

# Modeling Business Intelligence (BI) Requirements of Rural Healthcare Center Using Goal-Oriented Approach

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**Abstract**—When it comes to big data, the healthcare industry is swamped with hype and confusion. The healthcare industry has always been information intensive as organizations are swimming in an ever-deeper pool of data. The ability of an organization to transform data into information and information into intelligence will be vital to its survival. This paper attempts to model the business intelligence (BI) requirements for strategic business decision in Malaysian rural healthcare organizations. However, data requirements for rural healthcare not been fully employs due to insufficient in requirement gathering process and typically overlooked in real situation. Therefore, there must be a phase in the project that is dedicated to analyzing the requirements. To model the requirement, the following research questions are answered: (i) Who are the stakeholders in rural healthcare center? (ii) What are the decisions making requirements for rural healthcare center? (iii) What are the operational data sources of rural healthcare center? and (iv) How can the rural healthcare center's requirements of decision making be model? The results are a list of stakeholders that involved in rural healthcare center and the list of early requirements in decision making. The study also extracting the attributes of the operational data and all requirements are presented into star-schema. These outputs are expected to be elicited the early requirements of rural healthcare that serve as the most important stages to realize the functional for rural healthcare center. Also the star-schema model presented may be usable for pioneering physical design of BI system for rural healthcare center. This work ultimately serves as part of the research conducted towards the strengthening and improving of Malaysia healthcare delivery especially in rural area and added to the literature of the research body of knowledge.

**Keywords**—*business intelligence; requirements model; healthcare center; rural.*

## I. INTRODUCTION

Requirement modeling is a process of extracting individual stakeholder requirements and expand it into detail that can be used for related system development activities as the basis. However, requirement analysis is typically overlooked in real project which resulted in project failures. The following are some common reasons why requirement is typically overlooked [1]:

- Requirements for decision making often refer to information that does not exist in the required form, and must be derived from direct data sources.

- Information requirements for most applications are difficult to specify because decision processes are flexibly structured and mostly poorly shared across large organizations.

- Most projects are long-term projects, and it is very difficult to anticipate future requirements for the decision-making process.

Goal-oriented analysis has been proposed in the requirement literature to capture the intentionality behind application requirements. Goal represent an intentional used at the early requirements analysis phase to explain the “why” of a system. They have been used to represent the rationale of both humans and application systems. These are essential for the analysis and the design of an application system supposed to reflect stakeholders’ motivation [2].

The healthcare industry has always been information intensive as organizations are swimming in an ever-deeper pool of data. Rural healthcare center is currently facing challenges caused by the practices in collecting the data for analyzing their performances at the end. The obstacles faced by healthcare providers and patients in rural areas are greatly different from those who live in urban areas. Malaysian Ministry of Health (MOH) has done amazing in establishing an extensive network of rural healthcare services and delivering cost effective healthcare to Malaysian rural communities [3]. However, rural Malaysian still face a unique combination of factors that create differences in healthcare that not found in urban areas.

While healthcare in urban areas, the facilities are more inclusive, easy to reach to healthcare center in terms of transportation, easy to access information (telecommunication technology) and availability of the specialist. Meanwhile, in rural areas there are lacks of facilities (high technology equipment), accessibility (distance and transportation) and less of awareness, knowledge and information about healthcare among rural Malaysian become major challenges to healthcare providers to provide healthcare to the adjacent rural communities.

To model the requirement, this study sets out to answer the following research questions:

1. Who are the stakeholders in rural healthcare center?
2. What are the decisions making requirements for rural healthcare center?

3. What are the operational data sources of rural healthcare center?
4. How can the rural healthcare center's requirement of decision making be model?

This paper attempts to explore how to model the business intelligence (BI) requirements for strategic business decision in Malaysian rural healthcare organizations using goal-oriented approach.

## II. LITERATURE REVIEW

### A. Business Intelligence (BI)

BI is defined as a broad category of applications, technologies and processes for gathering, storing, accessing and analyzing data to help business user make better decisions.

### B. Requirements Analysis

The approaches to BI requirements analysis are usually classified in two categories: (1) data driven and (2) requirement driven.

Data-driven approaches starts the analysis of data sources which simplify the design, but they give user requirements a secondary role in determining the contents for analysis. Requirement-driven approaches start from determining the requirement from end users, which bring requirements to the foreground, but it requires larger efforts when designing as it needs a more structured and comprehensive technique.

### C. Goal-oriented approach

The goal-oriented approach focuses on early requirements. Goal-oriented approach used to examine several alternatives because this approach offers the identification of many parts of goals that are suitable for the identical high level goal in various ways.

In goal-oriented requirement modelling, the context of 'goal' is used to identify some required outcomes like 'what should be achieved?' In addition, the relation of goal are different in term of organization and IT. The goal for organization is more to abstract that describes why the goal is required while the goal for IT is to more concrete that define how the goal can be realized [4].

The used of this approach will reduce the possibilities of misunderstanding of user's needs and offer the accurate rank of abstraction to confirm completed selection and recommend neglected results. Some of the advantages of goal-oriented requirements [5] are:

- i. Requirements systematically maybe derived from user's goal.
- ii. Goals grant the rationale for requirements.
- iii. The Goal graphs granted with the right abstractions level which is decision maker would involve in important decisions.
- iv. The structure goal refinement grants a comprehensible structure for documentation of requirements.

- v. The refinements of agent assignment and alternative goal will allow exploration of alternative system proposals.
- vi. Formalization of goal allows the refinements to be proved correct and complete.

### D. Rural Healthcare

In general, rural can be defined as areas that are located outside a city including suburban and urban areas, rural and remote rural areas [6]. In Malaysia, the Ministry of Health (MOH) is responsible to prepare and deliver effective medical services to the rural areas. There are healthcare center every 5 kilometers of the country and more than 95 per cent of the rural population have access to a doctor. Thus, the government focuses on improving the socio-economic development of rural population by showing an excellent achievement in providing health care services. At the same time, the national healthcare developments mostly focus on the development and upgrading of existing health services.

In the turmoil between costs, care-results and patient satisfaction the right balance is needed. MOH should be using BI in a strategic and innovative manner to support healthcare center. In addition, data and analytic can provide the much needed backbone to support improvements critical to achieving long term success for the healthcare centers.

### E. Modelling BI Requirements

Modeling the requirements aims to provide users with more direct access to data through models. According to [7] without a solid understanding of user needs and desired external system behaviors, it is impossible to intelligently proceed with development. Requirement modeling is needed so that the data can be interpreted and analyzed in terms of familiar business concepts, enabling timely and effective decision making and action. Recent work has incorporated goal modeling in design methodologies for data in order to provide business users query facilities for reasoning about business strategies and operations, with analysis on the data accessible via mappings to databases and data warehouses [8].

## III. METHODOLOGY & ANALYSIS

This study employed qualitative research design because of the exploratory nature of the study.

### A. Data Collection

The study choose local rural healthcare center as a selected case and pre-data collection phase was done prior to the study. This study applied structured interviews for data collection from respondents. This method was employed to gather more information by identifying the services provided, processes involved, procedures and decision made. The information obtained from the interviews consists of variables that are related to medical data and management data.

The respondents are considered as stakeholder for this study. Open-ended questions were structured in advance as a guideline so that information obtained would answered the research questions.

Among the stakeholders who were interviewed are the medical officer, medical assistant, chief nurse, nurse, assistant nurse, community nurse, medical laboratory technologist, pharmacy assistant and administrative assistant. Audio recording was used for recording all conversations between researchers and stakeholders to be played back and used as proof of the study. The recording material is used to analyze in details the conversation and make interpretation and reflection so that the information can be understood more deeply.

**B. Data Analysis**

Content analysis was used to analyze the information collected from the stakeholders. Researchers explore and make interpretations on the information has been derived from stakeholders' interviews.

There are three categories identified based on the interpretations of the information collected. The purpose of identifying these categories is to select stakeholders, and tasks which are relevant, and types of decisions.

**IV. FINDINGS**

**A. The Stakeholders in Rural Healthcare Center**

Several classifications of stakeholder requirements provide a useful set of elements of classification. There are 42 staffs in the rural healthcare center consisting of Medical Officer (Doctor), Medical Assistant (MA), Head Nurse (Sister), Staff Nurse, assistant nurse (AN), Community Nurse (CN), Health Assistant (HA), Assistant Pharmacy (AH) and Public Health Assistant (PKA), all the identified staff known as a stakeholders. Through the scope of task, the stakeholders are categorized into two categories which are administrative staff and medical staff.

**B. The Decisions Making Requirements**

Based on the scope of task, the study analyzed and identified the decision making done by each stakeholder. The decision made was categorized to three categories which are routine decision, event trigger decision and emergency decision as shown in Table 1 below listed a number of stakeholders' decision making tasks.

Table 1: Stakeholders Analysis on Decision Making

Stakeholders	Main Tasks	Routine	Event Trigger	Emergency
Medical Officer (Doctor)	Handling emergency case			✓
	Examine and treat cases referred/referring cases to the hospital	✓		
Medical Assistant	Administration matters	✓		
	Treating patient	✓		
Chief Nurse	All details of the course, exchanges, complaints against the service and personal record services	✓		
	Giving health education/nutrition		✓	
Nurse	Manage all activities related to family health services in the area of operations	✓		
	Giving health education/nutrition		✓	
	Taking part in communicable disease control services		✓	

The definition of each decision categories are:

i. *Routine decision.* This decision is referring to decision that required stakeholder to make decision in daily task like treating patient, patient registration, dispensing medication

and other matters related to staff like overtime and leave record.

ii. *Event Trigger decision.* This decision was categorized as event trigger due to the nature of scope of task which required the stakeholder make decision when problems related to health occur such as communicable disease.

iii. *Emergency Decision.* This decision is referring to situations that endanger to life or might have serious implications for the continued health and well-being that require urgent intervention to prevent worsen situation. Example of emergency situation is accidents that involve serious injuries.

Example of decision making process: Medical officer (MO) is responsible for all matters pertaining to the maternal and child health services in the area of operations. The decision made by MO which have categorized to routine and emergency. The routine task is related to clinical duties like giving treatment to patient. MO is also responsible in administrative tasks like attending seminar or giving health talk as instructed by health office. MO also directly involved in emergency decision making when there are emergencies case.

Figure 2 shows the decision-making process when patients come for treatment. The necessary information required such as patient name, patient ID, gender, age, background can help determine the appropriate type of treatment needed. Normally, these are the steps when treating patient:

- i. Checking and provides treatment to patients.
- ii. Analyzing the type of investigation and treatment needed by the patient.
- iii. Create advanced procedures in the investigation of patients' illness such as radiographic examination and blood tests.
- iv. Provide treatment and medication with prescription drugs that are appropriate to the patient.
- v. Provide information to patients about the disease.
- vi. Determining if a patient in need of treatment in specialist clinics.

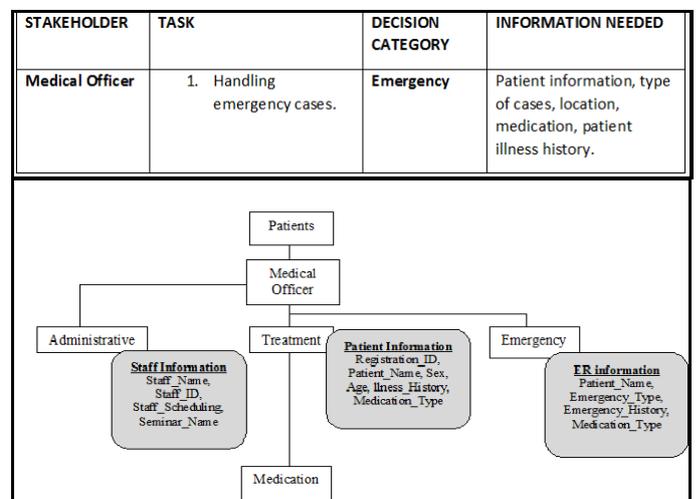


Figure 2: Decision making process for Medical Officer (MO)

### C. The operational Data Sources

After decision making model is produced, conforming process is done to ensure that all selected requirements been modeled clearly and acceptable. To achieve the above, data definition for patients, stakeholders, tasks, routine decision, event trigger decision, emergency decision and registration are presented in Table 2 below.

Table 2: Data Dimensional Model Definition

Data definition	Fields
Patient	Patient_ID, patient_name, Patient_registration_ID, patient_sex, patient_age, patient_illness_history, patient_medication
Stakeholders	Stakeholder_ID, stakeholder_name, stakeholder_address, stakeholder_age, stakeholder_sex, stakeholder_occupation, stakeholder_contact, stakeholder_category
Tasks	Task_ID, task_name, task_description, task_category
Routine Decision	Routine_id, routine_name, routine_type, routine_incharge
Event Trigger Decision	Event_ID, event_name, event_location, event_date, event_time, event_incharge
Emergency Decision	Emergency_registration_ID, emergency_case_type, emergency_history, medication_type, emergency_incharge
Registration Table	Registration_ID, patient_name, patient_ID, registration_fee, registration_tag

### D. The Requirements Model of Rural Healthcare Center

From the data dimensional model definition in Table 2, a star-schema was designed based on the requirements analysis. The star-schema designed having one (1) fact table and seven (7) dimension tables. The view of star-schema as presented in Figure 3.

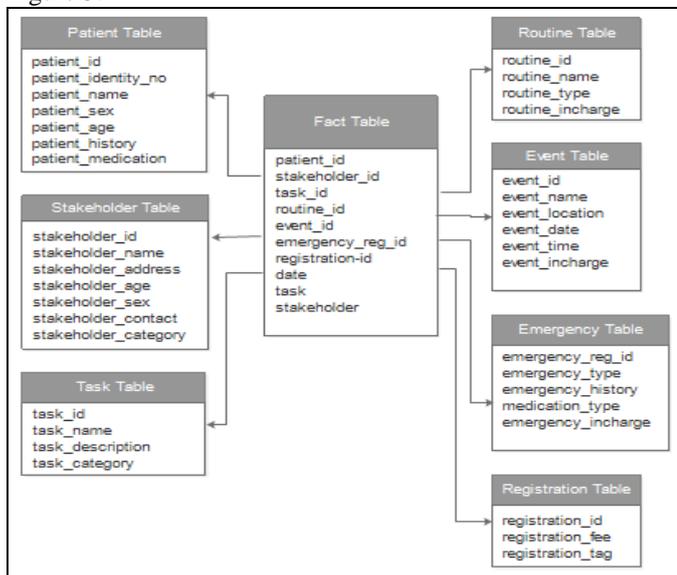


Figure 3: Star-schema for Rural Healthcare Center

## V. CONCLUSION

The main objective of the study is to design requirement model for rural healthcare center using goal-oriented approach. A qualitative approach was used to gather data for the study

and content analysis technique been used to analyzed the findings. The findings of the study are summarized as follows:

Based on pre-data collection, 10 stakeholders have been identified which is medical officer, medical assistant, chief nurse, nurse, community nurse, assistant health care, assistant pharmacy, medical laboratory technologist, administrative assistant and public healthcare.

From structured interview that have been done with stakeholders, the study have identified three categories of decision made by the stakeholder which is routine decision, event trigger decision and emergency decision. The categories of decision are extracted from task descriptions for every stakeholder. The study only focuses on three stakeholders such as medical officer, nurse and administrative assistant.

By identifying the task of each stakeholder, the study also identified the operational data sources that required for making decision. The study also extract the attributes of the operational data and all requirements are presented into star-schema. These outputs are expected to be elicited the early requirements of rural healthcare that serve as the most important stages to realize the functional for rural healthcare center.

The model presented in this paper still lacks the detailed requirements needed for rural healthcare center. For future work, extending the study to more rural healthcare centers would provide different aspect of requirements and information related to the study which then can be a representative of the requirements for all rural healthcare centers in Malaysia.

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