Lessons from a Hospital Business Intelligence Implementation

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Abstract. Organizations turn to technology as a possible solution to improve efficiency and reduce waste in their operating processes. Most of their inefficiencies and opportunities for improvement are hiding in their process level data. This experience paper describes the information needs in a hospital setting and the journey of delivering a business intelligence program that was designed to address those needs. The core focus in our business intelligence work was to deliver relevant and actionable information to the front line staff to assist them in their work. There are two story lines in this experience paper. One is about the value of information and evidence in solving business problems. The second is about the information systems methods toolbox we utilized in establishing an effective business intelligence program in an operating organization.

1 Introduction

As budgets in the not-for-profit sector are under continuous pressure, organizations and governments turn to technology as a possible solution to drive efficiencies, reduce waste in their operating processes, and ultimately lower their costs. At the same time big public sector technology projects have the tendency of high cost and poor outcomes for reasons that include the choice of architecture and implementation approach, complexity of stakeholder environment, and onerous regulatory requirements that must be followed. Methodologies such as lean six-sigma supported by information technology are sought as means to address process inefficiencies. Here we present an information-based approach to enable organizations improve efficiencies in a fiscally responsible manner.

This experience paper discusses business problems that we encountered in our practice in a Canadian hospital setting and the business intelligence program that we developed in order to support the organization's strategic goals. Application of technology alone cannot solve tough business problems. A solution to a business problem is a multidisciplinary and collaborative one. It involves understanding of goals, business processes, data sources and business domain and user workflows. The technical solution is not as simple as using a vendor product but it calls for methods and tools in organization modeling, collaboration, data integration, and human factors that are

drawn from a body of knowledge in advanced information systems engineering research of the last three decades.

Most of the inefficiencies and the opportunities for improvement in an organization are hiding in its data about its processes. Liberating these data from the esoteric systems and bringing them into a context that matches the concept model of the information consumers and enables business problem solving, is the first step towards bringing relevant and actionable information to front line business users. Another enabler is to give users a self-service service environment with advanced usability and visualization features to get the answers they need. This thinking shapes our approach to delivering a Business Intelligence (BI) program that aims to bring information to the front line staff to assist them in their work.

The rest of this paper is organized as follows: Section 2 introduces the business and clinical motivation for our work, including the economic and technological challenges, the need for information assisted problem solving and three example business problems. Section 3 defines a business modeling based framework employed by our BI implementation. Sections 4 and 5, provide information on the implementation and results, respectively. Lastly, Section 6 sunmarizes the messages and contributions of this work.

2 Problem Description

As demand for healthcare increases due to the ageing of the population, governments face financial pressures and cannot sustain annual increases in healthcare budgets. A recent report projects that by year 2030 [1] the healthcare spent in Ontario will rise from 42% to 70% of the provincial budget in order to care for its citizens, if nothing changes in the way the healthcare system operates and spends. Studies suggest that there is a 30% improvement opportunity in the system to be realized through waste reduction and process improvements [2]. Information technology is one of the enabling engines, among others such as changing health attitudes, which are called to task for driving efficiencies in healthcare delivery [3].

The information system landscape in a hospital is a maze of enterprise, departmental and personal information systems that grew organically until we realized that we have a large integration and poor interoperability problem to solve. These systems capture data related to operating and clinical processes. The best describing ‘organizational’ principle of hospital information systems is “not by design heterogeneity”. All types of heterogeneity including system, data (both syntactic and semantic), and process heterogeneity are present. To information management professionals, heterogeneity is not a bad thing but an inevitability that a technical architecture must handle. However, lack of interoperability or the way that interoperability is handled can contribute to information silos and process inefficiency.

In 2010 we initiated an effort to organize the hospital data and deliver relevant, actionable and timely information to clinicians, managers and front-line workers to help them do better whatever they do, that is to deliver better patient care, or improve the performance of the business processes they are responsible for. The foundations of

our information strategy are to organize the hospital data around its business processes, and integrate data across different information silos and systems. The aims of the strategy are to deliver a business intelligence platform that feeds the front-lines with actionable and relevant business intelligence related to process and system performance, assemble a knowledge base of the business processes and associated documents that capture the working memory of the organization, and provide a suite of applications that facilitate the collection and use of clinical data in patient care which further generates the evidence to improve clinical practice performance. Additional goals of the strategy include easy access for users, and low maintenance and development costs which led to a design decision to communicating information to users through the browser thus eliminating access and deployment barriers.

The information needs in a hospital differ by stakeholder group. Senior management needs access to clinical and financial performance and planning information such as patient volumes, patient wait times, rate of nosocomial infections etc., in order to create and monitor implementation of the overall strategy and management initiatives. Front-line staff and managers need access to process level data and performance such as number of patients waiting for bed, turnaround time of laboratory orders etc., in order to make resource allocation decisions. Clinicians require up to date, patient specific information as well as analytical data related to quality of care such as relationships between certain treatments and patient outcomes. Not all information needs of the various groups can be answered by a query against a single source, and most often the data that we collect are at different level of abstraction than the information requested by the business users.

These requirements relate to many aspects of information system engineering including business modeling, requirements engineering, data semantics, data integration, data quality, business process management and software engineering. The work described here draws from the body of knowledge in those fields in order to create a principled and repeatable framework to bring information to the front lines. Our contributions include a system engineering framework, a reference business model of a hospital and a business modeling notation that links people, processes and data, called AGIO [6].

The following example business problems are used to illustrate our business requirements, motivate our technical decisions, and assist the creation of an abstract framework for a hospital business intelligence platform. They are variations of the same pattern. It involves an actor who has a business objective or an information need. The achievement of the objective depends on a process or resource and it is monitored by evidence in the form of metrics (also referred to as indicators). The calculation of a metric requires data from operational systems that are retrieved by a business query. A business query is data request expressed in terms that are familiar to a business user.

Corporate scorecard. The corporate scorecard is the tool used by hospital management to track execution of the hospital's strategy, annual operating and quality improvement plan, and the hospital accountability to its funder. The Rouge Valley

Health System (RVHS) strategic plan, quality improvement plan and scorecard are available through the its website (www.rougevalley.ca)

The RVHS corporate scorecard has four perspectives (access to care, service excellence, fiscal responsibility, team engagement) and 20 indicators. The data for these indicators come for a variety of sources. Many indicators are rollups of indicators at the department and division level. The users of the corporate scorecard monitor the indicators on a monthly basis in order to detect potential issues that need to be mitigated.

Patient flow. Patient flow is defined as the set of hospital processes that move the patient through the system while receiving care. The typical patient journey in a hospital starts with the arrival of the patient at the emergency department or for a scheduled surgical appointment. While the majority of patients arriving to the emergency department are discharged to home, some with an acute illness are admitted for treatment often followed by some post-acute rehabilitation and when their care is completed discharged to home or long-term care facilities. The goal of the hospital is to provide good medical care in an efficient manner, which means to minimize the length of stay (LOS), which is good both for the patient and the system, as the bed occupied by this patient can be used sooner for the next patient who needs it.

The hospital patient flow problem can be abstracted as a chain of supply-demand relationships between departments depending on bed capacity and turnover. There is a lot of waiting happens between and within the stages of care which impact LOS and slows down flow. In order to create flow, we have to minimize the various type of wasteful wait. The information systems solution to patient flow is to provide the right information to the various actors across the value chain, i.e., create process visibility through data.

Hospital reports delivery. Healthcare delivery is a distributed process. A patient receives primary care by a family doctors in a community setting, acute care in hospitals and sees many specialists in a hospital or in the community. For the most part, the various actors communicate with written notes. One of the hospital processes to facilitate continuity of care is to send hospital reports (such as discharge notes, and test results) to the community-based providers after each patient encounter. One of our hospital's strategic objectives is to improve hospital access to family doctors, which among other things translates to delivering to them hospital reports of their patients within set time targets. Operationalization of this strategy involves two information systems that support parts of the reports delivery process, and the need for a system to monitor process performance. A performance metric based on this process is also present in the corporate scorecard.

3 Framework

In the previous section we presented three business situations that require access to data at a level that meets management needs. All three situations describe a need in the language and context of the business. We call this the business level. Integral in the descriptions of the three business situations above, are the concepts of actors and processes. Less explicit in these situations is the technology and data world that are required to respond to the business problems. We introduce the term *business query* to refer to, and represent a data need, at the business level. Business queries are stated at a level where there is no or limited knowledge of the ability of an organization to answer them. Here we present a structured process for bridging the business level with the process level and the data level. In order for these worlds to interoperate effectively, it is important to establish a framework that defines a set of common concepts and uses a series of linked models expressed in existing conceptual modeling notations to bridge business, process and data levels. These models form the building blocks of our BI platform and they are used as scaffolds for problem specific applications that are realized through the platform.

Figure 1 outlines the framework and describes the modeling methods leveraged by it. The key mechanism that 'links' the three levels is the AGIO mechanism that constitutes one of contributions of our work. A technology stack assembled in the portal complements the conceptual framework. The portal is the actual environment that delivers the BI platform and it is discussed in Section 4.

Business Level: The key concepts encountered at this level include strategies, actions, risks and indicators.

There is a plethora of strategy modeling notations coming both from business management and conceptual modeling fields [4],[5]. We found social modeling using goal models [12] to be an effective model to express a decomposition of a high level strategic objective to actionable ones. For example one of our IT strategy objectives is to "bring relevant, actionable and timely information to front-line staff" which is decomposed to "create a business intelligence program", "develop expertise in hospital data", and "create a strategy to enterprise data integration". These strategies are further decomposed until they become actionable. An actionable strategy is assigned to an Actor who has a specific objective, an indicator to measure achievement of the objective, and finally a resource (process or data) where we source the data for calculating the indicator. The mechanism that does the linking is the AGIO diagram [6].

At the business level, it is essential to maintain a map of business actors, also known as stakeholders. We found that two types of actor maps that work well in practice are organization (org) charts and stakeholder lists. Org charts show the flow of accountability. A stakeholder list captures the objectives and responsibilities (processes and metrics) for each stakeholder group. A stakeholder list is a reusable resource that is customized and included in project documents.

There is a robust literature on the use of indicators, also called metrics, to measure the success of a goal or the performance of a process [7]. We adopted and adapted the conceptual framework for indicators from [8]. The two main adaptations are the con-

cept of the indicator map, a graphical representation of a collection of indicators and indicator relationships, and a standardized indicator metadata specification, called AGIO sheet, that is used to specify the presentation of indicators in business intelligence dashboards, including the formula or the query that calculates the indicator. Choosing and designing indicators is delicate task. Outcome indicators are either given to us, for instance hospitals have to report on several healthcare outcome indicators mandated by public authorities, or created relative to goals they measure. Process based indicators are discussed in the next section.

Risks are powerful drivers at the business level. A risk is a statement that describes the possibility of an unwanted future event to happen. The modeling construct that we routinely use is that of risk catalog, where next to each risk we record a series of mitigating actions that will prevent the unwanted event to happen. Mitigations are actionable strategies similar to those discussed above in strategy models. For example, one risk documented in our IT strategies risk catalog is the "information risk" which is decomposed to "front-line staff does not have information to make patient flow decisions" and "patient information is separated from the patient at care transition points". The mitigation to the first is to "develop a patient flow specific business intelligence application".

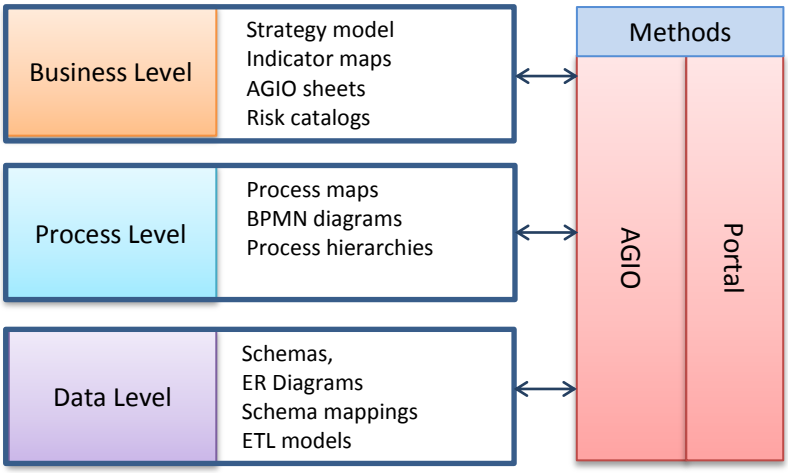

Fig. 1. Business Intelligence Framework Overview

In summary, the business level captures business requirements. Technically it drives the creation of a series of linked models following conceptual modeling paradigms and notations originating from computer science and enterprise modeling. Several adaptations, mostly simplifications, were made to those models in order to increase their usability by less technical business stakeholder. The collection of concepts and models employed, forms a business level ontology with strong similarities to the Business Intelligence Model (BIM) proposed in [9].

Process Level. This level documents a collection of operational processes organized in a specialization hierarchy. The key concepts encountered at this level are process, sub-process, activity, role, IT system and document.

We document business process knowledge using the de-facto modeling notation for business process modeling, BPMN (www.bpmn.org). In addition we link processes to data systems, documents, roles and physical environment, thus creating a spider web of knowledge. Given that most of the interdisciplinary collaboration within an organization is done at the process level, it is of paramount importance that there is a common understanding and a single source of truth around processes, and processes are communicated using an intuitive graphical representations. The added value is also the ability to reason and decide on meaningful process level indicators that are used to measure process performance.

Processes are operationalized by one or more information systems that facilitate execution and collection of process data, but it is also common that many processes are manually executed and process data are collected manually. The documentation of the link between processes and data is critical to business problem solving.

Actor	Emergency Dept. Manager
Goal	Reduce the % of patients leaving without being seen
Indicator	% patients left without being seen
Object	Physician initial assessment process

AGIO instantiation

Fig. 2. AGIO Diagram

Data Level. This level refers to the data assets in an organization from databases, datasets, data collections, processed data, excel files, personal data etc. The problem and challenges of data heterogeneity at the physical, syntactic and semantic level in organizations is well documented [13]. The toughest of all problems is the multiple definition and names for every concept that are used by the different stakeholder groups. A common solution to this problem is the creation of an enterprise data warehouse that harmonizes the semantics of the same concept from multiple systems and sources, and keeps up-to-date instance data for those concepts that we can programmatically harvest in it.

The supporting metadata of the data warehouse include schemas, ER diagrams, schema mappings, ETL scripts, data cleansing and data quality scripts and sample data. This knowledge may often be buried inside data management platform, sometimes even inside proprietary platforms, but here we make the point that it needs to be

documented, organized and versioned in the source code control system of the organization, and under proper data governance practices.

AGIO. The rationale for AGIO is to facilitate the linking of different perspectives as mentioned earlier (see Fig 2). The second use case for AGIO is to facilitate the design and documentation of indicators, the concept that we earlier referenced as AGIO sheet. An AGIO diagram represents graphically the link of a goal that an actor has to the object (process or resource) that the actor uses to achieve this goal, and to the metric that the actor evaluates in order to assess progress or achievement of the goal. Ultimately, an AGIO tells the story of the actor who wishes to achieve a goal, the way it goes about achieving it, and the way to know if it is achieved. A corporate strategy, or one's endeavors towards a goal can be broken down, as demonstrated in the evaluation section, in linked network of AGIO diagrams. These diagrams communicate how to establish relevant business requirements and monitoring tools.

AGIO is a design time concept that we use to link goal, processes and data. The operational concept that links business process management with business intelligence is the Define-Measure-Access-Improve-Control (DMAIC) cycle. DMAIC is widely used in the process improvement and lean six sigma practices [10]. The core premise is that a process improvement is informed by measurement of process performance in a continuous cycle. The Define and Improve steps that map to the Process Level, Measure, Access and Control are responsibilities of the Data Level. DMAIC is an embedded method in our framework. The integration of the modeling tools with business intelligence reporting enabled the rapid execution of DMAIC cycles and an engine to support lean improvements.

4 Implementation

An enterprise BI implementation aims to deliver a storefront for generic and problem specific data access that is backed by a data warehouse, and series of data marts. In [6] we discuss the methodology of a business model driven data warehouse design. In addition to business relevance a data warehouse must be trusted from a content perspective. We have performed significant amount of data quality work in the back-end in order to assure the quality of the data in the warehouse. Here we will mostly talk about the front-end that is the component our front-line users experience.

The portal is a web application that acts as the canvas to publish the various functionalities of the BI platform. The portal contains a shared by all applications user authentication module and role based access control such that only authorized to certain content users receive access to it. The front page is divided in four sections each supporting a different need. These include an application hosting area, the corporate BI front page, access to the document world and intranet resources, and an area for patient care specific content. The idea is to offer to our front-line staff a one stop shop for all the information needs.

The core BI application involves a series of dashboards, where a dashboard is a page with information specific to a situation including indicators and aggregated di-

mensional data that a business user is able to navigate through in order to solve a problem, or receive process specific statistics. A common type of dashboard that our users are interested in is a scorecard. Scorecards are a type of dashboards good for a big picture view of a business situation. Real time views are best suited for front-line staff. Next section describes a few sample dashboards of our implementation.

Dashboards are based on 'canned' business queries and target/support specific business situations. Regardless on how well one can anticipate the user information needs, there are always situations where ad-hoc information is needed that are not delivered by a dashboard. For this reason our platform provides an ad-hoc query tool. Dashboard themes also tend to be reused. For this reason we created a set a configurable dashboard objects that are easily deployable (in matter of hours) and configured based on metadata extracted from business queries while consuming data results of the corresponding data queries.

It is important to mention that the technology stack that is behind our BI platform is primarily based on open source components and libraries, and as the result is low cost from a license perspective.

5 Evaluation

In Section 2 we described three business situations describing business information needs that can be formulated as business queries. In this section we show how these business queries are handled in the BI framework and implementation described in Sections 3 and 4, respectively. We also share the lessons learned from our experience of creating a BI program in an operating organization.

Indicator Definition		Competency Question
ID	SE-5	
Name	Hospital Standardized Mortality Ratio (HSMR)	What is the indicator name?
Description	The ratio of the actual number of acute in-hospital deaths to the expected in-hospital deaths for conditions accounting for 80% of inpatient mortality	Can you provide a high level description of the indicator?
Type	Negative	Do you want to reduce, increase, or balance the value of the indicator?
Scorecards	Corporate	Does the indicator belong to some report?
Organizational Context		**Competency Question**
Goal	Reduce in-hospital mortality	Which is that goal you try to achieve monitored by the indicator?
Accountable	Chief of Staff	Who is the responsible of such a goal?
Measured Object	Patient outcomes	Which is the operating process or resource for which the indicator is measuring the performance of?

Fig. 3. Indicator Representation using an AGIO sheet

Fig. 4. (a) Corporate Scorecard View, (b) Zoom-in to indicator level

5.1 Business Situations

Corporate Scorecard. Given that the indicators in the corporate scorecard are predetermined the construction of a strategy model was not necessary. Each indicator was described using an AGIO sheet as shown in Fig. 3 (partial view). AGIO sheets are translated to indicator pages in the implementation in a straight forward, but yet manual fashion. Given the high level nature of the corporate level indicators the process level was skipped. The values were pre-calculated and loaded to a generic scorecard data schema. The dashboard implementation is based on a generic, reusable template that groups indicators under the four corporate priority areas (access to care, service excellence, team engagement, and fiscal responsibility) with the ability to zoom in/out to data details and comment history (Figs 4a-4b). This dashboard has public visibility and enables every member of the staff and governors to be up-to-date about the hospital's operating performance.

Patient Flow. At the highest level patient flow is a process that is linked to the goal of improving access to hospital services for patients which is measured by the length of stay (LOS). This goal is divided into two sub-goals one for the emergency department and one for the impatient stay based in knowledge of the process structure. The goal analysis can continue and a strategy and indicators map is constructed (details on construction of strategy and indicator maps are described in [6]). The process maps in Figs. 6a-6b illustrate process details still at a high level. These processes are further refined (not show here) to sub-process and tasks performed by stakeholders. This process knowledge informs us on 'what' to measure. The strategy map defines 'why'. A further elaboration of each process level indicator using AGIO indicator sheets elicits the 'how'. The complete bundle of the models that we create defines the BI application design document. The use of the structured, model based methodology to BI design ensures that the end product is relevant and meaningful for a business perspective; the indicators are actionable as they are connected to goals and strategies, and we end up measuring things that matter based on actual process knowledge.

One of the first patient flow dashboards that was created, called ED Now, intended to give a bird's eye of the ED process in the two RVHS hospital sites, showing arrivals and departures on hourly basis, compared to traffic of same day of the week over the last twelve periods, in order to detect high/low activity (Fig. 6). The dashboard was modeled after the process in Fig.5b, and it also shows the number of patient waiting at the various steps of the process in order to create awareness to front line about approaching bottlenecks and signal need for action.

Hospital Reports Delivery. This example explains how business queries are derived starting from a strategy. We defined business query as a request for information to solve a business problem expressed in business terminology. The high level strategy is to 'improve access to hospital for community physicians' which is broken down to sub-strategies that are documented in a goal model. In practice we use a mind map program (www.xmind.net) the represent goal decomposition and refinement. The stepwise decomposition continues until the response strategy is actionable. For exam-

ple the second level strategy is ‘reduce time of discharge summary to physicians’, and a next level one is ‘reduce transmission errors’ which followed by ‘maintain accurate physician dictionary’ that is an actionable strategy. An AGIO is used to link the parts: Actor: Informatics, Goal: ‘achieve 100% accurate physician data’, Indicator:’# dictionary corrections per month’, Object: Providers dictionary.

Another goal is to deliver hospital reports within a set time target from the time of discharge. The business questions are ‘am I meeting my target’ or ‘are there any issues that might prevent me from meeting my target’. An indicator that calculates the 90th percentile of the time from patient discharge to report delivery answers the first query. This indicator is published in several dashboards. The second query starts with an analysis of the process to find process control metrics that can be predictors of success, in this case the length of the report transcription work queue. This leads to data query. These data queries are made available through the portal as custom reports, and they are created after an analysis like the one described here.

5.2 Summary and Lessons Learned

We described an approach to solve business problems using information that involves business modeling and it is incorporated in, and empowered by a business intelligence platform. The platform is implemented and it is in use in a real organization, producing results. The framework used in the creation of the platform is generalizable. The core principle in the framework is to deliver a relevant and actionable BI, and it achieves that through the collection and documentation of a range of useful metadata that explain the business situation, the responding strategies, control indicators and linkages to data. Users of the BI implementation have commented the ease by which they can understand process performance at a glance.

We learned many lessons in the course of our BI journey, and not all of them were related to technology. In fact the most fascinating observation is how the BI platform affected change in the organization, altered attitudes towards use of information, and fundamentally transformed our BI team from system developers to data problem solvers [11].

Our end-users are used to expect regular data reports and process surveillance data in order to contact their business. We measure the users dependency on data by the helpdesk calls that we receive anytime there is a system glitch or data delay. We also notice that users take actions and make strategic and operational decisions based on the data evidence they receive. This is reflected in the performance metrics of the processes that are managed with the help of the BI tools we provide. Effectively, BI has become the engine that drives continuous improvement and business performance. We believe that there are several reasons why this is happening. First is the business relevance of our BI platform because it is derived through an extensive business, organization and process modeling. Second is data immediacy, as process level data are communicated to end-user promptly to enable the cycle of assessing and responding. When we first provided visibility of processes through data, the initial reaction was to verify if the data were correct, or reflected real phenomena.

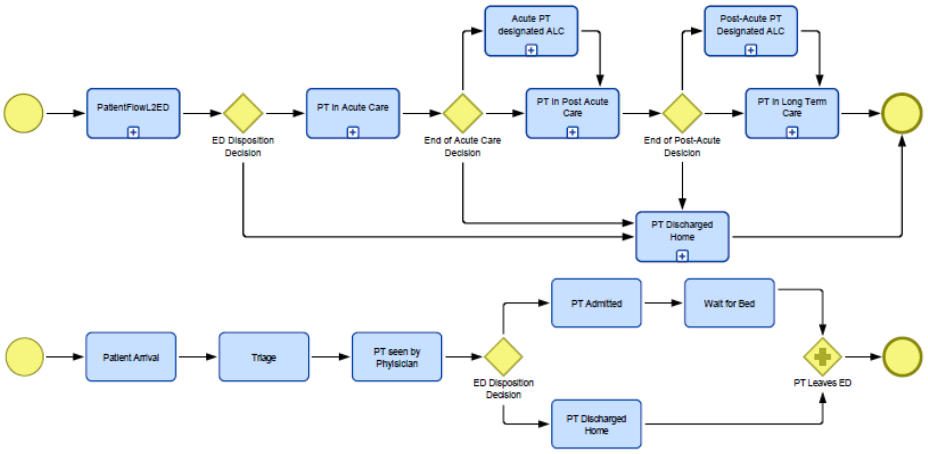

Fig. 5. (a) High level patient flow process, (b) ED flow process

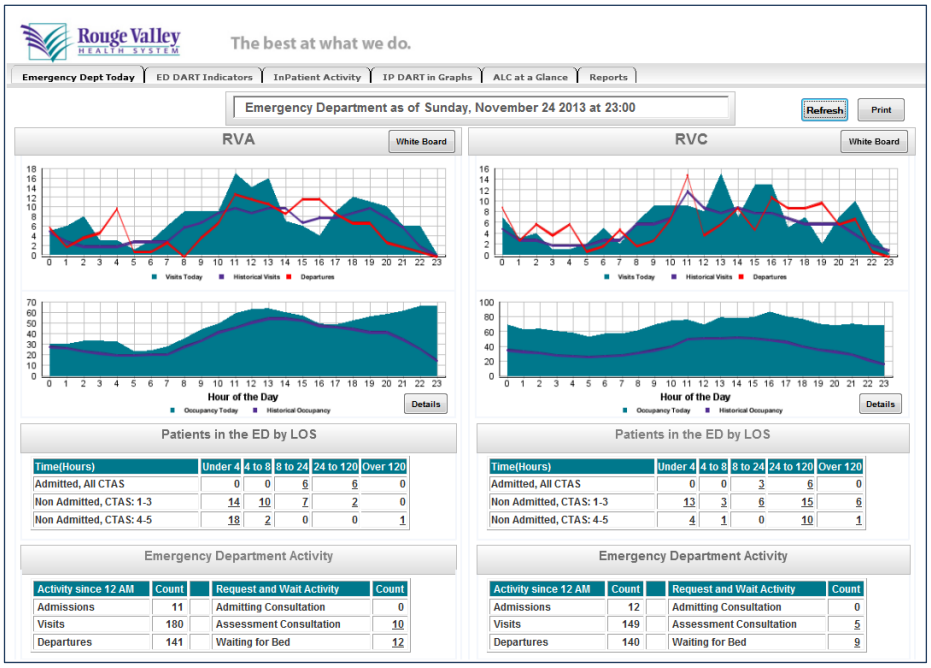

Fig. 6. ED Now Patient Flow Dashboard

This sparked both investigations on data quality and data semantics. For example, multiple names for the same entity or multiple definitions of similar concept such as a clinic visit had to be reconciled and accurate reference models were created. The benefit of such improvements goes beyond having better data. It contributes to better

communications. Moreover, our end-users ask for additional data evidence and expansion of the BI system to cover more processes and data domains.

As system developers we often focus on the delivery of a solution that meets the requirements, but we are not necessarily responsible in realizing business value and move performance indicators through the operation of the system. In this project this was not the case, mainly because the BI project was a partnership of corporate, clinical and technology departments with a clear objective to address business problems such as the patient flow problem. Also the quest to assess and validate the quality of data became a joint accountability as business and technology experts had help each other. The result was a shift in mentality and focus of our technical team, from tool smiths to problem solvers within the organization.

On the technical level, we had to remove a few barriers too. One is the absence of a good development lifecycle model for a BI project. BI is not software development where we enjoy an abundance of methods and tools to support the development process. We desired to have a similar way to design and implement BI solutions by creating models. As such, we adopted the approach from strategic business modeling [8] and extended it with the development framework that was presented in Section 3, and [6]. The end result is a principled approach to design BI solutions as was demonstrated with the running examples in this paper. Another dilemma was the buy vs. build decision. After weighing the pros and cons we end up creating a technology stack to allow us to follow the above described conceptual modeling driven framework. Our technology stack combines standard commercial data management technologies, e.g., DMBS, dimensional modeling and integration services, with open source components and libraries for dashboard development and data visualization, and as the result is low cost from a license perspective. Cost was not the only deciding factor. After the framework abstractions were developed, it was easier and faster to implement those using basic principles and components than mapping them to a different framework model of a COTS BI system. Another deciding factor was access to expertise. COTS BI platforms are proprietary systems that require specialized expertise which is challenging to acquire and in the long term restrictive of being able to grow our BI system capabilities.

6 Conclusions

There are two story lines in this experience paper. One is about the value of information in solving business problems. The second is about the information systems methods and tools that were assembled in a framework that led to the creation of a business intelligence platform that delivers information to the front line staff and management.

Having data and process visibility benefits an organization to improve its operating efficiency. During the development of our BI program we have seen an increased awareness in information quality and use of evidence in decision making. One of the several lessons that we learned in our BI journey is that through business modeling the information technology team converted from implementers to business problem solvers. A big enabler of delivering useful information was to fit data into a concept

model that matches that of the information consumer using methods form business modeling, data semantics, data integration and data quality.

The creation of the hospital BI program was a result of a partnership with other disciplines such as finance, decision support, and clinical operations, and it was a tremendously educational experience to all.

The lessons from the BI journey presented in this paper are drawn from a specific experience in healthcare but in our opinion they are broadly applicable to organizations that rely on evidence based decision making in resource constrained environments.

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