

# Development of Conceptual Information Systems Framework using Grounded Theory

Raja Rina Raja Ikram, Rosleen Abd Samad, Raihan Ab Hamid, Lizawati Salahuddin, Mohd Khanapi Ab Ghani

**Abstract:** This paper shall present a research protocol to develop a conceptual framework in the information systems field using grounded theory method. The research protocol presented is an exploratory research using qualitative methods. The grounded theory based study was conducted via healthcare experts in the field of modern medicine, Traditional Malay Medicine, and information technology subject matter experts. A conceptual framework was initially proposed from the literature review and analysis of interviews of the current framework. 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 were analysed and new themes that emerged from the findings was highlighted to be included in the revised framework.

**Keywords :** grounded theory, case study, information systems

## I. INTRODUCTION

There are many qualitative approaches towards Health Information Systems research. Qualitative research is a process of building a complex and holistic picture of the phenomenon of interest, conducted in a particular setting [1]. Researchers who use qualitative methods seek a deeper truth, attempting to make sense of, or interpret, phenomena in terms of meanings people bring to them to develop an understanding of the problem and propose practical solutions. The five main qualitative approaches are narrative, case study, grounded theory, phenomenological and ethnography.

## II. GROUNDED THEORY

Grounded theory is a research method that seeks to develop theory that is grounded in data systematically gathered and analysed [2]. Grounded theory is "an inductive, theory discovery methodology that allows the researcher to develop a theoretical account of the general features of a topic while simultaneously grounding the account in empirical observations or data" [3] [4]. Grounded theory approaches are becoming increasingly common in the Information Systems

research literature because the method is extremely useful in developing context-based, process-oriented descriptions and explanations of the phenomenon [5]. Grounded theory can be used to gain insight about a process and the explicit attempt to generate a conceptual model [6][7]. This method shall be used in throughout the development, validation and data analysis of the framework. Constant comparison between incidents, data and theory is required throughout all phases to ensure precision, consistency and avoidance of bias [8]. In this research, grounded theory was used as the overall methodology to study data from an exploratory case study and to drive data acquisition activities. Amongst the benefits of using case study strategy in information systems research is the research can study IS in a natural setting, generate theories from practice, understanding of the nature and complexity of the processes involved and it is an appropriate way to research a previously little studied area [9] [10].

**Table 1: Grounded Theory Methodology and Application in Study (Adapted from [8])**

No	Grounded Theory Method	Method Description	Research Methodology Phase
1	Developing codes or themes	Naming segments of data with a label that simultaneously categorizes, summarizes, and accounts for each piece of data.	Literature Review
2	Interconnecting Codes / themes (Axial coding),	Finding relationship and patterns between categories / themes/ codes from literature and data collection to form the conceptual framework.	Development of Conceptual Framework
3	Selective coding / themes (Build a story that connects the categories)	Comparing data collection, case studies and cross case analysis results to build context and theory.	Validation of framework
4	Sensitizing concepts and general disciplinary perspectives	Relating themes, concepts, literature and data collection results to finalise theory.	Finalising the framework

Table 1 explains the methodology of grounded theory and application in the current study. There are five main processes of grounded theory, open coding, axial coding, selective coding and sensitizing concepts to formulate the final theory [8]. Open coding involves developing codes from literature review. Initial data collection was also done to identify the current framework of the traditional and modern medicine healthcare system and to verify the initial coding.

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An analysis was conducted to interconnect the themes identified and to find relationship and patterns between categories / themes/ codes from literature and data collection to form the initial conceptual framework in the research phase Design and Development of Current Framework. A case study approach was conducted during the validation stage to validate the conceptual framework. The results of the cross case analysis was then reanalysed together with theoretical concepts to form the expected and emerging themes in the research phase Validation of Framework. The expected and emerging themes were then merged and restructured based constantly compared with relevant theories to form the revised framework.

This paper shall detail the research methodology protocol for an integrated health information system framework in traditional medicine that is exploratory in nature. An exploratory research has the objective to gather preliminary information that will help define problems and build a hypothesis or framework. Exploratory research has the aim of exploring an innovation in a unique context that leads to confirming and challenging the existing methods. Thus, a qualitative approach is deemed appropriate in studying a relatively new phenomenon or a new innovation in a particular context [11].

### III. CASE STUDY

The qualitative method used is based on the case study research within grounded theory. Case study is defined as an empirical inquiry that investigates a phenomenon within its real life context, particularly when boundaries between phenomenon and context are not clearly evident [12]. Case Study Research is the most common method used in information systems [13], [14]. Case study research method is suitable to Information Systems research since the object of the discipline is the study of information systems in organisations and interest has shifted to organizational rather than technical issues [10]. In this research, a case study of a public hospital, the current procedures, issues, gaps and propose a practical solution was done. Thus, case study method is the suitable to perform an in depth analysis of the current framework practiced in public hospitals.

#### A. Interviews

There are three fundamental types of research interviews: structured, semi-structured and unstructured. Structured interviews are orally administered questionnaires, in which a list of predetermined questions are queried, with little or no deviation and with no room for follow-up questions to responses that permit further elaboration [15]. Consequently, they are fairly quick and easy to administer and may be of particular use if clarification of certain issues are required. However, they only permit for limited participant responses and are, therefore, of little use if in depth elaboration is required.

On the other hand, unstructured interviews do not reflect any preconceived theories or ideas and are performed with little or no organization [16]. Unstructured interviews are usually very time-consuming and can be difficult to manage, and to participate in, as the lack of predetermined interview questions provides little guidance on what to response which may cause participants to be confused [17]. Their use is

generally only considered where significant 'depth' is required, or where virtually nothing is known about the matter (or a different perspective of a known topic is required).

Semi-structured interviews consist of several key questions that help to define the areas to be explored, but also allows the interviewer or interviewee to diverge in order to pursue an idea or response in more detail [18]. This interview format is used most frequently in healthcare, as it provides participants with some guidance on how to response or discuss which may be helpful. The flexibility of this approach, particularly compared to structured interviews, also allows for the discovery or elaboration of information that is important to participants but may not have previously been thought of as relevant by the research team [16].

This case study utilised semi structured interviews by providing participants with a guideline to response and is particularly suitable in the healthcare context [15]. The interview is aimed to investigate the initial critical data attributes and gather information and experience towards the current implementation of postnatal care in Traditional Malay Medicine and evaluate a proposed framework to solve the current problem. This approach provides a guide to understand areas being initially explored and as the interview progresses, the interviewer and interviewees may diverge into other relevant information important to interviewees. The researcher acts as an outside observer where the interviews are considered as a primary data source to provide interpretations of events and actions in the participants context [19]. As an outside observer, the researcher has no particular influence or specific interest from any stakeholders involved in the study, and established rapport allows the interviewees to be open in their views and response [20].

The interviews were mostly conducted in a mixture of English and Malay language, as majority of the participants were comfortable in conducting interview in this manner. The Traditional Malay practitioners however mostly preferred the Malay language due to their lack of exposure to English education, background and social lifestyle. The interview was divided into two phases, the first phase involves data collection to establish an initial critical data attributes and understand the current procedures in place for postnatal care in Traditional Malay Medicine at home and in the hospital setting. The second phase is the validation phase, where a proposed framework and prototype application was developed and evaluated by the participants involved in the first phase. The interview questions in the first phase and second phase can be found in Appendix 1 and Appendix 2 respectively. There was in no circumstance that the researcher coerced the participant to answer certain questions in a way researcher wanted them to.

#### B. Questionnaire

Questionnaire is one of the methodologies accepted in case study research. It is defined as a survey method which is a compilation of standardized information from a targeted sample population and is also considered similar to a structured interview. Questionnaire was used to collect data from IT subject matter experts during the validation on conceptual framework.

In addition, the IT subject matter experts were also provided with a manual and access to the prototype of the implementation of the proposed conceptual framework in the questionnaire. Results from the questionnaire were then categorised into respective case study categories and context and cross case analysis was also conducted to add rigour and increase the generalizability of the research.

#### IV. PROJECT BACKGROUND

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 were 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.

#### V. SUBJECT MATTER EXPERTS

Participants for this interview are categorized into pilot study, development study and validation participants. There were 2 participants in the pilot study and 36 participants in the main and validation category. The participants in the study consists of healthcare workers in the Traditional and modern medicine field, i.e. traditional Malay medicine practitioners

and modern medicine practitioners. The pilot study was conducted in order to gauge responses on the suitability of the interview questions and preliminary insights on the issues of the integration of modern and traditional medicine.

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 [21]. 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 [22]. 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. In addition, IT subject matter experts were also recruited academicians, healthcare organisations and health information systems experience.

The case study selected is Hospital P, Hospital L, Hospital M, Hospital S, Private TMM practitioners and Traditional Medicine practitioner. Hospital P particularly is one of the 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 Table 2 below shows the data collection details in this study.

**Table- II: Breakdown of participants involved in this study**

Phase	Traditional Medicine	Modern Medicine	IT Subject Matter Experts	Total participants
Pilot study	1	1	1	3
Development of conceptual framework	13	23	-	36
Validation of framework	10	19	25	54

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.

IT subject matter experts involved in this case study consists of six different case studies background – Health Information Systems (HIS) software developer experts, non HIS software developer experts, HIS academic experts, non HIS academic experts, healthcare industry expert and other IT industry subject matter experts.

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HIS software developer experts are experts whose working experience roles involve one or more of the software development lifecycles. These experts have indicated their experience in HIS projects during their working tenure. Non HIS software developer experts are experts whose working experience roles involve one or more of the software development lifecycle. However, they have indicated that they have no experience in healthcare related projects. HIS academic experts are experts involved in the academic industry and have experience managing HIS projects in the academic domain. However, some of these academic experts also have past experience in the healthcare IT industry. The inclusion of HIS academic experts are important to ensure the applicability of conceptual framework proposed as academic experts strength rely strongly in research theory. HIS software developer expert's strength is in implementation and thus their inclusion in this case study is to ensure the applicability of the implementation of the proposed framework. Non HIS academic experts are academic experts who have not indicated experience in the health information systems domain. The healthcare industry expert are subject matter experts in the IT health industry, particularly serving healthcare organisations such as hospitals. Other IT industry subject matter experts are IT experts who are not involved in software development, academic and healthcare sector. Non HIS experts have been included in this study for triangulation purposes and to increase the rigour and analysis of the validation process.

## VI. INTEGRATING GROUNDED THEORY IN THE RESEARCH METHODOLOGY

Qualitative methods used are interviews and survey via questionnaires. The respondents in this study represent various case study categories and organisations as discussed in the previous section. Constant comparison with literature and theory was conducted to ensure the method used are rigorous and results are grounded to theory. Triangulation of data sources and data collection methods were utilised by combining and integrating several studies to come to a more secure and more generalised results and reduce personal bias. The research methodology process can be summarized in Figure 1.

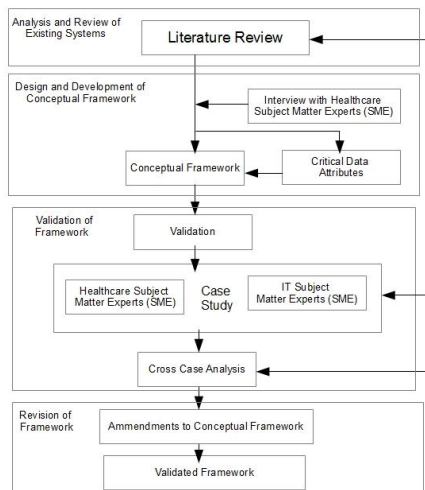


Figure 1: Overview of research methodology

## VII. ANALYSIS OF EXISTING SYSTEM

A systematic review on the implementation of Traditional Malay Medicine in the Malaysian healthcare system was conducted. A systematic review of current informatics application in Traditional Malay Medicine and three other traditional medicine systems were compared. This section also analyses the existing information systems architecture available and describes the characteristics of conceptual framework architecture selected in this research. An analysis of existing health information systems framework that concluded a summary of features in the proposed conceptual framework is also included. Furthermore, an evaluation of existing interoperability standards in healthcare are provided. In addition, a review of existing related works in postnatal care complications, data attributes of electronic health records and related design and process was performed. Grounded theory was applied where the results of the literature review were used to help develop theoretical sensitivity before conducting fieldwork or data collection [23]. Furthermore, an evaluation of existing interoperability standards in healthcare are provided. In addition, a review of existing related works in postnatal care complications, data attributes of electronic health records and related design and process was performed. Grounded theory was applied where the results of the literature review were used to help develop theoretical sensitivity before conducting fieldwork or data collection [23].

## VIII. DESIGN AND DEVELOPMENT OF CONCEPTUAL FRAMEWORK

The design and development of framework phase involved developing an initial list of critical data attributes and conceptual framework based on literature review and data collection from interviews. An initial list of data attributes was developed based on a review of existing postnatal data attributes in modern medicine. These data attributes are then ranked based on its relevancy by interviewees. The results were tabulated, discussed and proposed as a common data attribute for postnatal care in Traditional Malay Medicine. The results of the interview were analysed to identify the current framework problems and processes that can assist in the development of conceptual framework. The interview results were then supported with theory or literature to ensure the proposed conceptual framework developed is within the boundaries of grounded theory. An information model was developed from the critical data attributes. A conceptual framework was then proposed in this chapter taking account of inputs from the literature review, interview and critical data attributes.

## IX. VALIDATION

The validation of framework was conducted via subject matter experts in the healthcare and IT field. The healthcare experts consist of practitioners from the public hospital, private clinics, and freelance practitioners from modern and traditional Malay medicine services. The healthcare experts were interviewed on their response regarding the conceptual framework and provided feedback on the prototype application MyPostnatalSys.

The IT subject matter experts consists of experts who have experience in Health Information Systems from software development, academic, healthcare and other IT industries. The IT subject matter experts' feedback on the conceptual framework and prototype application MyPostnatalSys was gathered via a questionnaire. A cross case analysis was conducted to identify feedback pattern amongst the case studies and the emerging and expected themes. The results were than consolidated to be incorporated in the revised framework. During this phase, the emerging themes or new codes identified were compared or supported with theory or literature to ensure the newly discovered themes or codes are grounded to theory.

## X. GENERALISATION

Generalisability refers to the degree to which research findings are applicable to other populations or samples [2]. It involves 'the usefulness of one set of findings in explaining other similar situations' [3]. A pragmatic approach to assessing generalizability for qualitative studies is to adopt same criteria for validity [4]. One of the approaches to generalisation is through the use of triangulation and constant comparison, proper audit and documentation [5]. Triangulation is defined as the combination or integration of several studies to come to more secure and more general results [6].

Information Systems (HIS) experts and non Health Information Systems (HIS) experts from the IT background were both included for triangulation purposes in order to provide a more rigorous approach to the validation process. Software developer's strength is at the implementation stage where as academician's strength is at the formation of the conceptual framework or requirements and functional phase. IT subject matter experts serving healthcare organisations were also included to utilise their experience and intensive encounter with health information systems. The inclusion of these case studies are to ensure the applicability of the framework is validated both conceptually and its implementation feasibility. Case study from other IT industry experts were also included for triangulation purposes and cross case analysis.

Thus, this research has adopted eleven case studies with multiple and unique characteristics or phenomenon. Generalisation using a variety of case studies is a frequently recommended strategy. Thus the finding of similarities within the case study variations may lead to generalizations [4].

Comparative literature analysis was also adopted in the study to ensure the results are grounded to theory or literature. This is also an acceptable strategy for generalization [7]. Comparative literature analysis is used by constantly comparing our results with other literature. Findings from the case study in the research were compared against literature to ensure results were consistent with literature analysis within grounded theory.

## XI. SUMMARY

To summarize, this paper has presented a research protocol using a qualitative approach, where the respondents of this study are subject matter experts in either traditional Malay medicine or modern medicine field in postnatal care and IT subject matter experts. Qualitative methods used are

interviews and survey via questionnaires. The respondents in this study represent various case study categories and organisations. A total of 36 subject matter experts were involved in the design stage and 54 subject matter experts (29 healthcare experts and 25 IT experts) were involved in the validation phase. According to a study conducted by Guest [8], for studies with a high level of homogeneity among the population "a sample of six interviews may be sufficient to enable development of meaningful themes and useful interpretations". Thus, this research has surpassed the minimum level of interviews or data collection to develop meaningful themes and useful interpretations. Constant comparison with literature and theory was conducted to ensure the method used are rigorous and results are grounded to theory. Triangulation of data sources and data collection methods were utilised by combining and integrating several studies to come to a more secure and more generalised results and reduce personal bias.

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