



INTEGRATED HEALTH INFORMATION SYSTEMS FRAMEWORK IN
POST NATAL CARE FOR MODERN AND TRADITIONAL MALAY
MEDICINE

RAJA RINA BINTI RAJA IKRAM

DOCTOR OF PHILOSOPHY

2017



Faculty of Information and Communication Technology

**INTEGRATED HEALTH INFORMATION SYSTEMS FRAMEWORK IN
POST NATAL CARE FOR MODERN AND TRADITIONAL MALAY
MEDICINE**

Raja Rina binti Raja Ikram

Doctor of Philosophy

2017

**INTEGRATED HEALTH INFORMATION SYSTEMS FRAMEWORK IN POST NATAL
CARE FOR MODERN AND TRADITIONAL MALAY MEDICINE**

RAJA RINA BINTI RAJA IKRAM

**A thesis submitted
in fulfillment of the requirements for the degree of Doctor of Philosophy**

Faculty of Information and Communication Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2017

DECLARATION

I hereby declare that this thesis entitled “Integrated Health Information Systems Framework in Post Natal Care for Modern and Traditional Malay Medicine” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degrees.

Signature :

Name : Raja Rina bt Raja Ikram

Date :

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Doctor of Philosophy.

Signature :

Supervisor Name : Prof. Dr Mohd Khanapi Abd Ghani

Date : -----

DEDICATION

To my beloved family who has encouraged me from day one, particularly my husband, Yasser Ariff who has assisted and provided me with a strong support system and environment to conduct my research and complete my thesis writing. Thank you for the encouragement and patience. My children, Zahratul Husna, Muhammad Ammar and Nur Izzah who has endured me during this period. Also I would like to thank my supervisors, particularly Prof. Dr. Mohd Khanapi bin Abd Ghani, BIOCORE team members and lecturers, laboratory friends who have together supported each other throughout this period. I will always appreciate the friendship and guidance received.

ABSTRACT

The overall aim of this research is to produce an integrated health information systems framework for Traditional Malay Medicine (TMM) and modern medicine in the field of postnatal care. A qualitative study based on grounded theory was conducted via healthcare experts in the field of modern medicine, Traditional Malay Medicine, and information technology (IT) subject matter experts. This research examined health information systems applications in modern and traditional medicine systems, provide an overview of TMM services in Malaysia and critically analyse the existing electronic health records structures and interoperability standards available. A conceptual framework was initially proposed from the literature review and analysis of interviews of the current framework. This research also investigated the critical data attributes required for Traditional Malay Medicine in postnatal care. A set of critical data attributes was developed and proposed from the analysis of results of the structured interviews. An information model was then developed from the set of critical data attributes. A common TMM data attributes in postnatal care may assist in making the proposed framework more flexible and interoperable, particularly when applied with relevant healthcare interoperability standards. The conceptual framework was then validated via healthcare practitioners and IT industry experts. A prototype system of electronic health record was also examined by the respondents to validate the proposed conceptual framework via exploratory prototyping. Consequently, the validation findings was analysed and new themes that emerged from the findings was highlighted to be included in the revised framework. A revised integrated health information systems framework proposed included health record information, interoperability standards, training, support, awareness, separation of authority, accreditation, regulation and enforcement, and adoption incentives. This research may significantly contribute to four main audiences – software developers, healthcare providers, Malay medicine practitioners, and Malay confinement users. Malay women who are the main users of postnatal treatment shall benefit from information availability to compare services delivered by providers. Healthcare providers shall benefit from the standardization of information exchange with other healthcare providers. Software developers may use this study to assist them in developing healthcare related applications in the postnatal domain, particularly in the design of a generic and extensible information model.

ABSTRAK

Penyelidikan ini bertujuan untuk menghasilkan suatu rangka kerja penyepaduan sistem maklumat perubatan yang telah disahsahkan untuk perubatan Melayu tradisional dan perubatan moden sewaktu penjagaan semasa tempoh pantang. Suatu kajian kualitatif telah dijalankan dan melibatkan pakar dalam bidang perubatan moden, tradisional Melayu dan teknologi maklumat. Penyelidikan ini telah mengenalpasti rangka kerja teknologi maklumat kesihatan yang sesuai dalam perubatan tradisional dan moden, mengemukakan suatu analisa terhadap perkhidmatan perubatan tradisional Melayu di Malaysia, menganalisa secara kritikal struktur rekod perubatan kesihatan elektronik dan piawaian saling beroperasi yang sedia ada. Suatu konsep rangka kerja telah dicadangkan melalui kajian literatur dan analisa melalui temubual pakar dalam bidang perubatan terhadap rangka kerja yang sedia ada. Penyelidikan ini juga akan mengenalpasti data-data kritikal dalam perubatan tradisional Melayu untuk penjagaan sewaktu berpantang. Suatu dataset umum telah dihasilkan dan dicadangkan daripada analisa hasil temubual. Suatu model maklumat dirangka dari set data kritikal yang dihasilkan. Suatu set data umum dalam bidang penjagaan selepas bersalin boleh membantu menghasilkan rangka kerja yang lebih fleksibel dan saling beroperasi. Rangka kerja yang dicadangkan kemudiannya disahsahkan melalui temubual menggunakan pakar-pakar kesihatan dan teknologi maklumat. Suatu sistem prototaip rekod kesihatan elektronik juga telah dianalisa oleh pakar-pakar yang terlibat melalui kaedah prototaip eksploratori. Keputusan akhir dari latihan pengesahsahan ini telah dianalisa dan tema atau topik baru yang timbul dikenalpasti untuk dimasukkan dalam rangka kerja yang disemak. Akhirnya, suatu rangka kerja penyepaduan sistem maklumat kesihatan yang disemak dicadangkan termasuk maklumat kesihatan, piawaian operasi, latihan, sokongan, kesedaran, proses penyepaduan, pemisahan kuasa, akreditasi, peraturan and penguatkuasaan, dan insentif penggunaan. Para pesakit juga akan mendapat manfaat melalui kebolehsediaan maklumat untuk membandingkan perkhidmatan yang disediakan oleh pusat kesihatan yang berbeza. Pusat-pusat kesihatan akan mendapat manfaat melalui pemiawaian pertukaran maklumat dengan pusat kesihatan lain. Rangka kerja ini juga dijangka akan membantu pembangunan perisian ketika dalam fasa pembangunan perisian, terutamanya sewaktu merangka model maklumat yang generik dan mudah diperluas.

ACKNOWLEDGEMENTS

I would like to thank my husband, mother and children who has supported me throughout my study duration. Thanks also to my supervisors who has guided me throughout my PhD journey. I would like to also thank friends who have supported and provided ideas on improving my research. I would also like to thank UTeM for providing financial assistance in this research under the Fellowship Scheme. Finally, I would like to thank all who was directly or indirectly involved in this research.

TABLE OF CONTENTS

	PAGE
DECLARATION	
APPROVAL	
DEDICATION	
ABSTRACT	i
ABSTRAK	ii
ACKNOWLEDGEMENT	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	ix
LIST OF FIGURES	xiii
LIST OF APPENDICES	xviii
LIST OF ABBREVIATIONS	xix
LIST OF PUBLICATIONS	xxii
CHAPTER	
1. INTRODUCTION	
1.1 Overview	1
1.2 Research Background	1
1.3 Research Questions	6
1.4 The Problem and its Context	6
1.5 Research Objectives	9
1.6 Scope of Study	11
1.7 Significance of Study	11
1.8 Summary	12
2. LITERATURE REVIEW	
2.1 Overview	13
2.2 Informatics in Healthcare	13
2.3 Differences between Modern Medicine and Traditional Medicine	14
2.4 A Systematic Review of Application of Health Informatics in Traditional Medicine Systems	16
2.4.1 Objectives of Systematic Review	17
2.4.2 Methodology to Conduct Systematic Review	18
2.4.3 Discussion of Findings of Systematic Review	19
2.4.3.1 Application of Informatics in Traditional Medicine	20
2.4.3.2 Traditional Chinese Medicine	22
2.4.3.3 Traditional Ayurveda Medicine	23
2.4.3.4 Traditional Arabic Islamic Medicine	24
2.4.3.5 Traditional Malay Medicine	25
2.4.3.6 National healthcare informatics infrastructure for Traditional Medicine	26
2.4.3.7 Challenges of application of informatics in traditional and	30

complementary medicine	
2.4.4 Summary of Findings on Systematic Review	31
2.5 An Overview of Traditional Malay Medicine in Malaysian Healthcare System	32
2.5.1 An Overview of Traditional Malay Medicine in Malaysia	33
2.5.2 An Overview of Healthcare System Framework	34
2.5.3 Doctor Patient Consultation Framework in Traditional Malay Medicine	36
2.5.4 Research Objectives of Systematic Review of an Overview of Traditional Malay Medicine in the Malaysian Healthcare System	37
2.5.5 Methods of Conducting Systematic Review of an Overview of Traditional Malay Medicine in the Malaysian Healthcare System	38
2.5.6 Results and Discussion	38
2.5.6.1 Traditional Malay Medicine Healthcare System	38
2.5.6.2 Traditional Malay Medicine Doctor Patient Consultation Framework	41
2.5.6.3 Training of Malay medicine practitioners	43
2.5.6.4 Summary of Overview of Traditional Malay Medicine in the Malaysian Healthcare System	43
2.6 Information Systems Framework	44
2.6.1 Analysis of Information Systems Framework	50
2.6.2 Application of Information Systems Framework in this study	52
2.7 Health Information Systems	52
2.7.1 Analysis of Health Information Systems Framework	55
2.7.2 Summary of Health Information Systems Framework	74
2.8 Analysis of Existing Technology Interventions in postnatal care	79
2.9 Related works for Postnatal Electronic Health Records	83
2.10 Related postnatal care processes and workflow	86
2.11 Overview of Electronic Health Records Frameworks and Interoperability Standards	90
2.11.1 EHR Structure Frameworks	91
2.11.2 Interoperability Standards for Electronic Health Records	98
2.12 Theoretical Framework for Integrating Traditional Malay and Modern Medicine via electronic health records	105
2.13 Implications of Literature Review in this Study	111
2.14 Summary	112
3. METHODOLOGY	
3.1 Overview	114
3.2 Research Methodology	114
3.3 Interpretive and Positivist Research	115
3.4 Case Study	117
3.5 Grounded Theory	128

3.6	Participants	120
3.7	Interviews	124
3.8	Questionnaire	126
3.9	Generalisation	126
3.9.1	Approaches to Triangulation Strategy	130
3.10	Validating th Questionnaire	132
3.11	Summary of Research Methods Used in this Research	136
3.11.1	Analysis of Existing System	138
3.11.2	Design and Development of Conceptual Framework	139
3.11.3	Validation of Framework	140
3.11.4	Revision of Framework	140
3.12	Summary	140
4. DESIGN AND DEVELOPMENT OF CONCEPTUAL FRAMEWORK		
4.1	Overview	142
4.2	Design and Development of Critical Data attributes	142
4.2.1	Methods of analysis of critical data attributes	142
4.2.2	Sample of Participants	145
4.2.3	Results and Discussion of Critical Data attributes	147
4.3	Design and Analysis of Current Framework	159
4.3.1	Methods of analysis of Current Framework	159
4.3.2	Analysis of Current Framework	161
4.3.2.1	People	162
4.3.2.2	Process	164
4.3.2.3	Technology	171
4.4	Proposed Conceptual Framework	173
4.4.1	People	174
4.4.2	Technology	176
4.4.2.1	MyPostnatal Use Case	179
4.4.3	Process	187
4.4.4	Summary of MyPostnatal Framework	191
4.5	Summary	192
5. VALIDATION OF FRAMEWORK		
5.1	Overview	194
5.2	Overview of Validation Process	194
5.3	Validation Approach for Healthcare Practitioners	195
5.4	Validation via Healthcare subject matter experts	196
5.4.1	Perception of MyPostnatal Framework	197
5.4.2	Feedback of MyPostnatal Use Case and Processes	201
5.4.3	Barriers of Implementation	204
5.4.4	Benefits of Implementation	211
5.4.5	Healthcare Standards	213

5.5 Validation Discussion via MyPostnatalSys Prototype	213
5.5.1 MyPostnatalSys Workflow	213
5.5.2 MyPostnatalSys Module	215
5.5.3 Security Factors	216
5.5.4 MyPostnatalSys Interface	218
5.5.5 System test	220
5.5.6 Results and Discussion of Prototype Validation	224
5.6 Analysis of Case Studies for Healthcare Practitioners	228
5.6.1 Case Study of Hospital P	228
5.6.2 Case Study of Hospital L	232
5.6.3 Case Study of Hospital M	234
5.6.4 Case Study of Hospital S	236
5.6.5 Case Study of Private TMM	239
5.7 Validation of IT Subject Matter Experts	240
5.7.1 Overview Background of Respondents	241
5.7.2 Health Information Systems Software Developer Expert	244
5.7.3 Non Health Information Systems Software Developer Expert	246
5.7.4 Health Information Systems Academic Expert	248
5.7.5 Non Health Information Systems Academic Expert	250
5.7.6 Healthcare Industry Expert	252
5.7.7 Other Industry IT Expert	254
5.8 Analysis of Themes and Subthemes from the Validation Phase	256
5.8.1 Cross Case Analysis for Healthcare Practitioners	256
5.8.2 Cross Case Analysis for IT Industry Experts	258
5.8.3 Findings of Cross Case Analysis	261
5.8.4 Expected Findings	262
5.6.5 Emerging Themes	263
5.9 Summary	265

6. VALIDATED FRAMEWORK

6.1 Overview	266
6.2 MyPostnatal Components	266
6.3 MyPostnatal Framework	268
6.3.1 Process	269
6.3.2 Policy	271
6.3.3 People	272
6.3.4 Technology	274
6.4 Conclusion	275
6.5 Summary	275

7. CONCLUSION	
7.1 Overview	276
7.2 Summary of Completed Works	276
7.3 Contributions to Theory	278
7.4 Other Contributions	279
7.5 Validity of Research	280
7.6 Generalisation	280
7.7 Limitations and Constraints	281
7.8 Opportunities for Further Research	282
7.9 Reflections	282
REFERENCES	284
APPENDICES	313

LIST OF TABLES

TABLE	TITLE	PAGE
2.1	Differences between modern medicine and traditional medicine	14
2.2	Inclusion Criteria for Systematic Review	18
2.3	Comparison of informatics area applications in TCM, Ayurveda, TAIM and TMM	19
2.4	Informatics infrastructure to support Traditional Medicine in China, India, Middle East and Malaysia	26
2.5	Main components of healthcare system framework for modern medicine	36
2.6	The S.O.A.P. Model for Clinical Health Assessment	37
2.7	Inclusion Criteria	39
2.8	Comparison between TMM and modern medicine using the Healthcare System Framework	40
2.9	Comparison between TMM and modern medicine for doctor patient consultation using the S.O.A.P. model	42
2.10	Characteristics of ISA Framework	45
2.11	Information Systems Architecture Framework	46
2.12	The Horizontal Evaluation of ARIS/Zachman/CEO Framework	51
2.13	Classification of Health Information Systems	54
2.14	Analysis of Health Information Systems Framework	55

2.15	Analysis of HIS Frameworks based on What, Where and How Perspective	74
2.16	Healthcare Technology Interventions in Postnatal care	80
2.17	Related works for postnatal electronic health records	83
2.18	Related works for postnatal care process and workflow	86
2.19	Theoretical frameworks involved in the systematic review on electronic health records implementation	104
2.20	Themes categorisation of literature for implementation of electronic health records in TMM and modern medicine	109
3.1	Grounded Theory Methodology and Application in Study	119
3.2	Breakdown of interviews conducted in this study	122
3.3	Summary of Case Study Healthcare Organisation	128
3.4	Summary of Case Study for IT Subject Matter Experts	129
3.5	Results of Content Validation Exercise	135
4.1	Participants involved in the data collection process	148
4.2	Clinical indicators where TMM practitioners score more than 50% but MM practitioners score less than 50%	148
4.3	Clinical indicators where MM practitioners score more than 50% but TMM practitioners score less than 50%	149
4.4	Core and additional clinical indicators for TMM postnatal care	151
4.5	Recording guidelines for the Core Clinical Indicators for TMM postnatal care	155
4.6	S.O.A.P. Model for Core Clinical Data attributes for TMM postnatal care	157

4.7	Improvements in Proposed Technology Component	177
4.8	Information Component Description in Lifetime Health Record Model	181
4.9	Summary Improvements in Lifetime Health Record Integration Model	187
4.10	Summary Improvements in Proposed Process Component	188
5.1	Breakdown of respondents in the validation phase	196
5.2	Respondents involved in the validation phase	197
5.3	Results of MyPostnatalSys testing by practitioners	217
5.4	Questions used to measure the effectiveness of the system	225
5.5	Subthemes Categorisation for Hospital P	230
5.6	Overview of IT Subject Matter Experts	243
5.7	Health Information Systems Software Developer Response	245
5.8	Non Health Information Systems Software Developer Response	248
5.9	Health Information Systems Academic Expert Response	250
5.10	Non Health Information Systems Academic Expert Response	252
5.11	Healthcare Industry Expert Response	254
5.12	Other IT Industry Expert Response	256
5.13	Percentage of IT Experts who rated Agree or Strongly Agree	260
5.14	Summary of Applicable Themes Highlighted by IT Experts	261
5.15	Findings Categorisation	262
5.16	Supportive Literature for Expected Findings	263
5.17	Supportive Literature for Emerging Themes	265
6.1	Identified Elements from Conceptual Model	266
6.2	Identified Elements for Revised Framework	267
6.3	List of Changes of the Initial and Revised Process for Process theme	269

6.4	List of Changes of the Initial and Revised framework for Policy theme	271
6.5	List of Changes of the Initial and Revised framework for People theme	272
6.6	List of Changes of the Initial and Revised framework for Technology theme	273

LIST OF FIGURES

FIG	TITLE	PAGE
1.1	Information technology gap in the domain of Traditional Malay Medicine	7
1.2	Proposed framework solution for research problem	7
2.1	ARIS Framework	45
2.2	The CEO Framework	47
2.3	Human Perspectives in the CEO Framework	48
2.4	Comparison and Evaluation of Zachman, ARIS and CEO Frameworks	50
2.5	The general Architecture of the EHR System	58
2.6	EHR System Infrastructure	59
2.7	EHR System Architecture	59
2.8	In home extension and integration of hospital information systems	60
2.9	Device and Service Integration of iMedBox	61
2.10	Overall design workflow for Clinical Research System	64
2.11	Data Integration Model	65
2.12	Integrated and Distributed Malaysia Telemedicine Framework	68
2.13	High Level Architecture for Proposed Semi Centralised National Health Information Systems	69
2.14	Components of the proposed Semi Centralised National Integrated EHR	70

2.15	Conceptual Data Model for Semi Centralised Architecture Approach for National Integrated EHR	71
2.16	National Healthcare Centre (NHC) modules for the proposed Semi Centralised Architecture Approach for National Integrated HER	72
2.17	Guideline for Work Process of Wellness Massage	88
2.18	Work process for midwifery care	89
2.19	LHR Components	92
2.20	Message format for the VPI request and VPI response	94
2.21	Message format for RHR request	94
2.22	Message format for RHR response	95
2.23	Message format for MHR	96
2.24	Framework for Implementing electronic health records in hospitals	107
2.25	Requirements of successful implementation of IHIS projects	107
3.1	Summary of research methodology	138
4.1	Data attributes that score at least 50%	148
4.2	People Component in the Current Framework	161
4.3	Current Framework for patients seeking TMM postnatal treatment in patient home or practitioner facility	164
4.4	Current Framework for patients seeking TMM postnatal treatment in modern healthcare facility	166
4.5	Current Framework for patients seeking TMM postnatal treatment in modern healthcare facility in Hospital P	167
4.6	Isolation of patient consultation health records based on the SOAP model.	169
4.7	Current Process Flow for Modern Medicine and Traditional Medicine	170

4.8	Current Technology Architecture for TMM and MM in postnatal care	171
4.9	Integration of Traditional Malay Medicine and Modern Medicine healthcare services via electronic health records	172
4.10	Conceptual Framework for MyPostnatal	173
4.11	People Components in the Framework	174
4.12	Technology Component Framework	176
4.13	Deployment System for MyPostnatal	178
4.14	MyPostnatal Use Case model	179
4.15	MyPostnatal Health Record Integrated with Lifetime Health Record	180
4.16	MyPostnatal Lifetime Health Record Message format	181
4.17	MyPostnatal Maintain Lifetime Health Record Message format	182
4.18	Process Flow of MyPostnatal Health Record Message	183
4.19	MyPostnatal Retrieve Health Record message	184
4.20	Process Flow for MyPostnatal Retrieve Health Record	184
4.21	Sample message data for MyPostnatal Health Record in XML format	185
4.22	Sample MyPostnatal message in HL7 format	186
4.23	Sample XML schema for message formatter for MyPostnatal Health Record	186
4.24	Summary of Process Flow	187
4.25	MyPostnatal process flow for patient assessed as suitable for treatment or treatment with precaution	189
4.26	MyPostnatal process flow for patient assessed as not suitable for TMM postnatal treatment (bed rest)	190
4.27	MyPostnatal process flow for patients assessed as not suitable for treatment (emergency)	191

4.28	Proposed MyPostnatal Framework	192
5.1	Validation method for MyPostnatal framework	196
5.2	Percentage of respondents who agree with MyPostnatal framework	198
5.3	Respondents who agree with MyPostnatal Use Case and Processes	202
5.4	Respondents willingness to implement MyPostnatal if provided with complete documentation and training	208
5.5	Workflow for patients receiving TMM postnatal treatment	216
5.6	MyPostnatalSys module	217
5.7	Architectural view of MyPostnatalSys	218
5.8	Interface of Prototype of MyPostnatalSys	219
5.9	Modern Medicine Module	220
5.10	Traditional Medicine Module	221
5.11	MyPostnatalSys module integrated with ECSS	222
5.12	MyPostnatalSys being tested by traditional and modern medicine practitioners	223
5.13	Likert scale measurement	226
5.14	Results of respondents for Question 1	228
5.15	Results of respondents for Question 2	229
5.16	Results of respondents for Question 3	229
5.17	Results of respondents for Question 4	230
5.18	Results of respondents for Question 5	231
5.19	Subthemes mentioned for Case Study in Hospital P	233
5.20	Case Study Results for Prototype Validation	234
5.21	Subthemes mentioned for Case Study in Hospital L	236
5.22	Case Study Results for Prototype Validation in Hospital L	237

5.23	Subthemes mentioned for Case Study in Hospital M	238
5.24	Case Study Results for Prototype Validation in Hospital M	239
5.25	Subthemes mentioned for Case Study in Hospital S	241
5.26	Case Study Results for Prototype Validation in Hospital S	242
5.27	Subthemes mentioned for Case Study in Private TMM	243
5.28	Case Study Results for Prototype Validation in Private TMM	244
5.29	HIS Software Developer Expert Response	247
5.30	Non HIS Software Developer Expert Response	250
5.31	HIS Academic Expert Response	252
5.32	Non HIS Academic Expert Response	254
5.33	Healthcare Industry Expert Response	256
5.34	Other IT Industry Expert Response	258
5.35	Percentage of respondents from case studies that directly or indirectly that mentioned an issue	261
5.36	Percentage of IT Experts who Rated Agree or Strongly Agree	262
6.1	Initial Conceptual Framework	270
6.2	Revised MyPostnatal Framework	271

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
1	Design and Development of Critical Data attributes and Proposed Framework	313
2	Validation of MyPostnatal Framework	322
3	Research Ethics Consent Form for Patient Data	332
4	Testcases for Project Title: Health Informatics Framework for Postnatal Care – an integration of Traditional and Modern Medicine Services	333
5	Introduction to MyPostnatal	338
6	List of Data Fields for Segments for Lifetime Health Record Information Model	345
7	The Applicability of MyPostnatal Framework	350
8	MyPostnatal Information Model Schema	364