information science reference, pp. 402-417.

QU, W.G. and WANG, Z., 2011. Impact of experience on open inter-organizational systems adoption. *Industrial Management & Data Systems*, **111**(3), pp. 432-447.

QUINN, J., 2008. Health Information Technology Architecture vs. Semantic Interoperability, N.A., ed. In: *Making the e-health connection*, July 13-August 8 2008 2008.

RAGHUPATHI, W. and KESH, S., 2009. Designing electronic health records versus total digital health systems: A systemic analysis. *Systems Research and Behavioral Science*, **26**(1), pp. 63-79.

RAGHUPATHI, W. and KESH, S., 2007. Interoperable electronic health records design: Towards a service-oriented architecture. *E-service Journal*, **5**(3), pp. 39.

RANDEEP, R., 2011. NHS medical records project shows little benefit, say MPs. *The Guardian Society*.

- RANDELL, B., 2007. A computer scientist's reactions to NPfIT. *Journal of Information Technology*, **22**(3), pp. 222-234.
- RAWABDEH, A.A.A., 2007. An e-health trend plan for the Jordanian health care system: a review. *International journal of health care quality assurance*, **20**(6), pp. 516-531.
- RAY, S. and MUKHERJEE, A., 2007. Development of a framework towards successful implementation of e-governance initiatives in health sector in India. *International journal of health care quality assurance*, **20**(6), pp. 464-483.
- REID, T.R., 14 November 2011, 2008-last update, Taiwan Takes Fast Track to Universal Health Care [Homepage of National Public Radio], [Online]. Available: <http://www.npr.org/templates/story/story.php?storyId=89651916> [October 5, 2011].
- REINECKE, I., May 2007b. *HIMSS AsiaPac07: Accelerating healthcare reform*. Presentation edn. Australia: National E-health Transition Authority.
- RIDDER, H., HOON, C. & MCCANDLESS, A. 2009, "The theoretical contribution of case study research to the field of strategy and management", *Research methodology in strategy and management*, vol. 5, pp. 137-175.
- RODRIGUES, JOEL J. P.C. AND VAIDYA, BINOD 2010, "Health information systems: Concepts, methodologies, tools and applications" in Health information systems: Concepts, methodologies, tools, and applications, eds. Mehdi Khosrow-Pour, Steve Clarke, Murray E. Jennex, et al, 1st edn, Medical inforMation science reference, New York, pp. xxxv-ixiv.
- ROGERS, E.M., 2003. *Diffusion of innovations*. 5 edn. New York: Simon & Schuster International.
- ROKOS, I.C., SANDDAL, N.D., PANCIOLI, A.M., WOLFF, C. and GAIESKI, D.F., 2010. Inter-hospital Communications and Transport: Turning One-way Funnels Into Two-way Networks. *Academic Emergency Medicine*, **17**(12), pp. 1279-1285.
- ROMANOW, R.J., 2002. *Building on values: The future of health care in Canada – Final Report*. 0-662-33043-9. Canada: Commission on the Future of Health Care in Canada.
- ROUF, E., CHUMLEY, H.S. and DOBBIE, A.E., 2008. Electronic health records in outpatient clinics: perspectives of third year medical students. *BMC medical education*, **8**, pp. 13.
- ROUKEMA, J., LOS, R.K., BLEEKER, S.E., VAN GINNEKEN, A.M., VAN DER LEI, J. and MOLL, H.A., January 2006. Paper Versus Computer: Feasibility of an Electronic Medical Record in General Pediatrics. *Pediatrics*, **117**(1), pp. 15-21.

ROYAL COLLEGE OF GENERAL PRACTITIONERS, 2005. *Information management and technology in general practices*. London: Royal College of General Practitioners.

RUSS, A.L., SALEEM, J.J., JUSTICE, C.F., WOODWARD-HAGG, H., WOODBRIDGE, P.A. and DOEBBELING, B.N., 2010. Electronic health information in use: Characteristics that support employee workflow and patient care. *Health Informatics Journal*, **16**(4), pp. 287-305.

RYAN, G.W. and BERNARD, H.R., 2003. Techniques to identify themes. *Field methods*, **15**(1), pp. 85.

SAFRAN, C. & GOLDBERG, H. 2000, "Electronic patient records and the impact of the Internet", *International journal of medical informatics*, vol. 60, no. 2, pp. 77-83.

SAITWAL, H., FENG, X., WALJI, M., PATEL, V. and ZHANG, J., 2010. Assessing performance of an Electronic Health Record (EHR) using Cognitive Task Analysis. *International journal of medical informatics*, **79**(7), pp. 501-506.

SALIBA, V., LEGIDO-QUIGLEY, H., HALLIK, R., AAVIKSOO, A., CAR, J. and MCKEE, M., 2012. *Telemedicine across borders: A systematic review of factors that hinder or support implementation*.
<http://www.sciencedirect.com/science/article/pii/S1386505612001542#> edn.

SAMBROOK, S., 2006. Management development in the NHS: nurses and managers, discourses and identities. *Journal of European Industrial Training*, **30**(1), pp. 48-64.

SARKER, S. and LEE, A.S., 2003. Using a case study to test the role of three key social enablers in ERP implementation. *Information & Management*, **40**, pp. 813-829.

SARLAN, A., AHMAD, R., AHMAD, W., FATIMAH, W., DOMINIC, P. and DURAI, D., 2009. Conceptual Clinic Information System Success Framework for SME Clinics in Malaysia, N.A., ed. In: *The 11th International Conference on Information Integration and Web-based Applications & Services (iiWAS2009)*, 14-16 December 2009 2009, iiWAS2009, pp. n.a.-n.a.

SARLAN, A., AHMAD, R., WAN AHMAD, W.F.B. and DOMINIC, P.D.D., 2009. Hybrid approach of conceptual framework for SME clinics in Malaysia, *Proceedings of the 11th International Conference on Information Integration and Web-based Applications & Services*, Dec 14-16, 2009 2009, ACM, pp. 577-581.

SCHAPER, L.K. and PERVAN, G.P., 2007. ICT and OTs: A model of information and communication technology acceptance and utilisation by occupational therapists. *International journal of medical informatics*, **76**(Supplement 1), pp. S212-S221.

SCHULMAN, J., 2010. Evaluating healthcare IT and understanding the work of healthcare are entangled processes. In: MEHDI KHOSROW-POUR, STEVE CLARKE, MURRAY E. JENNEX, ANNIE BECKER, ARI-VEIKKO ANTTIROIKO, SHERIF KAMEL, IN LEE, JERZY KISIELNICKI, KENG SIAU, AMAR GUPTA, CRAIG VAN SLYKE, JOHN WANG and VISHANTH WEERAKKODY, eds, *Health information systems: Concepts, methodologies, tools, and applications*. 1 edn. New York: Medical information science reference, pp. 162-177.

SCHWEND, G.T., 2008. The Language of Healthcare. *Health management technology*, **29**(2), pp. 14.

SEALE, C., 1998. *Researching society and culture*. London: Sage.

SELVARAJU, S., 2006. Health information management: Malaysian experience, APAMI, ed. In: *Asia-Pacific Association for Medical Informatics Conference 2006*, 27th-30th October 2006 2006, APAMI 2006, pp. 1-7.

SFAKIANAKIS, S., CHRONAKI, C., CHIARUGI, F., CONFORTI, F. and KATEHAKIS, D., 2008. *Reflections on the role of open source in health information system interoperability*. Foundation for Research and Technology Hellas,; Institute of Computer Science.

SHABBIR, S.A., AHMED, L.A., SUDHIR, R.R., SCHOLL, J., LI, Y. and LIOU, D., 2010. Comparison of documentation time between an electronic and a paper-based record system by optometrists at an eye hospital in south India: A time–motion study. *Computer methods and programs in biomedicine*, **100**(3), pp. 283-288.

SHEKELLE, P.G., MORTON, S.C. and KEELER, E.B., 2006. Costs and benefits of health information technology. *Evidence report/technology assessment*, **(132)**(132), pp. 1-71.

SHERSHNEVA, M.B., MULLIKIN, E.A., LOOSE, A.S. and OLSON, C.A., 2008. Learning to Collaborate: A Case Study of Performance Improvement CME. *Journal of continuing education in the health professions*, **28**(3), pp. 140-147.

SICOTTE, C. and PARÉ, G., 2010. Success in health information exchange projects: Solving the implementation puzzle. *Social science & medicine*, **70**(8), pp. 1159-1165.

SIKORSKI, D., 1998. *Malaysia Malaysia's Political Economy: Politics, Patronage and Profits*. By Terence Gomez Edmund and K.S. Jomo Cambridge: Cambridge University Press, 1997. Pp. xx, 207. Note on Currency, List of Abbreviations, Tables, Figures, Bibliography, Index. *Journal of Southeast Asian Studies*, **29**(02), pp. 443.

SINGAPORE HEALTH SERVICES, 2011-last update, Corporate profile [Homepage of Singapore Health Services], [Online]. Available:

<http://www.singhealth.com.sg/AboutSingHealth/CorporateOverview/CorporateProfile/Pages/Home.aspx> [July 23, 2011].

SLOANE, E.B. and CAREY, C.C., 2007. Using Standards to Automate Electronic Health Records (EHRs) and to Create Integrated Healthcare Enterprises, *Engineering in Medicine and Biology Society, 2007. EMBS 2007. 29th Annual International Conference of the IEEE 2007*, pp. 6177-6178.

SMITH, S.R., 1996. Transforming Public Services: Contracting for Social and Health Services in the Us. *Public Administration*, **74**(1), pp. 113-127.

SNYDER-HALPERN, R., 2001. Indicators of organizational readiness for clinical information technology/systems innovation: a Delphi study. *International journal of medical informatics*, **63**(3), pp. 179-204.

SOM, M.H.M., NORALI, A.N. and ALI, M.S.A.M., 2010. Telehealth in Malaysia — An overview, *Industrial Electronics & Applications (ISIEA), 2010 IEEE Symposium on 2010*, pp. 660-664.

SPIEGEL, J.M., LOCKHART, K., DYCK, C., WILSON, A., O'HARA, L. and YASSI, A., 2012. Tool, weapon, or white elephant? A realist analysis of the five phases of a twenty-year programme of occupational health information system implementation in the health sector. *BMC Medical Informatics and Decision Making*, **12**(1), pp. 84.

SPII, T.A.M., LEROUGE, C., TRIMMER, K. and WIGGINS, C., 2010. IT adoption and evaluation in healthcare: Evolutions and insights in theory, methodology, and practice. In: MEHDI KHOSROW-POUR, STEVE CLARKE, MURRAY E. JENNEX, ANNIE BECKER, ARI-VEIKKO ANTTIROIKO, SHERIF KAMEL, IN LEE, JERZY KISIELNICKI, KENG SIAU, AMAR GUPTA, CRAIG VAN SLYKE, JOHN WANG and VISHANTH WEERAKKODY, eds, *Health information systems: Concepts, methodologies, tools, and applications*. 1 edn. New York: Medical information science reference, pp. 89-116.

STALLMAN, R., 2009. Viewpoint Why open source misses the point of free software. *Communications of the ACM*, **52**(6), pp. 31-33.

SULEIMAN, A.B., 2001. The untapped potential of Telehealth. *International Journal of Medical Informatics*, **61**(2-3), pp. 103-112.

SUOMI, R. and TÄHKÄPÄÄ, J., 2004. Governance structures for IT in the health care industry. In: WIM VAN GREMBERGEN, ed, *Strategies for Information Technology Governance*. 1 edn. London: IGP Global, pp. 357-381.

SYED ARIS, SYARIPAH RUZAINI, ARSHAD, N.H., and AZLINAH, M., 2008. Risk management practices in IT outsourcing projects, *Information Technology, 2008. ITSIM 2008. International Symposium on 2008*, pp. 1-8.

TAYLOR, G., 2002. *Hong Kong's healthcare reform: Nursing an ailing healthcare system back to health*.
<http://www.lehigh.edu/~incntr/publications/perspectives/v20/Taylor.pdf> edn. Lehigh University: Perspectives on business and economics.

TAY-YAP, J. and HAWAMDEH, S., 2001. The Impact of the Internet on Healthcare in Singapore. *Journal of Computer-Mediated Communication*, **6**(4), pp. 0-0.

TERRIS, A., 2007. New Zealand HIT case study. In: CLAIRE TOPAL AND KALEB BROWNLOW, ed, *Health information technology and policy lab: HIT briefing book*. 1 edn. Washington: The National Bureau of Asian Research, pp. 61-64.

THE COMMISSION OF PUBLIC SERVICES, November 20, 2011-last update, Information about post and grade [Homepage of The Commission of Public Services], [Online]. Available: <http://www.spa.gov.my/> [October 1, 2011].

THE COMMITTEE OF PUBLIC ACCOUNTS, 2011. *The National Programme for IT in the NHS: an update on the delivery of detailed care records systems*. HC 1070. London: The Stationery Office Limited.

THE ENERGY COMMISSION OF MALAYSIA, 2010. *Electricity supply industry in Malaysia: Performance and statistical information 2009*. 1 edn. Putrajaya: The Energy Commission of Malaysia.

THE MALAYSIAN GOVERNMENT, 1987. *The Malaysian Copyright Act 1987*. Malaysia Copyright Act edn. Laws of Malaysia Act 332.

THE MINISTRY OF HEALTH OF SINGAPORE, Oct 20, 2011b-last update, Healthcare services [Homepage of Ministry of Health Singapore], [Online]. Available: http://www.moh.gov.sg/content/moh_web/home/our_healthcare_system.html [July 20, 2011].

THE MINISTRY OF HEALTH OF SINGAPORE, Oct 20, 2011a-last update, Our healthcare system [Homepage of Ministry of Health Singapore], [Online]. Available: http://www.moh.gov.sg/content/moh_web/home/our_healthcare_system.html [July 20, 2011].

THE NATIONAL COORDINATING COUNCIL FOR MEDICATION ERROR REPORTING AND PREVENTION, September, 2011, 2011-last update, About the medication errors. Available: <http://www.nccmerp.org/aboutMedErrors.html> [September 16, 2011].

THE OFFICE OF PRIME MINISTER OF MALAYSIA, 2009b. *The guidelines on procedures to apply the technical endorsement for ICT projects in government agencies*. UPTM(S) 159/267/2 Klt 26 (8). Putrajaya: The Office of Prime Minister.

THE WORLD WIDE WEB CONSORTIUM, May 8, 2000-last update, Simple Object Access Protocol (SOAP) 1.1 [Homepage of W3C], [Online]. Available: http://www.w3.org/TR/2000/NOTE-SOAP-20000508/#_Toc478383486 [September 30, 2011].

THEMISTOCLEOUS, M., 2004. Justifying the decisions for EAI implementations: a validated proposition of influential factors. *Journal of Enterprise Information Management*, **17**(2), pp. 85-104.

THOMAS, J.W., 2006. *The adoption of and diffusion of data exchange standards*, Loughborough University.

THONGPITHOONRAT, P., MCKNEELY, P.K., GUMUDAVELLI, S., GURKAN, D. and CHAPMAN, F.M., 2008. Networking and plug-and-play of bedside medical instruments, *Engineering in Medicine and Biology Society, 2008. EMBS 2008. 30th Annual International Conference of the IEEE 2008*, pp. 1514-1517.

TJORA, A.H. and SCAMBLER, G., 2009. Square pegs in round holes: Information systems, hospitals and the significance of contextual awareness. *Social science & medicine*, **68**(3), pp. 519-525.

TONNESEN, A., LEMAISTRE, A. and TUCKER, D., 1999. Electronic medical record implementation barriers encountered during implementation. *Proceedings of the AMIA Symposium 1999*, American Medical Informatics Association, pp. 624.

TORRACO, R.J., 2005. Writing Integrative Literature Reviews: Guidelines and Examples. *Human Resource Development Review*, **4**(3), pp. 356-367.

TROCHIM, W., 1989b. An introduction to concept mapping for planning and evaluation. In: WILLIAM M.K. TROCHIM, ed, *Concept mapping for evaluation and planning*. 1 edn. New York: Pergamon Press, pp. 1-16.

TROCHIM, W., 1989a. Outcome pattern matching and program theory. *Evaluation and program planning*, **12**(4), pp. 355-366.

TSAI, J. and BOND, G., 2008. A comparison of electronic records to paper records in mental health centers. *International Journal for Quality in Health Care*, **20**(2), pp. 136-143.

TSE, S.Y., 27 November 1997, 1997-last update, Aspects of Telemedicine on the Hong Kong health information superhighway [Homepage of Hong Kong Hospital Authority], [Online]. Available: <http://www.ha.org.hk/it/mic97/telem9.htm> [September 2011, 2011].

ULIN, P.R., ROBINSON, E.T. and TOLLEY, E.E., 2005. *Qualitative methods in public health: A field guide for applied research*. 1 edn. San Francisco: Jossey-Bass Inc Pub.

UMR RESEARCH, 2008. *Connected for Health: A qualitative study*. 1 edn. Wellington: Ministry of Health of New Zealand.

UROWITZ, S., WILJER, D., APATU, E., EYSENBACH, G., DELENARDO, C., HARTH, T., PAI, H. and LEONARD, K., 2008. Is Canada ready for patient accessible electronic health records? A national scan. *BMC Medical Informatics and Decision Making*, **8**(1), pp. 33.

VALDES, I., KIBBE, D.C., TOLLESON, G., KUNIK, M.E. and PETERSEN, L.A., 2004. Barriers to proliferation of electronic medical records. *Informatics in primary care*, **12**(1), pp. 3-9.

VAN DER LINDEN, H., KALRA, D., HASMAN, A. and TALMON, J., 2009. Inter-organizational future proof EHR systems: A review of the security and privacy related issues. *International Journal of Medical Informatics*, **78**(3), pp. 141-160.

VAN DUIVENBODEN, H. and THAENS, M., 2008. ICT-driven innovation and the culture of public administration: A contradiction in terms? *Information Polity: The International Journal of Government & Democracy in the Information Age*, **13**(3), pp. 213-232.

VEN, K., VERELST, J. and MANNAERT, H., 2008. Should You Adopt Open Source Software? *Software, IEEE*, **25**(3), pp. 54-59.

VISHWANATH, A. and SCAMURRA, S.D., 2007. Barriers to the adoption of electronic health records: using concept mapping to develop a comprehensive empirical model. *Health Informatics Journal*, **13**(2), pp. 119-134.

VON KROGH, G. and VON HIPPEL, E., 2006. The promise of research on open source software. *Management Science*, **52**(7), pp. 975.

WAEGEMANN, C., 2003. Ehr vs. cpr vs. emr. *Healthcare Informatics online*, .

WAINWRIGHT, D. and WARING, T., 2000. The information management of technology strategy of the UK National Health Service: Determining progress in the NHS acute hospital sector. *The International Journal of Public Sector Management*, **13**(3), pp. 241.

WALKER, J., PAN, E., JOHNSTON, D., ADLER-MILSTEIN, J., BATES, D.W. and MIDDLETON, B., 2005. The Value Of Health Care Information Exchange And Interoperability. *Health Affairs*, .

WALSH, S.H., 2004. The clinician's perspective on electronic health records and how they can affect patient care. *BMJ*, **328**(7449), pp. 1184-1187.

WANG, E.H., 1999. ICT and economic development in Taiwan: analysis of the evidence. *Telecommunications Policy*, **23**(3-4), pp. 235-243.

WANGA, S.W., CHENB, W.H., ONGA, C.S., LIUC, L. and CHUANGB, Y.W., 2007. RFID applications in hospitals: a case study on a demonstration RFID project in a Taiwan hospital, N.A., ed. In: *Proceedings of the 39th Hawaii International Conference on System Sciences-2006*, January 4-7 2007, pp. 33-42.

WANGA, S.W., CHENB, W.H., ONGA, C.S., LIUC, L. and CHUANGB, Y.W., 2006. RFID applications in hospitals: a case study on a demonstration RFID project in a Taiwan hospital, N.A., ed. In: *39th Hawaii International Conference on System Sciences 2006* 2006, IEEE, pp. 33-43.

WANLESS, D., 2002. *Securing our future health: Taking a long-term view final report*. n.a. London: HM Treasury.

WARING, T. and MADDOCKS, P., 2005. Open Source Software implementation in the UK public sector: Evidence from the field and implications for the future. *International Journal of Information Management*, **25**(5), pp. 411-428.

WASTELL, D. & WHITE, S. 2014, "Making sense of complex electronic records: Socio-technical design in social care", *Applied Ergonomics*, vol. 45, no. 2, Part A, pp. 143-149.

WATERSON, P. 2014, "Health information technology and socio-technical systems: A progress report on recent developments within the UK National Health Service (NHS)", *Applied Ergonomics*, vol. 45, no. 2, Part A, pp. 150-161.

WEBSTER, J. and WATSON, R.T., 2002. Analyzing the past to prepare for the future: Writing a literature review. *MIS Quarterly*, **26**(2), pp. 13-23.

WEIR, C.R., HAMMOND, K.W., EMBI, P.J., EFTHIMIADIS, E.N., THIELKE, S.M. & HEDEEN, A.N. 2011, "An exploration of the impact of computerized patient documentation on clinical collaboration", *International journal of medical informatics*, vol. 80, no. 8, pp. e62-e71.

WEJNERT, B., 2002. Integrating Models of Diffusion of Innovations: A Conceptual Framework. *Annual Review of Sociology*, **28**, pp. 297-326.

WESTERN, M.C., DWAN, K.M., WESTERN, J.S., MAKKAI, T. and DEL MAR, C., 2003. Computerisation in Australian general practice. *Australian Family Physician*, **32**(3), pp. 1-6.

WETTER, T., 2007. To decay is system: The challenges of keeping a health information system alive. *International journal of medical informatics*, **76**(Supplement 1), pp. S252-S260.

WHITE, N.J., 2004. The Beginnings of Crony Capitalism: Business, Politics and Economic Development in Malaysia, c. 1955–70. *Modern Asian Studies*, **38**(02), pp. 389-417.

WILEY-PATON, S. and MALLOY, A., 2004. Understanding healthcare professionals' adoption and use of IT, GALLETE D. AND ROSS., ed. In: *Proceedings of Tenth Americas Conference on Information Systems, (AMCIS 2004), (GALLETTE D and ROSS J, Eds)*, August 2004 2004, Citeseer, pp. 179-183.

WILJER, D., UROWITZ, S., APATU, E., DELENARDO, C., EYSENBACH, G., HARTH, T., PAI, H. and LEONARD, J.K., 2008. Patient Accessible Electronic Health Records: Exploring Recommendations for Successful Implementation Strategies. *J Med Internet Res*, **10**(4), pp. e34.

WILKINS, M.A., 2009. Factors Influencing Acceptance of Electronic Health Records in Hospitals. *Perspectives in Health Information Management/AHIMA, American Health Information Management Association*, **6**(Fall),.

WIMALASIRI, J.S., RAY, P. and WILSON, C.S., 2005. Security of electronic health records based on Web services, *Enterprise networking and Computing in Healthcare Industry, 2005. HEALTHCOM 2005. Proceedings of 7th International Workshop on 2005*, pp. 91-95.

WINTER, A., BRIGL, B. and WENDT, T., 2003. Modeling Hospital Information Systems (Part 1): The Revised Three-layer Graph-based Meta Model 3LGM². *Methods of information in medicine*, **42**(5), pp. 544-551.

WITHROW, S.C., 2008. Why can't physicians interoperate?: barriers to adoption of EHRs. *Healthcare Financial Management*, **62**(2), pp. 90.

WORLD HEALTH ORGANISATION (WHO), 2009. *World Health Organisation-Malaysia: Country Corporation Strategy 2009-2013*. 3 edn. Kuala Lumpur: WHO.

WORLD HEALTH ORGANISATION (WHO), 2006. *Electronic health records: Manual for developing countries*. 1 edn. Geneva: World Health Organisation.

WORLD HEALTH ORGANIZATIONS, 2004. *ICD-10: International Statistical Classification of Diseases and Related Health Problems 10th Edition*. 2 edn. Geneva: World Health Organization.

WU, J.H., CHEN, Y.C. and GREENES, R.A., 2009. Healthcare technology management competency and its impacts on IT-healthcare partnerships development. *International journal of medical informatics*, **78**(2), pp. 71-82.

WU, S., CHAUDHRY, B., WANG, J., MAGLIONE, M., MOJICA, W., ROTH, E., MORTON, S.C. and SHEKELLE, P.G., 2006. Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. *Annals of Internal Medicine*, **144**(10), pp. 742-752.

XIANZHONG CHENG, KUANG CHENG and LIANYUN HE, 2010. OPENLIMS: The Internet of Things Oriented Laboratory Information Management System, *Information Science and Management Engineering (ISME), 2010 International Conference of 2010*, pp. 426-429.

YALAHO, A., 2006. A Conceptual Model of ICT-Supported Unified Process of International Outsourcing of Software Production, *Enterprise Distributed Object Computing Conference Workshops, 2006. EDOCW '06. 10th IEEE International 2006*, pp. 47-47.

YALAHO, A. and NAHAR, N., 2008. Risk management in offshore outsourcing of software production using the ICT-supported unified process model: A cross-case study, *Management of Engineering & Technology, 2008. PICMET 2008. Portland International Conference on 2008*, pp. 1721-1748.

YARBROUGH, A.K. and SMITH, T.B., 2007. Technology Acceptance among Physicians. *Medical Care Research and Review*, **64**(6), pp. 650-672.

YELLOWLEES, P.M., MARKS, S.L., HOGARTH, M. and TURNER, S., 2008. Standards-Based, Open-Source Electronic Health Record Systems: A Desirable Future for the US Health Industry. *TELEMEDICINE and e-HEALTH*, **14**(3), pp. 284-288.

YI, Q., HOSKINS, R., HILLRINGHOUSE, E., SORENSEN, S., OBERLE, M., FULLER, S. and WALLACE, J., 2008. Integrating open-source technologies to build low-cost information systems for improved access to public health data. *International Journal of Health Geographics*, **7**(1), pp. 29.

YIN, R.K., 2009. *Case Study Research: Design and Methods* 4 edn. London: SAGE Publications Inc.

YOUNG, K., February 25, 2004-last update, Is it time to rely on Linux? [Homepage of The Guardian], [Online]. Available: <http://www.guardian.co.uk/society/2004/feb/25/epublic.technology2> [September 10, 2011].

YU, G., 2007. China HIT case study. In: CLAIRE TOPAL AND KALEB BROWNLOW, ed, *Health information technology and policy lab: HIT briefing book*. 1 edn. Washington: The National Bureau of Asian Research, pp. 49-52.

YUSOF, M.M., 2008. *Re: Research on Interoperability of discrete healthcare information*. n.a. edn. Putrajaya: Ministry of Health of Malaysia.

YUSOF, M.M., KULJIS, J., PAPAZAFEIROPOULOU, A. and STERGIOULAS, L.K., 2008. An evaluation framework for Health Information Systems: human, organization and technology-fit factors (HOT-fit). *International Journal of Medical Informatics*, **77**(6), pp. 386-398.

ZAITUN, A.B. and TERMANINI, M.M.S., 2007. An Early Warning Predictive System for Knowledge Cities. *eHealth*, **2**(2), pp. 23-26.

ZAKARIA, N., MOHD YUSOF, S.A. and ZAKARIA, N., 2010. Managing ICT in healthcare organization: Culture, challenges, and issues of technology adoption and implementation . In: MEHDI KHOSROW-POUR, STEVE CLARKE, MURRAY E. JENNEX, ANNIE BECKER, ARI-VEIKKO ANTTIROIKO, SHERIF KAMEL, IN LEE, JERZY KISIELNICKI, KENG SIAU, AMAR GUPTA, CRAIG VAN SLYKE, JOHN WANG and VISHANTH WEERAKKODY, eds, *Health information systems: Concepts, methodologies, tools, and applications*. 1 edn. New York: Medical inforMation science reference, pp. 1357-1372.

ZALTMAN, G., DUNCAN, R. and HOLBEK, J., 1973. *Innovations and organizations*. 1st edn. New York: John Wiley & Sons.