GOAL-ORIENTED APPROACH TO BUSINESS INTELLIGENCE REQUIREMENT ANALYSIS FOR MALAYSIAN RURAL HEALTHCARE CENTER

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ABSTRACT

Despite the advancement in the Malaysian rural healthcare centers operations, the healthcare delivery is currently facing some challenges caused by the techniques in collecting the data for analyzing their performances at the end of the day. It is posited that healthcare centers can take advantages of these data and explore analytics as a competitive tool provided by Business Intelligence (BI). However, several surveys indicate that a significant percentage of business intelligence projects fail to meet business objectives or are outright failures. One of the reasons for this is that requirement analysis is typically overlooked in real BI project. The objective of this paper is to explore a goal-oriented approach to BI requirements analysis for Malaysian Rural Healthcare Centers. The goal-oriented method proposes for the study is Goal-oriented Requirement Analysis (GRAnD). GRAnD is based on the Tropos methodology. GRAnD adopts two different perspectives for requirements analysis: organizational modeling and decision modeling. The proposed methodology is described with reference to a real case study.

Keywords: Business Intelligence; Requirement Analysis; Goal-oriented Analysis.

I INTRODUCTION

The Malaysian Ministry of Health (MOH) has done remarkably well in establishing an extensive network of rural healthcare services and delivering cost-effective healthcare to Malaysian rural communities (Kamil & Teng, 2002). Despite the advancement of operations in the rural healthcare centers, healthcare delivery is currently facing some challenges as the result of the techniques used in collecting the data for performance analysis at the end of the day. It is posited that healthcare organizations can take advantages of these data and explore analytics as a competitive tool provided by Business Intelligence (BI). Although there is no well-accepted definition of BI, most researchers defined BI as a broad category of applications, technologies and processes for gathering, storing, accessing and analyzing data to help business user make better decisions (Watson, 2009). He further explained that there are three specifics BI targets, the first target can be identified as the development of few BI applications, the second target is the creation of infrastructure that supports current and future BI needs, and the final target is organizational transformation where BI is used to fundamentally change on how organization competes in the marketplace.

However, a significant percentage of business intelligence projects fail to meet business objectives or are considered as outright failures (Pourshahid et al., 2011). The reasons for failures are often related to organization or the quality of data that can be traced back to how the project processes were conducted. One of the most common reasons for this is that requirement analysis is typically overlooked in real BI projects.

In this paper we propose a goal-oriented approach to BI requirements analysis for Malaysian Rural Healthcare Center. The paper first describes some of the issues related to Malaysian Rural Healthcare Center. Then, the GRAnD method selected for the study, which is based on the Tropos methodology which integrated two different perspectives for requirement analysis: organizational modeling and decision modeling is presented. In addition, discussion on the technique of organizational modeling and decisional modeling is presented. This is followed with discussion on how the technique resulted in conceptual design. Finally, the conclusions of this paper are presented.

II MALAYSIAN RURAL HEALTHCARE CENTER

In general, rural can be defined as regions or areas that are located outside a city including suburban and urban fringe areas, rural and remote rural areas (Racher & Annis, 2012). At present, most of the healthcare centers in Malaysia are managed by the Medical and Health Officer (MHO) who accepts

referral from the medical assistants, nurses and midwives. The MHO is also expected to oversee the work of the public health team such as food inspection, vector control, and surveillance of infectious diseases. Some of the larger centers currently are being managed by a family medicine specialist (who has postgraduate training in family medicine). Many of these facilities are now equipped with laboratory, diagnostic imaging facilities (X-ray, ultrasound) and provide a much wider range of services (e.g. geriatric programs and delivery services) (Kamil & Teng, 2002).

Malaysia has one of the best rural health services in the world, according to the International Health Organisation. The services being offered, including new technologies such as telemedicine, have helped rural folk enjoy the latest treatments. There are health clinics every five kilometres of the country and more than 95 per cent of the rural population have access to a doctor. There are 2,965 clinics and 151 mobile clinics in rural areas in the country, which is why Malaysia has won kudos for its rural health programmes from international agencies such as the International Health Organisation (Cruez et al., 2008).

According to Sarlan et al. (2012), using IT in a strategic and innovative manner to support health related decision making represent a serious challenge for healthcare organization management as well as for systems developers. Therefore, healthcare centers should be equipped with and familiar with the latest technologies in providing a good quality services to gain patients' trust. In addition, data and analytic can provide the much needed backbone to support improvements critical to achieving long term success for the healthcare centers. In the turmoil between costs, care-results and patient satisfaction the right balance is needed and can be found in BI.

III BUSINESS INTELLIGENCE

BI is coined by the Gartner group in the mid 1990s and become a popular terms in the business and IT communities.BI tools and methodologies have the following characteristics as described in Table 1 Ahmad et al., 2013).

Table 1. Characteristics of BI.

Characteristic	Description
Access to information	Flexible and allows end users to gain access to data regardless of the source of data
Support decision-making	Present the information and gives access to analysis tools that will allow the users to select and manipulate data that are important to them
Strategic advantage	Create fewer barriers to entry for new competitors to enter and possess globalization features for readily available supply chain

However, many reported that BI implementation failed to influence information process in any meaningful way (Ko & Abdullaev, 2007). As most data delivery schemes are based on dimensional models which often lead to sound technical data model, but might not fit user's decision model (Pourshahid et al., 2011). Requirement analysis is often overlooked in most BI projects. Giorgini et al. (2008) suggested a common design-related reason for failure, where requirement analysis is often overlooked, for the following reasons:

- It is difficult to anticipate future requirements for decision-making process, resulted in only few requirements that can be stated in the beginning.
- Information requirements are difficult to specify because decision processes are often flexibly structured, poorly shared in organization, and unstable over time as business processes are evolving.
- Decision making requirements often refer to information that does not exist in the required form, and must be derived from other sources by integrating, transforming, and cleaning them.

A. BI Requirements Analysis

Most methodologies claim there must be a phase dedicated to analyze the business requirements. However, there is no consensus on what relevance and priority should be assigned to it (Giorgini et al., 2008). The approaches to BI requirements analysis are usually classified in two categories:

Supply-driven or *Data-driven.* Data-driven approaches starting from analysis of data sources; user requirements impact on design by allowing the designers to select which chunks of data are relevant for decision making and by determining their structure according to the multidimensional model. While data-driven approaches simplify the design, they give user requirements a secondary role in determining the contents for analysis.

Demand-driven or *Requirement-driven.* Requirement-driven approaches start from

determining the information requirements of end users, and how to map these requirements onto the available data sources. While requirement-driven approaches bring requirements to the foreground, but it requires larger efforts when designing as it needs a more structured and comprehensive technique.

IV GOAL-ORIENTED APPROACH TO BI REQUIREMENTS ANALYSIS

The goal-oriented approach focuses on early requirements. The approach explores the real motivation behind users' requests. This in turn will significantly decrease the possibility of misunderstanding of user's requests. Some of the advantages of goal-oriented requirements (van Lamsweerde, 2001) are:

- Requirements can be derived systematically from goals.
- Goals provide rationale for requirements.
- Goal graph provides vertical traceability from high-level strategic concerns to low-level technical details
- Goal graphs provide the right abstraction level which decision makers can be involved for important decisions.
- The goal refinement structure provides a comprehensible structure for requirements document.
- Alternative goal refinements and agent assignments allow alternative system proposals to be explored.
- Goal formalization allows refinements to be proved correct and complete.

In this paper, we propose the use of a goal-oriented approach to BI requirements analysis for Malaysian Rural Healthcare Center. The approach is called GRAnD (Goal-oriented Requirement Analysis for Data), based on the Tropos methodology.

Tropos is a software development methodology that covers the whole software development process. It is based on two main ideas. First, the idea that all related goals and plans are used from early analysis down to the actual implementation of software development. Second, Tropos covers the early phases of requirements analysis, thus allowing for a deeper understanding of the environment and interactions that should occur between software and human ("Tropos methodology," n.d., para.1).

In line with Tropos, GRAnD focuses on early requirements. The analysis emphasizes the high-level objectives of the stakeholders and decision makers, and the organizational setting where it will operate rather than the functionalities of the system-to-be (Giorgini et al., 2008). The idea is to explore the real motivations behind user requests before suggesting any possible solutions.

GRAnD can be employed in (1) *Within a demand-driven framework*- In this case, conceptual design will be based on requirements or (2) *Within a mixed supply/demand-driven framework* - In this case, requirements analysis and source inspection are carried out in parallel.

Figure 1 summarizes the analysis phase in GRAnD approach.

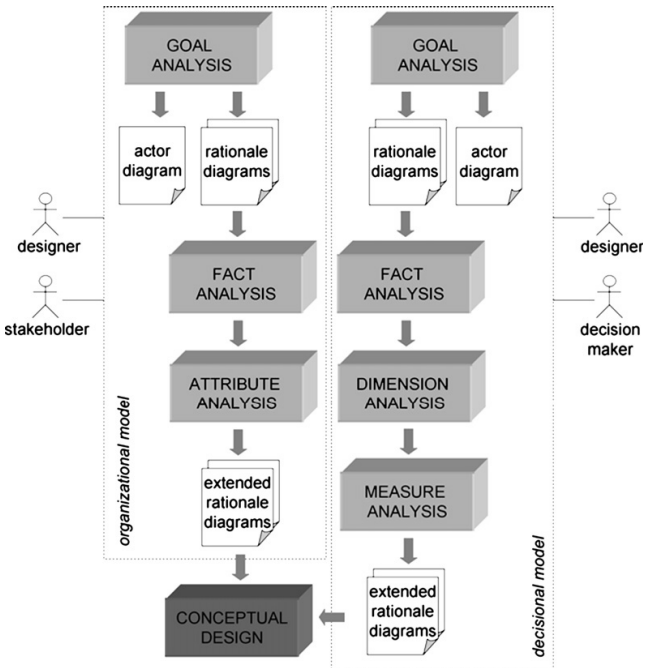

Figure 1. The GRAnD approach (Giorgini et al., 2008).

GRAnD adopts two perspectives for requirements analysis namely organizational modeling and decisional modeling.

Organizational modeling. Centered on stakeholders, it's primary role in enabling identification of facts and in supporting the supply-demand component of the approach. It is important to model and analyze the organizational setting in which the system will operate. This includes designing the actor diagram as well as the rationale diagram for each stakeholder.

Decisional modeling. Focus on decision makers, and it is directly related to the information needs of decision makers. This is to capture the functional and non-functional requirements; including

designing rational diagrams for decision makers, who are the main actors in the decision process.

V REQUIREMENTS ANALYSIS WITH GRAnD FOR MALAYSIAN RURAL HEALTHCARE CENTER

The study proposes GRAnD as the methodology for requirement analysis. When analyzing the requirement of Malaysian rural healthcare centers, the two perspectives should be taken into account. Firstly, analyst needs to model and analyze the organizational setting in which system-to-be will operate. Secondly, analyst needs to capture the functional and non-functional requirements and rationale diagrams for decision makers as the main actors in the decision process. The following section summarizes the process of the GRAnD methodology.

A. Organizational Modeling

Organizational modeling consist of three phases, namely (1) goal analysis; (2) fact analysis (where rationale diagrams are extended with facts); and (3) attribute analysis (rationale diagrams are further extended with attributes.

Goal analysis. The goal analysis will produce the actor diagrams and rationale diagrams. Goal analysis is to represent the relevant stakeholders for organization and their dependencies. This is illustrated with an actor diagram, in which actors can represent agents, roles or positions within organization (Giorgini et al., 2008).

The first step of the analysis is conducted by interviewing the stakeholders and producing documentation organized in a number of templates. Three types of table form templates are: Main actors (Actors, Objectives), Sub-actor (Sub-actor, Type, Goals), and Dependencies (Depender, Dependee, Goal).

The next step of the process is analyzing goals of each actor in more details to produce a rationale diagram for each actor. The processes end when all relevant goals of each actor have been analyzed and all dependencies among actors are established.

A table form for each actor is created for each identified goal, sub-goal, in-contribution, and out-contribution; where in-contribution is the list of goals that contribute to satisfaction of the goal and out-contribution is the list of goals that receive a contribution from the satisfaction of the goal.

Example 1: Figure 2 shows a partial actor diagram for the Rural-Healthcare Case1 case study. The *Patient* depends on the *Healthcare Center* for achieving the goal *treatment transaction* and on *Doctor* for the goal *gets medication*. *Healthcare Center* depends on the *Doctor* actor for the goal *supply services*.

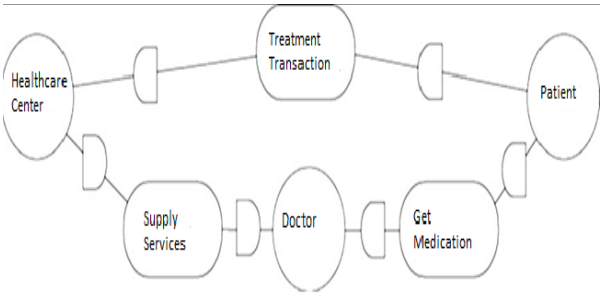

Figure 2. An actor diagram for the Healthcare Case1 case study.

Example 2: Figure 3 is a part of rationale diagram for the *Healthcare Center* actor focusing on goal *treatment transaction.* The goal *treatment transaction* is decomposed into *manage patient entry* and *manage patient check-out. Manage patient entry* is OR-decomposed into *record emergency case* and *record routine case*. Another dependency, *Healthcare Center* depends on the *Doctors* to *supply services.*

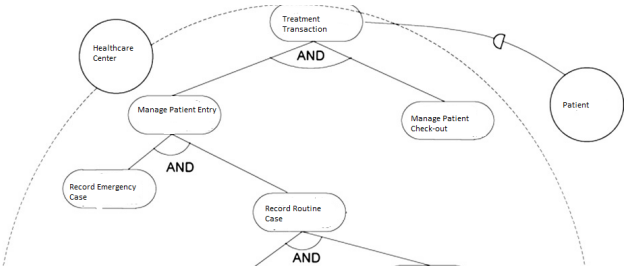

Figure 3. Rationale diagram from organizational perspective.

Fact analysis. The objective of fact analysis is to identify all relevant facts for the organization. The rationale diagrams of each actor are extended by associating goals with facts that model the set of events to be recorded when goals are achieved.

As in the previous analysis, in fact analysis, the information is collected using two table forms. First table (Fact, Description) that describes each fact; and the second table (Goal, Facts), where each goal is associated with a number of facts.

Attribute analysis. The aim of attribute analysis is to identify all the attributes that are given a value when facts are recorded. The attributes are identified without specifying their possible role as dimensions or measures as from the organizational view, attributes are simply data associated with goals. To collect information a table form (Attribute, Goal, Fact) is used.

B. Decisional Modeling

Decisional modeling focuses on the goals of decision makers. Here the main objective is to model how the system-to-be can support the decisional process of the organization.

In decisional modeling, firstly all decision makers are identified. Then, the following four steps are carried out: (1) goal analysis, (2) fact analysis, (3) dimension analysis, and (4) measure analysis.

Goal analysis. Like the organizational modeling, actor diagram is analyzed for decision maker. Actors are identified, dependencies between them are established and goals associated to each actor are then decomposed to produce rationale diagram. The same templates used for organizational modeling are used here to collect and organize information.

Fact analysis. Rationale diagrams are extended by identifying facts and associating facts to goals of decision makers. Goals of decision makers are related to the operational process, so facts associated to organization activities are important for fulfilling decision makers' goals.

Dimension analysis. Each fact is related to the dimensions that decision makers consider necessary to achieved decisional goals. Two table forms are used to collect information. The first table capture relationship between goals, facts and dimensions (Goal, Fact, Dimension), while the second table describe the dimensions (Dimension, Description).

Measure analysis. A set of measures is associated to each fact identified previously.

C. **Conceptual design.**

The organizational model produced through the requirement analysis that represent the main data on which healthcare center operation is based, hence it consist of relevant attributes that are part of database. The decisional model describes the decision maker's needs. The diagrams produced are used for conceptual design within a mixed and a demand-driven framework.

In the mixed framework, the supply-driven and demand-driven joins facilities. The requirements derived during organizational and decisional modeling are matched with the schema of the source database to generate the conceptual schema. Three phases are involved: (1) requirement mapping, where facts, dimension and measure identified are map to the source schema; (2) hierarchy construction, where basic schema is generated by navigating the source schema; and (3) refinement, where the basic conceptual schema is edited to meet the users' objective.

On the other hand, within a demand-driven framework, with no prior knowledge of source schema; the process will depend heavily on the experience and skill of designer to interact with domain experts to capture the existing dependencies between attributes.

The start point is setting the preliminary conceptual schema obtained by associating each fact from decision model with the corresponding dimensions and measures. The most difficult part is building of hierarchies. Hierarchies are determined by navigating the source schema, but in this case they are defined manually by interacting with business users.

GRAnD is also supported by a prototypical CASE tool to support analyst and designer in their activities.

VI CONCLUSION

In this paper we have proposed GRAnD as our goal-oriented approach for requirements analysis for Malaysian rural healthcare center. This approach can employ both within a demand-driven and a mixed supply/demand-driven design framework.

GRAnD approach will help us in conducting our study as rural communities offer a potential for numerous innovative applications. As GRAnD focuses on early requirements which are properly taken into account and formalized to ensure good design and at the same time resulting in data schema that are tightly rooted to operational database.

In addition, the approach also provides techniques to map high-level users' goals to design model. GRAnD proposes a methodology to directly derived conceptual schema from the results of organizational model and decisional model (Giorgini et al., 2008).

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