

## A conceptual integrated health information systems framework in postnatal care for modern and traditional Malay medicine

Raja Rina Raja Ikram<sup>1</sup>, Lizawati Salahuddin<sup>2</sup>, Mohd Hariz Mohd Naim<sup>3</sup>, Ariff Idris<sup>4</sup>,  
Nor Afirdaus Zainal Abidin<sup>5</sup>, Nadiyah Ishak<sup>6</sup>, Noor Raihan Ab Hamid<sup>7</sup>

<sup>1,2,3,4</sup>Centre for Advanced Computing Technology (C-ACT), Fakulti Teknologi Maklumat dan Komunikasi,  
Universiti Teknikal Malaysia Melaka

<sup>5</sup>City University Malaysia, Menara City U, Malaysia

<sup>6</sup>Department of Science and Technology, Faculty of Business Innovation and Technology, Malaysia

<sup>7</sup>Asia Graduate School of Business, UNITAR 3-01A, Level 2, Malaysia

---

### Article Info

#### Article history:

Received Jun 16, 2019

Revised Sep 17, 2019

Accepted Oct 2, 2019

---

#### Keywords:

Electronic health records

Health information systems

Traditional medicine

---

### ABSTRACT

This paper proposes an integrated health information systems framework for Traditional Malay Medicine (TMM) and modern medicine in the field of postnatal care. A qualitative study was conducted via healthcare experts in the field of modern medicine and Traditional Malay Medicine to assess the current situation and identify the research gap and point of isolation between both traditional and modern medicine field. A total of 26 healthcare practitioners whom represented five different set of healthcare organisations participated in this study. The healthcare practitioners consist of modern and traditional Malay medicine background with and without proper training. Results show that there is a gap in the current people, process and technology areas of the current framework. A novel conceptual framework, MyPostnatal, proposes the existence of a sufficiently generic, extensible in-formation model where new data sources can be integrated without major changes to the data scheme. Human and organization factors are also highlighted to stimulate the adoption towards electronic health records.

Copyright © 2020 Institute of Advanced Engineering and Science.  
All rights reserved.

---

### Corresponding Author:

Raja Rina Raja Ikram,  
Centre for Advanced Computing Technology (C-ACT),  
Fakulti Teknologi Maklumat dan Komunikasi,  
Universiti Teknikal Malaysia Melaka.  
Email: raja.rina@utem.edu.my

---

## 1. INTRODUCTION

Traditional medicine (TM) is described as a group of health care practices and products with an extensive history of use. Traditional Medicine often refers to medicinal knowledge established by home-grown cultures that include nature based remedies, spiritual treatments and manual methods designed to cure illness or preserve health [1]. Traditional Medicine is usually practiced outside of allopathic medicine (commonly known as modern or Western medicine), which is the dominant system of medicine in the developed world. Some of the well-known Traditional Medicine systems include traditional Indian (Ayurveda) medicine, traditional Chinese medicine (TCM), and traditional Arabic (Unani) medicine [1]. The World Health Organization (WHO) defines traditional medicine as “the sum total of the knowledge, skills and practices based on the theories, beliefs and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health, as well as in the prevention, diagnosis, improvement or treatment of physical and mental illnesses” [2]. “Traditional Medicine practices, particularly comprehensive medical systems such as traditional Chinese Medicine and Ayurveda, share many of the same core values [3].

The main informatics areas that has been researched in Traditional Medicine are clinical data warehouse, computational intelligence, bioinformatics, chemoinformatics, informatics standards, clinical

decision support systems, data mining, image processing, pharma-coinformatics, spiritual care informatics, electronic health records and informatics standards [4, 5]. Traditional Arabic and Islamic Medicine major usage of informatics is in spiritual care and assisting users in performing Islamic obligations [6]. TAIM consists of medicinal herbs, dietary practices, mind body therapy and spiritual healing where many of these elements reflect a relationship between Islamic medical and prophetic influences as well as regional healing practices emerging from cultural origins [7]. This indicates that there is strong religious influence in the roots of Traditional Arabic Islamic Medicine, contributing to emerging informatics applications in spiritual and religious obligations. On the other hand, Traditional Malay Medicine lags behind all three Traditional Medicine systems since not a single literature regarding on informatics applications was found. Most of the technology emerged from Traditional Malay Medicine are pharmaceutical products or usage of medical devices to measure key indicators such as blood pressure, pulse, and temperature during treatment [8]. This shows that there is a huge informatics gap in the Traditional Malay Medicine field [9]. In addition, no literature was found for application of informatics in Traditional Malay Medicine [10].

This paper shall address the following research problem, what is the current framework or problem related to usage of health records in Traditional Malay Medicine and how is it isolated from the Modern Medicine? and what is the suitable framework that can solve this problem and provide an integrated solution?

## 2. RESEARCH METHOD

A qualitative study based on grounded theory was conducted via healthcare experts in the field of modern medicine and Traditional Malay Medicine. An unstructured interview was conducted to 23 modern medicine and 13 Traditional Malay Medicine practitioners [11]. The main questions that were included in the interview are :

- a) Are computerized systems used to manage Malay postnatal services? Please specify the scope of computerized systems used if any.
- b) What is the current procedure for a patient to undergo Malay postnatal treatment?
- c) What factors encourage modern medical practitioners refer patients to undergo Malay postnatal treatment?
- d) What factors will trigger Malay postnatal patients to refer to medical practitioners?

The selection criteria of participants in case study include experience in maternity care for traditional or modern medicine, have experienced both modern medicine and traditional medicine treatment, minimum 10 years' experience for Traditional Malay Medicine practitioners, and the modern medicine respondents are legally registered practitioners.

The participants in the study were recruited based on the snowball process. The snowball technique is a method that yields a sample based on referrals made by people who share or know others who present the characteristics that are of research interest [12]. Historically, this method has been widely used in qualitative studies of hidden populations where identification of such populations requires a knowledge of insiders who can locate people willing to participate in the study [13]. There are some concerns in using the snowball method as issues such as selection bias may arise. Selection bias can be a consequence of friendship matching if the selection of participants is not independent of the exposure under study within the matching factors. However, a study by Lopes [13] using 185 samples of drug abusers in a particular community confirms that there are no selection bias in this study. Thus, the use of snowball method can produce a valid basis for a case-control study. The snowball method is appropriate in this study because the population of Traditional Malay Medicine practitioners in Malaysia is unable to be accurately established as these providers are not entirely regulated and may only exist through referral by neighbourhood or family contacts [14].

A summary of healthcare organisations involved in this study can be found in Table 1. Nurses involved in this study are well trained in the field of maternity care. A total of 16 out of 23 modern medicine practitioners' respondents consists of nurses specialising in Midwifery care. Medical officers selected in this study consists of mothers who are experienced in implementing Malay postnatal practices during their self-confinement period. Traditional Malay Medicine practitioners involved all have a minimum of 10 years of experience in Malay postnatal care services. Eight out of thirteen (8/13) TMM practitioners respondents selected have been trained and underwent a rigorous interview process before selected by Hospital L to provide postnatal care services on behalf of their organisation. One out of thirteen (1/10) of the TMM practitioner involved works in traditional and complementary unit in Hospital P. Thus, all TMM practitioners' respondents involved in this study are well sought to provide postnatal care services in their respective residence communities.

Table 1. Summary of Participants from Case Study Healthcare

Case Study Organisation	Hospital M	Hospital L	Hospital P	Hospital S	Private TMM
Characteristics					
Government healthcare centre	/		/		
Private healthcare centre		/		/	
Freelance practitioner					/
Modern Medicine practitioner	/	/	/	/	
Traditional Medicine practitioner		/	/		/
Computerised Health Record System					
Paper based Health Record	/		/	/	
No health record		/			/
Number of participants	17	8	2	1	1

The participants involved in this study come from various organisation background. Hospital S is one of two hospitals in Malaysia that provide Traditional Malay postnatal care services. Even though there are nine hospitals in Malaysia that practice Traditional and Complementary medicine, only two provide postnatal care services whereas the remaining seven hospitals only practise postnatal massage. Thus Hospital P is a suitable case study as it also provides other traditional Malay postnatal care services such as hot compress or bertungku and herbal body wrap or bengkung and Malay postnatal massage as part of the services in their traditional and complementary medicine unit facility.

Hospital L is a government agency which provides women healthcare services to the public at a subsidized cost. Hospital L also organizes a postnatal care scheme named Mamacare, which screens qualified traditional Malay practitioners with extensive experience and provide them training to modernize the method of traditional Malay medicine treatment. Amongst the objective of this programme is also to increase the income of these traditional Malay practitioners. A few levels of interviews are conducted to select qualified practitioners in this Mamacare programme. Thus, practitioners selected from this Mamacare program are subject matter experts in the field of Traditional Malay Medicine with some exposure in modern medicine. These practitioners commonly visit the home of customers or provide treatment in the centre once a week according to their rotation schedule. Hospital M is one of the renowned public hospitals with modern healthcare facilities in Melaka that provide general and specialised healthcare services including obstetrician and gynaecology services with experienced practitioners. All practitioners that practise in this hospital are registered with the Malaysian Medical Council and Malaysian Nursing Board. Hospital S is a private clinic open to public that provide general healthcare services by General Practitioner doctors, including prenatal and postnatal checks. Private TMM practitioners provide freelance TMM healthcare services to the public. These practitioners are not registered to any regulated body, but their services are commonly sought by the community.

**3. RESULT AND ANALYSIS**

Based on the data collection and literature review, the researcher has managed to identify a few issues related to the current framework and have categorised these findings into three categories - people, technology and process.

**3.1. People-Unavailability of Training and Accreditation**

Traditional Malay practitioners training are not fully regulated. Most of their knowledge is inherited from elder family members that are involved as Traditional Malay practitioners. There are also traditional practitioners who took initiatives to learn from courses provided by experienced practitioners, even though the courses are not regulated by the Ministry of Health. Non registered practitioners still practice freely and are widely sought in the Malaysian community. The cost per session can be from RM50 to RM500, depending on the demand, income in the practicing community, duration and package of the session. Most young practitioners in the late thirties or early forties are usually motivated to obtain certificates in this field as this will improve their skills and opportunity to obtain more customers by increasing their customers' confidence and ultimately increasing their income [15, 16].

A postnatal care scheme provided by a government agency named Mamacare does exist, which screens qualified traditional Malay practitioners with extensive experience and provide them training to modernize the method of traditional Malay medicine treatment. Information of customer health records, symptoms or complications are not required to be reported. No regulations or procedures on pre-screening of customers are required, and selection of customers depends solely on the judgement on these practitioners without any endorsement from modern medicine physicians. The judgement by these practitioners also may vary according to experience and is difficult to standardize. These practitioners commonly visit the home of

customers or provide treatment in the centre once a week according to their rotation schedule. Thus, there is no integration in traditional Malay with modern medicine in this Mamacare programme, other than the one-off training received by these practitioners. According to the interviewees, the training provided lasted a few days and emphasized on modern anatomy, do's and don'ts during treatment that are often taken for granted such as hygiene, and medically correct procedures to provide treatment, particularly postnatal care massage. However, minimal monitoring of traditional practitioner activities are executed other than reporting of monthly income and customers.

### 3.2. Existing Process

Figure 1 shows the current process flow involves isolated patient health records. Paper based doctor patient consultation is used for Traditional Malay Medicine. There is limited accessibility to patient health information. A practitioner may not be able to suitably diagnose or recommend a patient treatment plan without complete information of patient such as the objective information i.e. vital signs – blood pressure, pulse, etc. Modern medicine practitioner can only provide emergency related health problems whereas Traditional Malay Medicine practitioners provide Traditional Malay Medicine postnatal treatment. Both these treatment complements each other and is considered a more holistic treatment for the patient.

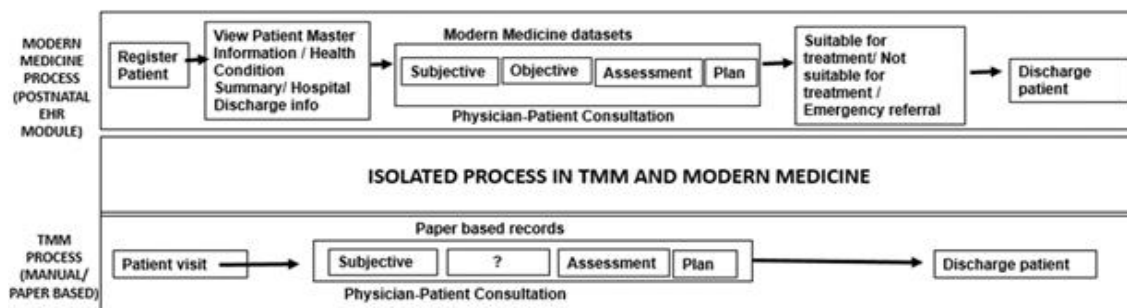


Figure 1. Isolation of patient consultation health records based on the SOAP model

### 3.3. Existing Technology

Currently, there is no information technology used in the field of Traditional Malay Medicine. Postnatal home visits or check ups are based on an established schedule and recorded in manual health records in Hospital P, M and S. No health records are rec-orded by Hospital L and private TMM practitioners. The current issue is the current system has resulted in isolated patient health records. Traditional Medicine patient health records are also paper based. There is lack of availability of critical data attributes in Tradi-tional Malay Medicine. Application of electronic health records standards (i.e. HL7, ICD10) and standard clinical diagnosis coding are only applicable in the modern medicine domain. Patient objec-tive information is not available for proper diagnosis.

### 3.4. Proposed Integrated Solution

This section shall highlight the proposed integrated solution, MyPostnatal Framework, Figure 2 shows MyPostnatal, the proposed conceptual framework for health informatics in postnatal care to integrate traditional Malay and modern medicine. Three main criteria or components were identified as vital for a successful integration- people, technology and process.

Traditional Malay healers are an integral part of TMM. However, traditional practitioners' training and accreditation has yet to be established [17]. Both modern medicine and TMM are regulated by government policies. However the scope of TMM regulation is limited. Modern medicine services are provided in established medical centres under government regulation, however TMM may be provided in homes and wellness centres without proper regulation [6]. Thus, training is a vital key factor to ensure the success of integration. Training involves accreditation or certifica-tion for these traditional medicine practitioners to upgrade their knowledge to ensure services provided are consistent with modern medical standards. Many traditional practitioners interviewed re-sponded that they found training provided by Hospital L as essential because they were educated with vital information such as the correct treatment procedure, do's and don'ts including basic hygiene and effective methods to provide faster relief to patients.

In addition, re-training of staff when new processes, procedures or technology are implemented is also crucial, particularly when implementing an innovationb [18].

It is still unclear the formal training required by traditional Malay practitioners even though pilot treatment has been implemented in the public healthcare. According to Ministry of Health Malaysia Traditional and Complementary Medicine Handbook, list of certified institutions that provide training for traditional medicine are related to Traditional Chinese medicine, homeopathy, chiropractic, and natural medicine [19]. No training providers for TMM is listed in the official handbook [20]. GAPERA merely monitors registration of traditional Malay practitioners and the requirements are the approval from the local head community or ketua kampung. In contrast, modern medicine is highly regulated and all its practitioners require formal training before any formal practice in the healthcare system.

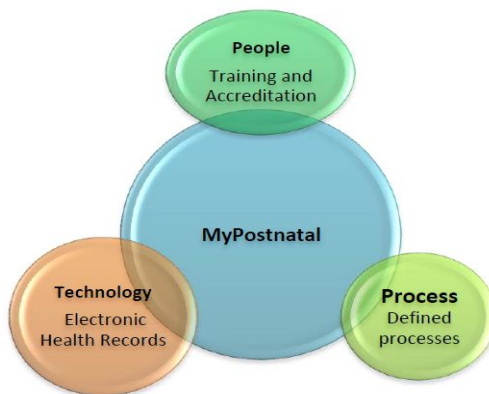


Figure 2. Proposed MyPostnatal Framework

Figure 3 represents the integration process model for MyPostnatal framework proposed. There are 3 process model represented: (1) the modern medicine module (2) traditional Malay medicine module, and (3) manual TMM module. Information re-quired by Traditional Medicine practitioners such as vital signs i.e. blood pressure, temperature, pulse, shall be elicited from the shared modern medicine module interface and EHR repository. The final recommendations by practitioners are either suitable for treatment, not suitable and emergency referral.

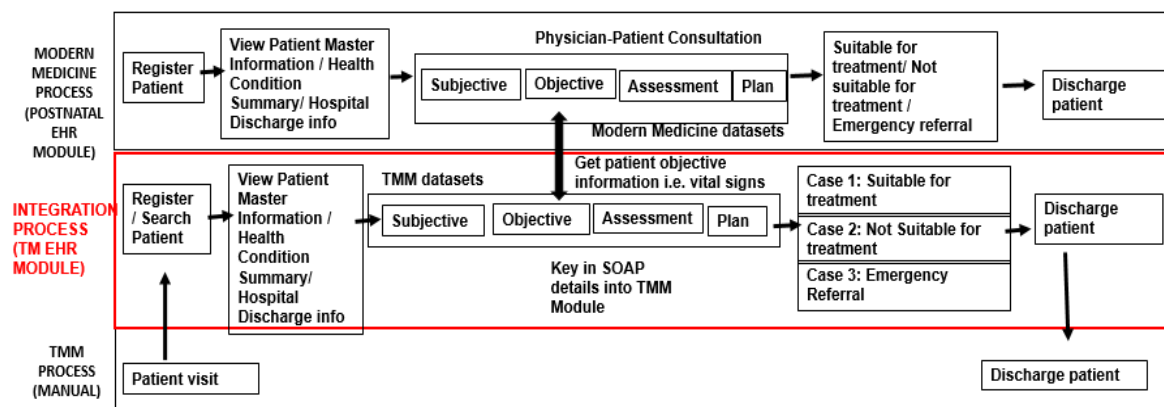


Figure 3. Integration process model for MyPostnatal

MyPostnatal Framework proposes a solution by centralising health records, accessibility to patient health information and usage of electronic health records in doctor patient consultation in the traditional malay medicine module, which is currently paper based. Information Technology performance relationship in healthcare is observed after a certain period and the results indicate support for the impact of technology contingent on Business Process Reengineering practiced by hospitals [19]. Thus, a standardized process is

essential to reap benefits from in-formation technology implementation and to align People and Technology in MyPostnatal Framework [21].

Figure 4 shows the technology component of MyPostnatal Framework. There are 2 major modules used in the proposed technology model: (1) the Traditional Medicine Module and (2) Modern Medicine module. Both modules contain the submodule for doctor patient consultation which contains the Subject Objective Assessment and Plan (SOAP) data. During doctor patient consultation, electronic health records are retrieved and maintained in the EHR repository via the defined critical data attributes. Objective information for patients such as vital signs (i.e. blood pressure, pulse) and other patient information can be extracted from the integrated EHR repository to assist patient diagnosis. The application of EHR standards format and coding in the modern medicine module are extended to the Traditional Medicine EHR Repository for standardization. Multiple EHR repositories from different healthcare providers in Traditional Medicine and Modern Medicine can also be utilized and access from the modules. In addition, the critical data attributes have been defined and the application of standard clinical codings such as HL7 and ICD10 has been extended to be used in Traditional Malay Medicine [22].

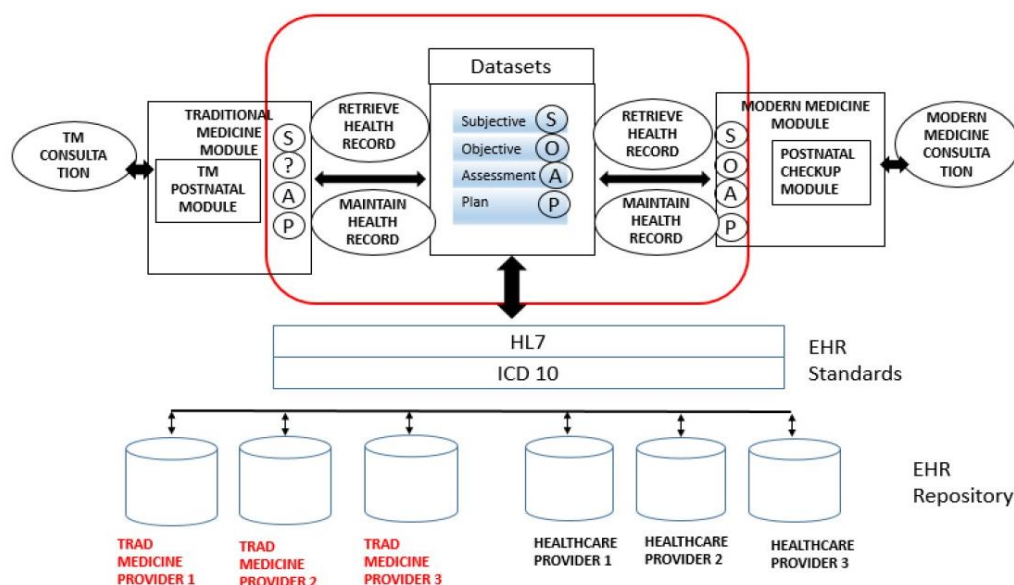


Figure 4. MyPostnatal technology component

There are four major categories of the Lifetime Health Record mainly Patient Master Index, Health Condition Summary, Episode Summary and Traditional Malay Medicine. The message header includes formatting and vital information for the Lifetime Health Record message. The Patient Master Index consists of patient master information that such as Patient Identification Information, Patient Demographic Information, Contact Information, Educational Information, Insurance Information and Next of Kin information. The Health Condition Summary information consists of semi static information that may change throughout the patient's lifetime such as Accident information, Disability Information, Patient Allergy Information, Problem / Chronic Disease. The Episode Summary information consists of dynamic information that is recorded during every patient visit such as diagnosis, observation results, pharmacy treatment dispense, procedures and patient visit information [23].

The Traditional Malay Medicine segment consists of Traditional Malay Medicine information, which currently includes the postnatal information. The Lifetime Health Record information model was then translated into a HL7 message format. The term HL7 is used both: i) as a name for the organization and ii) as a set of messaging standards. The HL7 organization focuses on the interface requirements that are needed by the entire health care organization, when communicating healthcare data within or outside its healthcare systems. HL7 standards are the most successful messaging standards in the healthcare industry [24]. It is a protocol that consists of standardized grammar and vocabulary. HL7 standards work by assuming that an event in the real world of healthcare systems creates the need for data to flow amongst various systems. This will be initiated by a trigger, which in the HL7 standard is equal to a Trigger Event [25]. When an event

occurs in an HL7 compliant system a message is passed to the requesting application as EDA (Electronic Data Interchange) by gathering the relevant data from the applications [21].

#### 4. CONCLUSION

The proposed MyPostnatal framework has three main components-People, Process and Technology. The people component is the human and organizational factors that is required to ensure successful implementation of technology and processes. In the proposed framework, training and accreditation by IT and regulatory healthcare organisation is a mandatory component. For the technology component, the main highlights are integrated EHR repository, patient health records accessibility, and development of data attributes for Traditional Medicine as modern medicine data sets are already established. A generic and extensible information model is also proposed in this framework. For the process component, the integration workflow will be via the Traditional Medicine Electronic Health Record Module. The objective information for Traditional Medicine practitioners can be accessed from the modern medicine module. The treatment plan process is also defined to ensure patients that require to seek treatment are properly referred and standardize treatment options. MyPostnatal provides a holistic framework for the implementation of electronic health records in Traditional Malay Medicine domain in postnatal care for the benefit of software developers, policy makers and regulatory officials. In addition, the framework contributes to the usage of complete lifetime patient data by improving data accessibility among healthcare providers in the modern and traditional medicine.

#### ACKNOWLEDGEMENTS

This study was supported by Centre for Advanced Computing Technology (C-ACT), Fakulti Teknologi Maklumat dan Komunikasi, Universiti Teknikal Malaysia Melaka.

#### REFERENCES

- [1] WHO, "WHO Traditional Medicine Strategy," *WHO Rep.*, 2013, pp. 1–78.
- [2] World Health Organisation (WHO), "WHO | Traditional Medicine: Definitions," *World Health Organisation*, 2014. [Online]. Available: <http://www.who.int/medicines/areas/traditional/definitions/en/>. [Accessed: 18-Nov-2014].
- [3] R. Leung, K. F. Chung, V. Li, R. Cheung, C. Lam, and E. Ziea, "Development of Electronic Health Record for Chinese Medicine eHR(CM) Sharing System in Hong Kong," *Integr. Med. Res.*, vol. 4, no. 1, May 2015, p. 115.
- [4] X. Zhao, X. Li, W. Yang, Q. Feng, Y. Zhou, and Q. Wang, "Primary health information standard system based on semantic interoperability," *BMC Med. Inform. Decis. Mak.*, vol. 18, no. S5, Dec. 2018, p. 112.
- [5] J. Walonoski, R. Scanlon, C. Dowling, M. Hyland, R. Ettema, and S. Posnack, "Validation and Testing of Fast Healthcare Interoperability Resources Standards Compliance: Data Analysis," *JMIR Med. informatics*, vol. 6, no. 4, Oct. 2018, p. e10870.
- [6] K. Chatfield, B. Salehi, J. Sharifi-Rad, and L. Afshar, "Applying an Ethical Framework to Herbal Medicine," *Evidence-Based Complement. Altern. Med.*, vol. 2018Sep. 2018, pp. 1–7.
- [7] E. Coiera, *Guide to Health Informatics, Third Edition*, 2015. CRC Press, 2015.
- [8] R. R. Raja Ikram, M. K. Abd Ghani, N. R. Ab Hamid, and L. Salahuddin, "Enabling Ehealth in Traditional Medicine: A Systematic Review of Information Systems Integration Requirements," *J. Eng. Sci. Technol.*, vol. 13, no. 12, 2018, pp. 4193–4205.
- [9] R. R. Raja Ikram and M. K. Abd Ghani, "An Overview of Traditional Malay Medicine in the Malaysian Healthcare System," *J. Appl. Sci.*, vol. 15, no. 5, 2015, pp. 723–727.
- [10] R. R. R. Ikram, M. K. A. Ghani, and N. Abdullah, "An analysis of application of health informatics in Traditional Medicine: A review of four Traditional Medicine Systems," *Int. J. Med. Inform.*, vol. 84, no. 11, Nov. 2015, pp. 988–996.
- [11] O. M. Hambaran, M. Khanapi, A. Ghani, R. Rina, R. Ikram, and B. M. Aboobaidar, "Implementation of Hybrid Software Architecture Framework in Clinical Information System: A Case Study of a Malaysian Clinic," *ARN J. Eng. Appl. Sci.*, vol. 10, no. 20, 2015.
- [12] P. Biernacki and D. Walford, "Snowball sampling: Problems and techniques of chain referral sampling. 1981; 2: 141-63," *Soc. Methods Res.*, vol. 21981, pp. 141–163.
- [13] C. S. Lopes, L. C. Rodrigues, and R. Sichieri, "The Lack of Selection Bias in a Snowball Sampled Case-Control Study on Drug Abuse," *Int. J. Epidemiol.*, vol. 25, no. 6, Dec. 1996, pp. 1267–1270.
- [14] L. Salahuddin, Z. Ismail, R. R. Raja Ikram, U. R. Hashim, A. Idris, N. H. Ismail, N. H. Hassan, and F. Abdul Rahim, "Safe use of hospital information systems: an evaluation model based on a sociotechnical perspective," *Behav. Inf. Technol.*, Mar. 2019, pp. 1–25.
- [15] C. S. Kruse, A. Stein, H. Thomas, and H. Kaur, "The use of Electronic Health Records to Support Population Health: A Systematic Review of the Literature.," *J. Med. Syst.*, vol. 42, no. 11, Sep. 2018, p. 214.

- [16] M. K. Abd Ghani and R. R. Raja Ikram, "Development of clinical minimum dataset for postnatal treatment in traditional Malay medicine," *ARNP J. Eng. Appl. Sci.*, vol. 10, no. 19, 2015, pp. 9032–9037.
- [17] B. L. Melton, "Systematic Review of Medical Informatics–Supported Medication Decision Making," *Biomed. Inform. Insights*, vol. 9Jan. 2017, p. 117822261769797.
- [18] R. Rina, R. Ikram, M. Khanapi, A. Ghani, and U. M. Hambaran, "Integrated Modern and Traditional Malay Medicine Healthcare Services in Postnatal Care – An Evaluation of Mypostnatalsys," *ARNP J. Eng. Appl. Sci.*, vol. 10, no. 19, 2015, pp. 9002–9008.
- [19] L. Salahuddin, Z. Ismail, U. R. Hashim, N. H. Ismail, R. R. Raja Ikram, F. Abdul Rahim, and N. H. Hassan, "Healthcare practitioner behaviours that influence unsafe use of hospital information systems," *Health Informatics J.*, Mar. 2019, p. 146045821983309.
- [20] A. H. Maimunah, S. Shamzaini, A. R. Aidatul Azura, M. Maria Safura, A. H. Nut Hidayati, M. Z. Mohd Hadi, W. C. Wong, M. R. Asmirah, K. Nur Hazirah, and A. Ng, "A Handbook of Traditional and Complementary Medicine Programme in Malaysia," 2011.
- [21] M. L. Braunstein, "Healthcare in the Age of Interoperability: Part 3," *IEEE Pulse*, vol. 10, no. 1, Jan. 2019, pp. 26–29.
- [22] K. M. Schwei, R. Cooper, A. N. Mahnke, Z. Ye, and A. Acharya, "Exploring Dental Providers' Workflow in an Electronic Dental Record Environment.," *Appl. Clin. Inform.*, vol. 7, no. 2, 2016, pp. 516–33.
- [23] N. A. Abu Bakar, W. M. Wan Ramli, and N. H. Hassan, "The internet of things in healthcare: an overview, challenges and model plan for security risks management process," *Indones. J. Electr. Eng. Comput. Sci.*, vol. 15, no. 1, Jul. 2019, p. 414.
- [24] Deepika N, M. Anand, and F. Jerald, "A novel three tier internet of things health monitoring system," *Indones. J. Electr. Eng. Comput. Sci.*, vol. 15, no. 2, Aug. 2019, pp. 631–637.
- [25] M. Yi, "Major Issues in Adoption of Electronic Health Records Subject Categories and Descriptors J.3 [Life and Medical Sciences]; Medical information systems," *J. Digit. Inf. Manag.*, vol. 162018.

## BIOGRAPHIES OF AUTHORS



Raja Rina binti Raja Ikram is a senior lecturer in Universiti Teknikal Malaysia Melaka. She received a double degree in Bachelor of Eng (Software) and Bachelor of Commerce (Finance) from University of Melbourne, Australia in 2007. She then worked in various multinational companies in Malaysia since 2008. Consequently, she proceeded to study her Masters and PhD in the field of Health Informatics and Health Information Systems in Universiti Teknikal Malaysia Melaka.



Lizawati Salahuddin is a senior lecturer in Universiti Teknikal Malaysia Melaka (UTeM) since 2010. Previously, she worked at a multinational company in Malaysia for two years. She graduated with honors from Universiti Teknologi Malaysia (UTM) with a bachelor degree in Computer Science (Software Engineering) in 2005. Subsequently, she received Master degree in BioSystem from Korea Advanced Institute of Science and Technology (KAIST), South Korea in 2008. She obtained PhD in the field of Information Systems from Universiti Teknologi Malaysia (UTM) in 2016.



Mohd Hariz Mohd Naim is a lecturer in Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka. He received his Bachelor and Masters Degree from Universiti Teknologi MARA, Shah Alam, Malaysia. His research interests include health informatics and mobile applications.



Ariff Idris is a senior lecturer in Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka. He received his bachelor from Universiti Teknologi MARA and his Masters degree from Universiti Kebangsaan Malaysia. His research interests include system and internetworking integration.

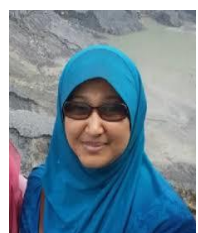




Nor Afirdaus Binti Zainal Abidin is a lecturer at City University, Petaling Jaya, Selangor, She received her Bachelor and Masters degree from Universiti Utara Malaysia, Perlis and Universiti Teknologi MARA, Shah Alam, Malaysia. She is currently a PhD candidate at Universiti Teknikal Malaysia Melaka.



Nadiah Ishak received her Bachelor and Masters degree from University of Adelaide, Australia. She then received her PhD from Universiti Tun Hussein Onn Malaysia. She is a lecturer in Kolej Universiti Islam Malaysia Melaka.



Noor Raihan Ab Hamid is a Professor at UNITAR International University, Malaysia. She received her Bachelor and Master degree from Barney School of Business and Public Administration, University of Hartford, Connecticut, USA. She then pursued her PhD at School of Information Systems, Faculty of Business and Law, Victoria University Australia.