INTENTIONAL MODELING FOR ENTERPRISE ARCHITECTURE

- MANAGING KNOWLEDGE ABOUT "WHY" TO SUPPORT CHANGE

by

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Intentional Modeling for Enterprise Architecture - Managing Knowledge about "Why" to Support Change

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Abstract

Enterprises often use Enterprise Architecture (EA) as a blueprint to deal with change. Most modeling techniques used in EA are intended for representing the knowledge about data and processes. However, understanding the *motivation* can be just as important for successful change. Intentional Modeling (IM) can be used to represent the knowledge about "why". This thesis demonstrates a framework showing one way to incorporate IM into EA. Two IM examples, the Business Motivation Model and the i* framework are utilized in this framework to test the feasibility of the incorporation and to assess the potential benefits that IM could bring to EA. Interviews with experts showed that IM can help enterprises make sense of the motivation for change and make informed decisions to deal with change. A health claims payments case was used as a domain example.

Acknowledgement

I would like to take this opportunity to thank Professor Eric Yu for his guidance throughout the entire project. He spent extensive time helping me define the research topic, figuring out ways to solve problems arising from the research, reviewing the thesis, and making recommendations. His enduring effort and support have enabled me to complete my thesis successfully.

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I thank all the participants who agreed to participate in the research by providing me with useful documents and taking the time from their busy schedule to allow me to interview them. Without their assistance, I would not have been able to gain insights into EA practice in order to make sure the thesis is applicable to the real world and would not have been able to evaluate the research from practitioners' perspective.

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1. Introduction

1.1 Background

As large companies involve complex business and information technology structures and processes, they experience difficulties in coordinating disparate groups to function together towards their business goals in a dynamic environment. The information age enterprises can neither accommodate complexity nor high rates of change without a blueprint like Enterprise Architecture (EA) (Zachman, 1999a). In Canada, different levels of governments use EA to provide architectural reviews of key projects and to coordinate the identification of new and common components and services within the Government (Chief Information Officer Unit, Treasury Board of Canada Secretariat, 2005). In the U.S., developing EA is mandatory for CIOs in the federal government as regulated by law, such as the Clinger-Cohen Act of 1996. There are conferences and professional communities devoted to EA, such as The National Association of State Chief Information Officers (NASCIO). EA, analogous to traditional architecture in building construction, is a holistic body of knowledge of the components of an enterprise and their relationships. However, just as constructing architecture for a building is not straightforward, constructing EA is not always easy. What makes the process even more challenging is using EA to cope with organizational change.

Suppose a house owner contracts an architect to renovate a house. The architect may need to layout the structure of the house showing how its electrical system, heating ventilation & air conditioning (HVAC) system, and other systems work together. The architect also needs a blueprint of how the house owner wants the house to be. The architect

can compare the two pictures and decide how to reconstruct the house so that desired results can be achieved. As the needs of the house owner are often communicated informally, house renovation projects could fail due to lack of common understanding of the owner's motivation for the makeover. Similarly, to use EA to deal with organizational change, an enterprise needs both as-is and to-be (target) pictures of the organization to depict accurately or map how it operates, to enable the discovery of business improvements opportunities, and to support the planning and implementation of change initiatives that deliver transformational results. Without understanding the motivation for business and change, change projects could fail or not meet the desired expectations.

To see how EA could be used to reach common understanding of the motivation, it is important to understand how EA is constructed. An Enterprise Architecture Framework (EAF) is a conceptual tool to guide systematic development of EA in terms of building blocks and how the blocks fit together (The Open Group, 2002). Examples include Zachman's framework (Zachman, 1987&1992), Institute of Enterprise Architecture Developments' Extended Architecture Framework (E2AF) (Schekkerman, 2005a), US Department of Treasury's Enterpriser Architecture Framework (TEAF) (Popkin Software, 2004), and U.S. federal government's Federal Enterprise Architecture Framework (FEAF) (The U.S. Chief Information Officer Council [CIOO], 1999). Some of the EAFs give procedural instructions of how EA could be built to implement change, such as The Open Group Architecture Framework (The Open Group, 2002) and Buchanan and Soley's (2002) proposal on the alignment of EA with business goals. However, the artifacts and methodologies defined in these frameworks tend to focus on knowledge about "what" an organization has and what the organization wants in the future as opposed to knowledge

about “why” to change and “why” to change in a certain way.

This thesis aims to provide additional EA tools and methodologies for enterprises to reveal answers to the above questions around *motivation* and focuses on a specific area not so well covered till now: incorporating Intentional Modeling (IM) into EA. Different from traditional modelling techniques, IM focuses on motivation, reasons and choices (Yu, 1994) and can be adopted by enterprise architects to manage the “why” knowledge.

1.2 Research Problems, Questions, and Objectives

One crucial step in utilizing EA to cope with change is the construction of target architecture. With target architecture an enterprise could analyze the gaps between the as-is and the to-be architecture and take actions to achieve new business goals (see Figure 1). Even though there are considerable work on the target architecture construction process (The Open Group 2002; Buchanan & Soley, 2004), the explicit presentation of motivation for business and change is not well examined. Most of the knowledge about motivation is either scattered over organizational documents or undocumented. Thus, when the enterprise tries to make judgement on the environment and business and tries to make justification for its decisions, it depends on domain experts’ expertise. When the experts leave, the knowledge is lost. Moreover, as a result of inadequate representation of motivation, EA offers weak traceability between business processes (“how”) and business goals (“why”). This leads the enterprise to focus on what it needs to do rather than why it does business this way and how the business processes would impact the achievement of its goals. The lack of a systematic way to reveal motivation knowledge and traceability between “how” and “why” knowledge sets obstacles for the enterprise using EA to make change. As in the house renovation

analogy, without understanding why the house owner wants the makeover and without linking changes to needs, the project could probably fail.

In current EA practice, as motivation is used in an ad hoc way, enterprises often do not have a clear idea on what kinds of "motivation" knowledge are needed, and architects are often not clear about what motivation knowledge they need to include in EA. This may result in leaving some important questions on motivation unanswered. Even though the EA community has realized the importance of Knowledge Management (KM) to EA, most of the work is done to manage the end products of the development process, i.e., manage EA artifacts in some repositories. Little work has been done to apply KM concepts to the construction process itself to clarify what motivation knowledge enterprises need to construct in their target architecture. According to Choo's Knowing Cycle (1998) concept, to adapt itself to a changing environment, an enterprise needs to make sense of the environment and the business, to create the knowledge needed for the change, and to make a decision on how the change is to proceed. The three steps should be implemented in an integral way, and for each step, there is a set of knowledge necessary for successful change. The knowing cycle provides a structure for knowledge needed for dealing with change, but its application to EA has not been studied.

The motivation knowledge could include how the enterprise does business, why it is doing this way, who would trigger change, why there is the need for change, where to make change, how interrelated stakeholders could be affected by the change, what kinds of alternative courses of action exist, which one would be the best choice, and why choose one over the other. If EAFs cannot help architects build such EA that could reveal the knowledge, enterprises may question about stakeholders' goals, motivation behind business, and how to

use the motivation to construct to-be architecture. As a result of that, it will be hard for enterprises to propose an informed strategy to cope with change.

EA relies on models to represent knowledge about different perspectives of an organization. Models offer different levels of abstraction, and they could facilitate communications among business and technology personnel. However, current EAFs consist primarily of models that describe information entities and flows. The only limited knowledge about motivation is represented in some simple forms like tables and lists. They are not sufficient to answer the above questions. As discussed before, IM could help reveal and manage the "why" knowledge to support change, but little work has been done to demonstrate its application to EA/EAFs.

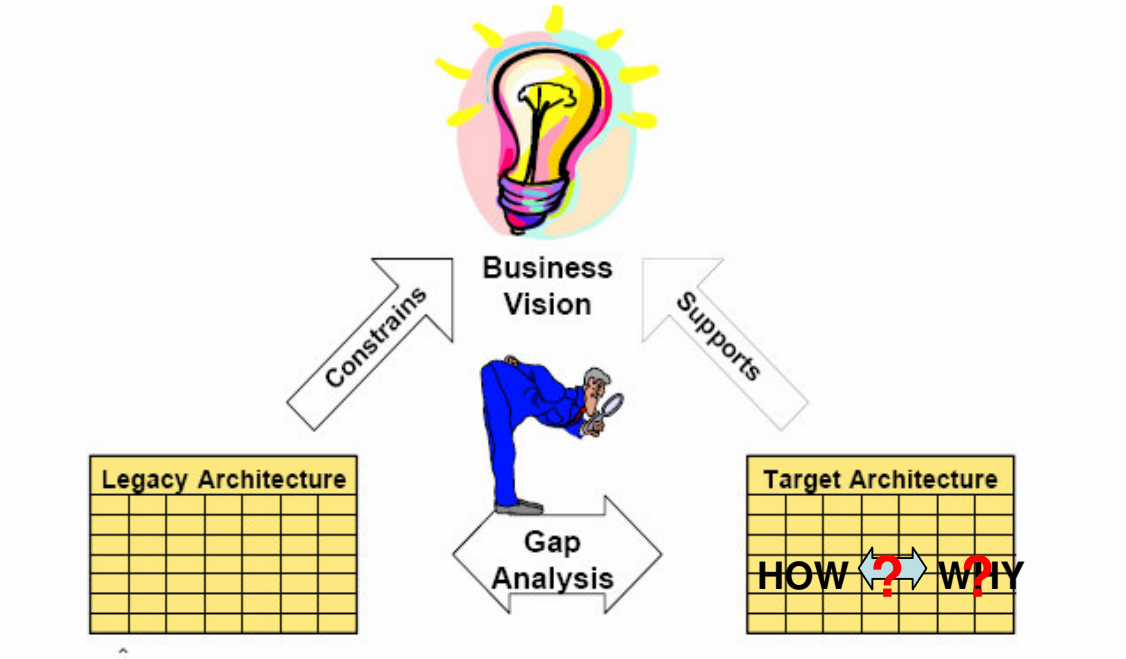


Figure 1: The problems of constructing target architecture

Based on the problems and potential solutions, this research is aiming to find answers to the following research questions:

- How could KM concepts help identify what kinds of "why" knowledge are needed for

change?

- How could IM be applied to EAFs so that the resulting EA could explicitly reveal the "why" knowledge for change, provide traceability among "why" and "how" knowledge, and help an enterprise better deal with change?

  Specifically,

  - How could intentional models help **depict how an organization works**?
  - How could the models help **discover the motivation** for change and opportunities for business improvements?
  - How could the models **support identification, selection, and implementation of change initiatives** that fulfill an enterprise's needs?

The purpose of this study is to build a methodological framework that demonstrates one way to incorporate IM into EAFs. The intention of the framework is to test the feasibility of the incorporation as well as to assess the potential benefits of the incorporation in terms of helping enterprises better utilize "why" knowledge, reveal traceability between "how" and "why", and deal with change. The framework is not meant for practical adoption as such, but rather a demonstration of how intentional models could be used in EA context and what kinds of benefits they could bring to enterprises. Further work will be needed for adoption for practical settings.

To assess the ability of IM in terms of managing the "why" knowledge, it is necessary to know what kinds of "why" knowledge are needed for dealing with change. Thus, the framework first uses KM concepts to provide a knowledge structure for the three components necessary for an enterprise to deal with change – sense making, knowledge creation, and decision making. The framework then demonstrates how IM could fulfil the

knowledge needs. Based on existing modelling frameworks, the framework combines two types of intentional models, the Business Motivation Model (BMM) and the i* framework, and a set of analysis techniques associated with the models.

According to The Business Rules Group (BRG), "if an enterprise prescribes a certain approach for its business activity, it ought to be able to say *why*" (BRG, 2005, p.14). The BMM approach is meant to achieve the goal of modeling business motivation. It identifies factors that motivate the establishment of the elements of business and indicates how all these factors and elements inter-relate. The BRG claims that the BMM is designed for the motivation component of EA at a business level. However, the group has not yet illustrated how to integrate the model into EA. Thus, it is natural to choose the BMM as part of the study and to explore what kinds of benefits it can bring to EA.

Moreover, change involves multiple players and their intentions. Agent-based intentional modelling could be used to enable rich description and analysis of strategic relationships among stakeholders and strategic rationales behind their dependencies. Thus, the second type of modelling for this study is the i* framework (Yu, 1995), an agent-oriented intentional modelling framework, which will be used to strengthen the representation and analysis of the "why" knowledge. Originating from information systems requirements engineering, i* has been used to analyze goals of different stakeholders (agents) in fields very close to EA, including system architecture, security, knowledge management, and change management. Thus, it should be valuable to investigate i*'s application to EA. The proposed framework will demonstrate how i* could help enterprises better understand triggers for change, identify alternatives, reveal the alternatives' implications and consequences through a systematic approach, and eventually come up with an appropriate

solution to deal with change.

The proposed framework is tested through a health claims payments program typically seen in a government health system. Improving claims payments services is a challenging task, as there are multiple players, such as patients, doctors, policy developers, and governments. Each of them has increasing needs over limited resources. Moreover, there are increasing needs for managing the health encounter data gathered through claims in a cost-effective and accurate way. The research will show how the proposed framework could help solve these problems.

1.5 Importance of the Study

The goal of this thesis is to advance the study of EA. This is achieved by contributions from three perspectives:

- For architects: This research clarifies the "why" knowledge they should represent in EA to facilitate enterprises to deal with change. The research introduces architects with the concepts of intentional modeling and a framework showing one way to incorporate IM into the EA construction process. It shows how to use intentional models, especially the BMM and the i* and associated analysis to represent the "why" knowledge and to provide the traceability between "why" and "how", which were ignored and hard to present using traditional modeling techniques.
- For enterprises: This research helps enterprises respond quickly to change by having the knowledge required for making sense of the business and the needs for change and making decisions with explicit rationales. Using the knowledge, enterprises could then take better actions to minimize the gaps between as-is and to-be architecture.

- For EA research community: The research enriches the “motivation” elements of enterprise architecture with intentional modeling and shows that the current EAF studies could be enhanced by incorporating IM techniques.

1.6 Definition of Terms

The key terms used in this research are defined as follows.

Enterprise A definition of "enterprise", in this context, is any collection of organizations that has a common set of goals. In that sense, an enterprise can be a whole corporation encompassing all of its information systems, a division of a corporation, a single department, or a chain of geographically distant organizations linked together by common ownership. In all cases, the architecture crosses multiple systems and multiple functional groups within the enterprise (The Open Group, 2002).

Enterprise Architecture vs. System Architecture Enterprise architecture involves multiple systems working towards the enterprise’s objectives, while system architecture involves one single system with its specific goals. System goals may change without changing enterprise goals. Furthermore, models for enterprise architecture capture enterprise wide knowledge; whereas models for system architecture only capture the knowledge enough for designing and developing a single system.

Knowledge Management The term knowledge management is not universally understood. Organizations often mix information management with knowledge management. . “Information management is the harnessing of the information resources and information capabilities of the organization in order to add and create value both for itself and for its clients or customers. Knowledge management is a framework for designing an

organization's goals, structures, and processes so that the organization can use what it knows to learn and to create value for its customers and community"(Choo, 2001, para 2). This research focuses on using knowledge management concepts to guide an organization to utilize enterprise architecture to understand its business, create new knowledge for improvement, and made right decisions to deal with change.

1.7 Scope of the Research

The paper focuses on the business layer rather than the information and information technology (I&IT) layer of the enterprise architecture. To lead through change and transformation, business owners always need to understand the "current" and "future" views of their business. These are deliverables of business architecture. Moreover, business architecture is a resource for all participants to understand how the business operates. It enables the discovery of opportunities for business improvements that address potential redundancies and gaps or needs for increased cross-enterprise alignment. These models also provide better understanding and better communication of business. Business decisions can now be made systematically and explicitly. The process of creating business architecture is in itself beneficial as personnel from both business and I&IT functions are involved in the process of establishing the relevant models that describe the organization. This collaboration brings forth greater understanding of the business by I&IT personnel and vice versa.

1.8 Organization of the Thesis

Section 2 introduces concepts of enterprise architecture and enterprise architecture framework, the knowledge management, the Business Motivation Model, the i* framework,

and traceability. Section 3 describes the research methodology used to conduct this research. Section 4 presents the framework which demonstrates one way to incorporate intentional modeling techniques into enterprise architecture. The framework is illustrated using a health claims payments case. Section 5 reveals the evaluation results. Section 6 summarizes the contributions of the study, and section 7 discusses some potential extensions to the research and concludes the study.

2. Literature Review

2.1 Enterprise Architecture and Enterprise Architecture Frameworks

Enterprise Architecture

Enterprise architecture, similar to traditional building architecture, describes the structure, functions, and behaviors of an enterprise or enterprise component in a given environment. Most current EA work traces the origin of EA concepts to Zachman (1987). EA is a top-down, business-driven strategy, and holistic expression of the components of an enterprise, and their relationships. EA also demonstrates how the components support the objectives of that enterprise and are maintained over the period of their useful life (Schekkerman, 2005b; The Open Group, 2002; Institute for Enterprise Architecture Developments, 2005; Buchanan & Soley, 2002). EA includes two major components (Buchanan & Soley, 2002):

- Business Architecture describes the structure and behaviors of business.
- Information &Information Technology Architecture describes the structure and behaviors of an enterprise's I&IT assets that support the business.

Business architecture sets scope for I&IT architecture, and I&IT architecture needs to align with business architecture. I&IT Architecture has four distinctive domains (Buchanan & Soley, 2002):

- Information System Architecture details the enterprise's information system strategies

- Application Architecture is a collection of application systems used to satisfy business needs
- Technology Architecture contains details of the enterprise's technology strategies.
- Some enterprises also have security architecture to oversee the security issues for the enterprise's systems.

Architecture has been long recognized for dealing with change. Zachman mentions in his EA workshops that:

> *"Seven thousand years of history would suggest the only known strategy for addressing complexity and change is ARCHITECTURE."*
> *"If it gets so complex you can't remember how it works, you have to write it down ... ARCHITECTURE."*
> *"If you want to change how it works, you start with what you have written down ...ARCHITECTURE."*

An internal presentation at one of the study sites on "Enterprise Business Architecture Based Transformation Strategic Business Planning" (S. Mathewson & B. Maloney, personal communication, May7, 2005) gives more specific views of how EA could help with change:

- Businesses have become more complex over time. Knowledge about the business has been embedded into the process performers (humans and/or computer systems). As employees leave, knowledge leaves with them. EA is explicit, documented and managed knowledge about the enterprise.
- Enterprises are required to respond more quickly to change. A strategic plan establishes the "target state" (target architecture) that the enterprise would like to achieve in a given time period. EA describes the business in a way that can be used to make more effective strategic decisions. Once the target architecture is developed, it serves as a valuable knowledge asset for the enterprise to use to respond in a strategic way to external drivers.

- EA provides a common method for describing the business. Without this common approach, organizations are not speaking the same language.
- Enterprises are making significant investments in information technology to automate their business. Many I&IT initiatives fail because the automated solution does not meet business needs. Doing EA mitigates the risk of failure by providing tools and methods that align the business needs with the technology solutions.

In EA, knowledge describing the business is normally represented and organized in lists, tables, charts, and models. At the business level, EA knowledge is represented in informal or semi-formal formats such as lists and tables and some models with less formal definitions that are accessible to the audience. At the I&IT level, formal representations like UML models are required to ensure the accurate implementation of software applications. The question is how the enterprise could use lists, tables, charts, and models in EA to provide a cohesive picture of the business.

Enterprise Architecture Frameworks

An EAF is a conceptual tool that can be used to guide the systematic development of EA. It also specifies the knowledge that needs to be made explicit in EA, such as business scope and processes, information processes, technology constraints, and implementation details. Various frameworks have been developed from different perspectives with different knowledge specifications.

Many EAFs that have been proposed defining EA in terms of layers or building blocks to show how the layers and building blocks fit together (Zachman, 1992; Schekkerman, 2005a; Popkin Software, 2004; The U.S. Chief Information Officer Council, 1999). Among them, Zachman's (1992) EA Framework (see Figure 2) is one of the most widely used

frameworks. It is an extension to Zachman's (1987) Information System Architecture. The information systems architecture was developed to address the complexity of contemporary information systems and derived from analogous frameworks found in traditional disciplines of architecture in building construction. This framework logically classifies and organizes the descriptive expressions of an enterprise along two dimensions in a tabular format. One dimension (rows) looks at an enterprise from different perspectives. Row 1 of the framework (contextual view from planner) corresponds to an executive summary of an enterprise. Row 2 corresponds to business models (conceptual view from owner) that represent the knowledge of business entities and processes and how they interact. They are used to reach agreement among stakeholders on how the enterprise work or will work – how its functions, structures, and behaviors address the requirements expressed in Row 1. Conceptual models are where the expectations and potential for innovation should be highest. System models (logical view from designer, i.e., Row 3) include the knowledge of system data elements and functions. It defines the models that express or specify the business and technology design, which can be tested and validated. The last two perspectives include technology models (physical view from builder) and detailed presentations. The context and conceptual models in rows 1 and 2 of the EA framework are considered to be the business architecture, where as rows 3, 4, and 5 contain the details of information and information technology architecture.

The other dimension (columns) represents different ways of describing things: "what" (data) to describe part-relationship-part relations, "how" (function) to represent input-process-output, "where" (network) is for node-line-node relations, "who" (people) is used to reveal people-work-people, "when" (time) is for event-to-event relations, and "why"

(motivation) is there for means-ends relationships. Because each perspective reflects a different set of constraints, the meaning (or definition) of the basic entity in a given column will change from row to row, i.e. an entity has one meaning for the owner, another one for the designer, and yet a different one for the builder. Note that even though "motivation" knowledge is explicitly identified as one important facet in the framework, there has been little systematic treatment of this facet and how it can be linked to other facets.

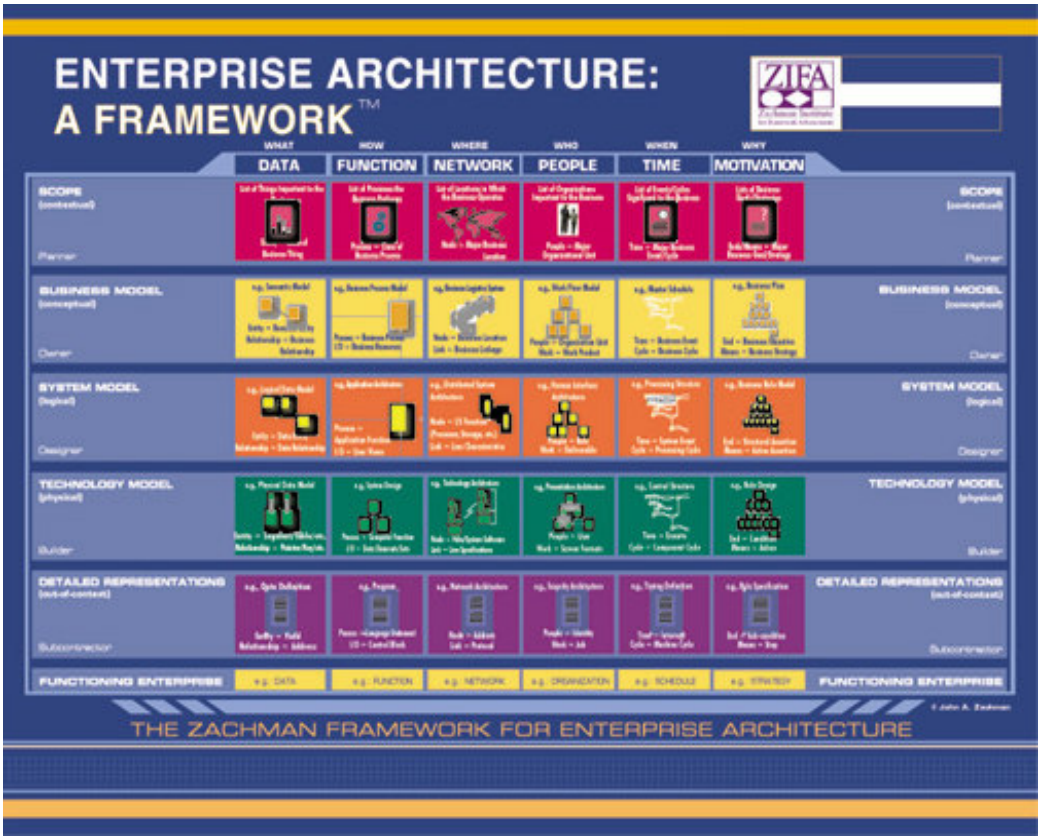


Figure 2: Zachman Framework (1992)

Treasury's Enterprise Architecture Framework (TEAF) Similar to Zachman's framework, TEAF has four perspectives (scope, business model, system model, and technology model) and four views (how, what, who, and where) (Popkin Software, 2004). In addition to the knowledge presented in these perspectives and views, it includes descriptions about emerging technologies, standards, and software/hardware products that are expected to

be available in a given set of timeframes and will affect future development of the architecture. This kind of knowledge is useful for an enterprise to prepare for upcoming changes. However, as the framework does not include the "why" component of EA, it is hard to tell why certain technologies or standards are to interest of an enterprise and how these new technologies could impact the enterprise's goals.

Federal Enterprise Architecture Framework (FEAF) Another framework based on Zachman's EAF is the Federal Enterprise Architecture Framework (FEAF) developed by the U.S. Chief Information Officers Council [CIOO] (1999). The purpose of FEAF is to transform the federal government to one that is "citizen-centered, results-oriented, and market-based" (CIOO, 1999, p.3). FEAF "allows critical parts of Federal Enterprise, called segments, to be developed individually, while integrating these segments into the larger Enterprise Architecture" (CIOO, 1999, p. 15). Within each segment, Zachman's framework is employed. Notably, the "who", "when", and "why" columns are omitted because "few formal modeling designs are available [for them]" (CIOO, 1999, p. 34). As mentioned before, our proposed framework will enrich the modeling design for the "why" column.

Extended Enterprise Architecture Framework One recent EA development is the Extended Architecture Framework (E2AF) developed by Institute for Enterprise Architecture Developments (2005b) based on Zachman's framework. This framework focuses on how extended enterprise stakeholders (such as supplier and customers) affect the goals, objectives and behaviors of an enterprise, and it emphasizes that these groups of stakeholders could have different concerns and different sets of viewpoints from economical, legal, ethical and discretionary perspectives (Schekkerman, 2005a). Even though the problems with Zachman's framework still exist with E2AF, it is useful for this research because it points

out the importance of identifying both internal stakeholders of an enterprise and external stakeholders and analyzing their impacts on the enterprise.

Procedural Guidance for Developing Enterprise Architecture for Change

The above EAFs are descriptive in that the procedures of how to construct the building blocks and integrate them are left to the enterprises who adopt the EAFs. In contrast, there are some EAFs which give procedural instructions of how EA could be built to implement change, such as The Open Group Architecture Framework (The Open Group, 2002, see Figure 3) and Buchanan and Soley's (2004) proposal on alignment of EA with business goals (see Figure 4).

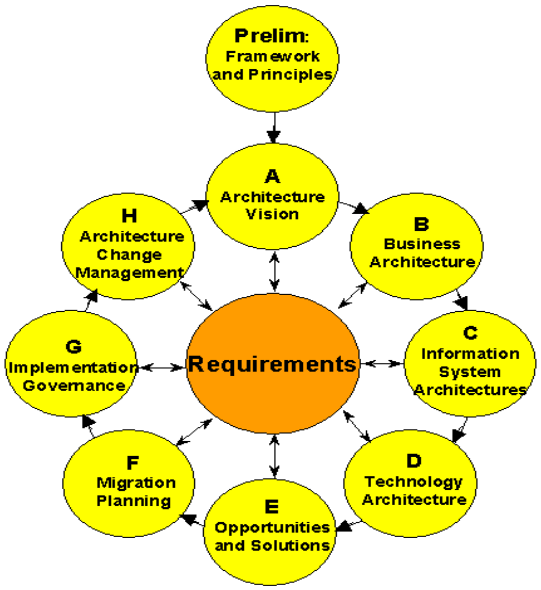


Figure 3: The Open Group Architecture Framework (2002)

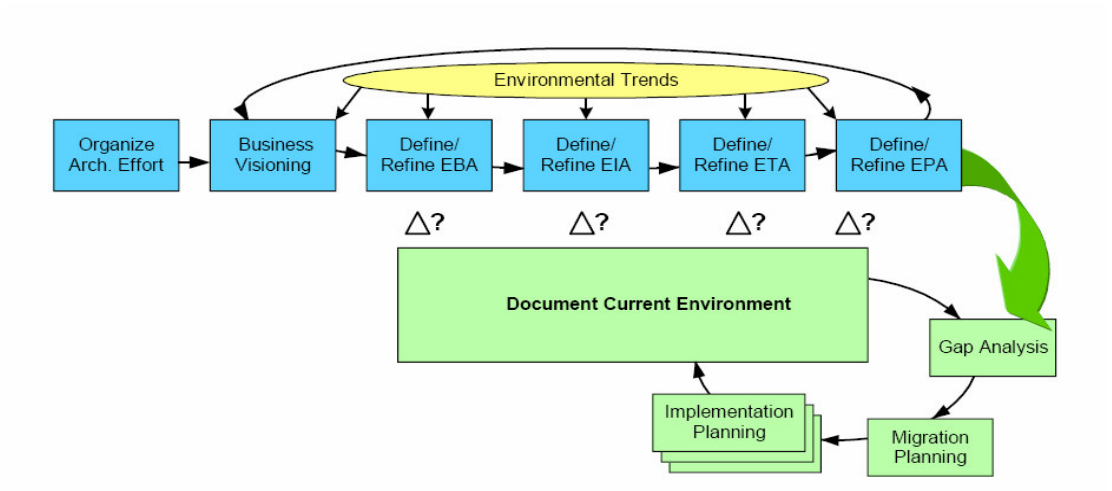


Figure 4: Meta Group's enterprise architecture process model (Buchanan & Soley's, 2004)

Both the procedures taken by enterprises following descriptive EAFs and the procedures defined by procedural EAFs show synergy about the process of utilizing EA for change. Figure 5 shows a typical process combining the above two procedural frameworks using the structured analysis and design technique (SADT) (Ross, 1977). The SADT activity notation is used to show the relationships among inputs, outputs, and controls (vertical arrows).

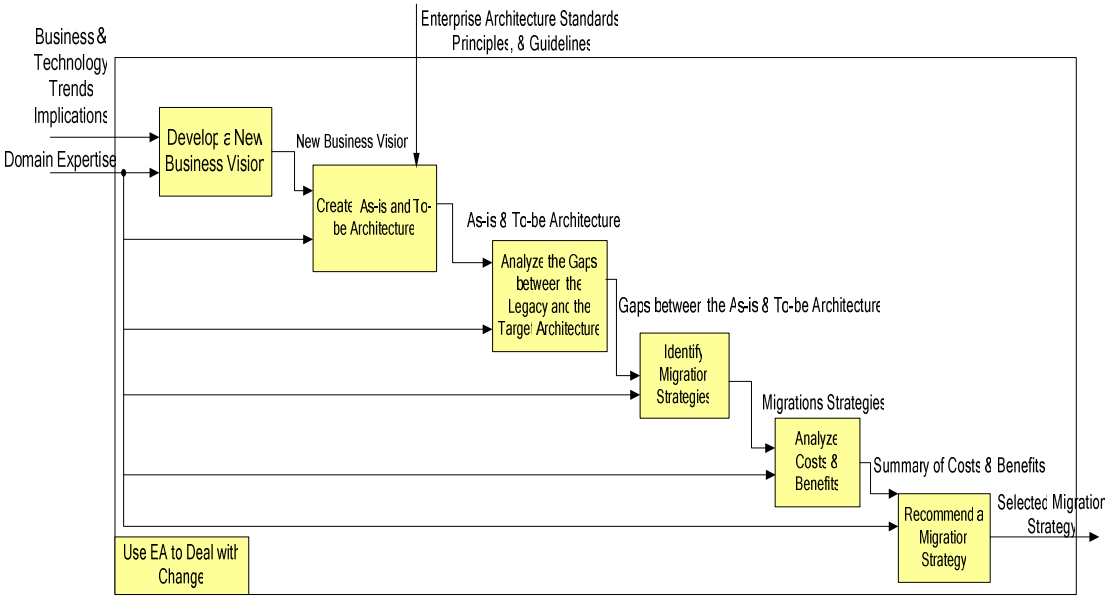


Figure 5: Process model for architectural planning

"Business and Technology Trends Implications" like a new market, a new regulation, or

new technology could trigger an enterprise to “Develop a New Business Vision”. With the new vision, the enterprise needs to “Create As-is and To-be Architecture”. The activity is under the help of domain business experts and architecture experts through conducting workshops to identify the salient features of the as-is architecture and the target architecture required to support the business vision. The construction process should follow the “Enterprise Architecture Standards, Principles as well as Guidelines” (see Appendix B for examples of EA standards and principles). Then the enterprise needs to “Analyze the Gaps between the Legacy and the Target Architecture”, “Identify Migration Strategies” with the help of domain experts. Since there could be many migration strategies, the enterprise needs to “Analyze Costs and Benefits” of each strategy and “Recommend One Preferred Strategy” to take actions.

Since the construction of the target architecture is the focal point of the whole process, an architect needs to take a closer look of the construction process. As the focus of this research is on enterprise business architecture (EBA), the following diagram shows how target EBA is constructed from the “New Business Vision”, based on the Open Group Enterprise Architecture Framework (2002) and the Enterprise Architecture Process Handbooks collected from some participating organizations.

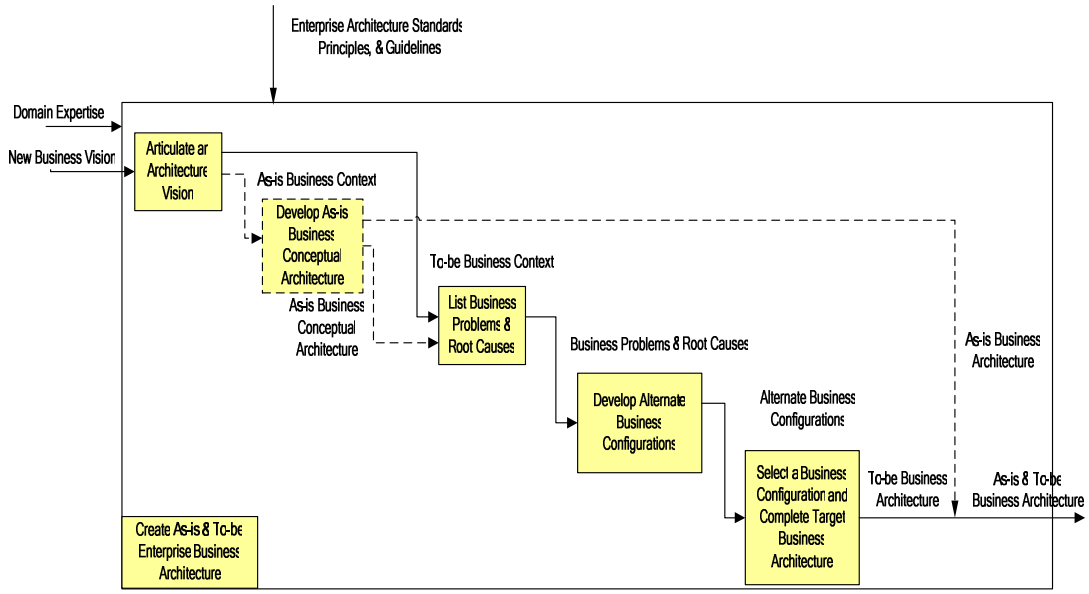


Figure 6: Construction of as-is and to-be enterprise business architecture

From the new business vision, the enterprise can "Articulate an Architecture Vision". The output of this activity will be "As-is Business Context" and "To-be Business Context", which will be Row 1 for the as-is and to-be architecture according to Zachman's framework. From the as-is context and with the help from domain business experts, the enterprise could "Develop As-is Business Conceptual Architecture". Depending on the type of change, this step may not be necessary. In case of new business needs, new business driver, or new technologies, the target architecture may be totally different from the legacy architecture. Therefore, there is no need to build the as-is business architecture in order to build the target architecture. In cases where the target status needs to evolve from the current situation, this step will be necessary. In architecturally more mature environments, there will be existing architecture definitions which perhaps will have been maintained since the last architecture development cycle. If these architectural descriptions exist, then they can be used as a starting point and verified and updated if necessary. If no such descriptions exist, then information will have to be gathered in whatever format comes to hand. Whatever the

approach, the goal should be to reuse existing materials as much as possible and to gather and analyze only that information that allows informed decisions to be made regarding the target business architecture (The Open Group, 2002). From the "To-be Business Context" and "As-is Business Conceptual Architecture", the enterprise should be able to "List Business Problems" which set obstacles to the achievement of "New Business Vision" and "Root Causes" for the problems. Then the enterprise needs to "Develop Alternate Business Configurations". The last step the architect needs to do is to "Select a Business Configuration and Complete Target Business Architecture".

There are some deficiencies in this process:

- The models illustrated by Zachman (1992) are designed to express the knowledge of data, functions, and processes. The models for "who", "when", and especially "why" columns are not mature yet. The intentional dependencies among people, their objectives, and to whom the objectives belong are not well defined. To deal with change, it is necessary to understand motivation behind why an enterprise does business the way it is doing and understand the motivation of other stakeholders in order to understand the change. However, how to use the motivation to help plan for the future i.e., how to represent the knowledge in to-be architecture, is vague.
- As argued above, EA is explicit, documented, and managed knowledge about an enterprise. However, the synergy between EA and KM are not fully exploited. The process does not define what kinds of knowledge each activity needs to produce in order to deal with change.

2.2 Knowledge Management

The need to systematically manage knowledge in an enterprise is increasingly being recognized. However, knowledge is often intangible, which makes it hard to manage. Knowledge management has recently emerged as an area of business practice and academic study to focus on these issues. For example, Davenpot and Prusak's (1998) study demonstrates how organizations manage what they know; Stewart's (1997) work shows how to treat knowledge as the intellectual capital of organizations; and Alavi and Dorothy's (2001) study illustrates how to use systems to facilitate KM.

EA contains lots of knowledge about an enterprise that needs to be managed. This section reviews the relevance of KM for EA in terms of the three critical elements identified in Choo (1998) - sense making, knowledge creation, and decision making, and the information needs, seeking and use in these activities. .

2.2.1 Sense Making

"The critical dependencies between an organization and its environment require the organization to be constantly alert of changes and shifts in its external relationships" (Choo, 1998, p2). This requires the organization to sense potential change and make sense of what is happening in order to develop a shared understanding that can guide its actions. "The organization that has developed early insight on how the environment is shaping will have a competitive edge" (Choo, 1998, p2). The central problem in sense making is how to reduce ambiguity and develop shared meaning on "what is happening here?", "why is this taking place?", and "what does it mean?" so that the organization may act collectively (Choo, 1998). These are also the questions that the architect needs to answer when constructing as-is

business architecture which is used to reach common understanding of the external environment and the business itself.

People in organizations make sense through three major processes: enactment, selection, and retention (Weick, 1979). “In enactment, people notice some change in the flow of experience, and they isolate some of these changes for attention by bracketing and labeling part of the experience or by taking action to create features in the environment to attend to” (Choo, 2006, p.124). The output of this enactment process is equivocal raw data about these changes. Selection is a process that people try to answer the question “what is taking place here?” by drawing from past interpretations and selecting plausible interpretations that can be imposed on the data they have bracketed (Weick, 1979). “The result is an enacted environment that is meaningful in that it provides a cause-and-effect explanation of what is going on” (Choo, 2006, p124). Retention is a process by which the enacted environment and business information from successful sense making are stored for further reference. Retained meaning could be a summary of a previously equivocal display or as cause maps that identify and label variables, and connect the variables in causal relationships (Weick, 1979).

Furthermore, sense making can be driven by beliefs or actions (Weick, 1995). Belief-driven processes are those in which people connect small but clear and plausible pieces of cues into larger structures of meanings. The processes could be based on augmenting and expecting. Augmenting is to create meaning by connecting contradicting interpretations, whereas expecting is to create meaning by connecting similar interpretations. Action-driven processes are those in which people create meaning about their commitment and manipulations by changing their cognitive structures to give significance to these behaviors. The processes could be based on committing or manipulating. Committing is to

create meaning to justify the actions high in choice, visibility, and irrevocable; manipulating is to create meaning to explain actions taken to make things happen. All processes could "serve as reference points for meaning generation", and "the essence of sense making is in the blending together of cognitive structures and active choices to construct reality" (Choo, 1998, p79).

Organizational cultural plays an important role in the sense making process. Through coping with problems of external adaptation and internal integration, organization members develop shared beliefs and behaviors among them, which is the essence of organizational culture (Choo, 1998). Organizational culture has impacts on the nature and extent of the consensus developed through the sense making process (Martin, 1992).

The heart of organizational sense making lies in the reduction of ambiguity. Through sense making equivocal information is interpreted and negotiated so that collective action can be taken (Choo, 1998).Initially, an organization may not be clear about which messages and cues are important and which interpretation is plausible to understand them. In order to answer the questions "what is happening here?" and "why is this happening?" the organization could seek information through scanning, noticing, and interpreting (Choo, 1998). An organization first broadly scans the elements in the environment which could impact the organization. During the scanning process, special issues would be noticed and taken a closer look. The next task is to interpret the noticed event by reaching the common understanding through discussing different perceptions. The interpretation process can also be facilitated by accessing the organizational memory for information about what sense the organization made in the past (Walsh & Ungson, 1991). The information culture of the organization, its dependence on the environment and its access to channels could affect

information-seeking behavior (Choo, 2006). The information sought are parsed to reduce ambiguity and to reach shared understanding of the situation that enable organization members to act. Sense making could be a political arena for “sense giving” and “sense contesting”, in which different parties may construct new causal orders and propose rationales that are advantageous to their interests (Choo, 2006).

2.2.2 Knowledge Creation

The process of constructing EA is also a knowledge creation process as the enterprise artifacts embrace large amount of business and IT knowledge.

In general, there are three kinds of knowledge: tacit, explicit, and culture knowledge.Tacit knowledge is the personal knowledge used by members to perform their work and to make sense of their worlds. Most of the enterprise knowledge about “why” remain tacit. Despite it being difficult to articulate, tacit knowledge can be and is regularly transferred and shared through observation and imitation of rich modes of discourse that include the use of analogies, metaphors or models, and through the communal sharing of stories (Choo, 2000). Explicit knowledge is knowledge that is expressed formally using a system of symbols, and can therefore be easily communicated or diffused. Since explicit knowledge has been codified, it remains with the organization even after its inventors or authors leave the organization (Choo, 2000). An organization’s cultural knowledge consists of the beliefs it holds to be true based on experience, observation, reflection about itself and its environment. These beliefs then form the criteria for judging and selecting alternatives and new ideas, and for evaluating projects and proposals. Although cultural knowledge is not written down, it remains with the organization through staff turnover (Choo, 2000).

As long as knowledge remains internalized in the individual, the organization is limited in its ability to make use of the knowledge strategically. Therefore, an organization normally "amplifies the knowledge created by individuals and crystallizes it as a part of the knowledge network of the organization" (Nonaka & Takeuchi, 1995, p.59).

The basis of the knowledge creation is the conversion between tacit knowledge and explicit knowledge. According to Nonaka and Takeuchi (1995), there are four modes of conversion. First mode is socialization, which is the process of sharing experiences to create tacit knowledge. Second mode is externalization, which is a process of converting tacit knowledge into explicit concepts through the use of abstractions, metaphors, analogies, or models. The third mode is combination, which is a process of creating explicit knowledge by bringing together explicit knowledge from a number of sources. This process can be done through media, such as, documents, meetings, telephone conversations and computerized communication networks. The last mode is internalization, which is a process of embodying explicit knowledge into tacit knowledge. This mode can be helped if the knowledge is captured in documents.

2.2.3 Decision Making

When the organization has the understanding and knowledge to act, it must choose from among available options or capabilities, and commit itself to a strategy. EA plays an important role in helping an enterprise come up with change initiatives and deciding which one to go for. In real world, decisions could not be made based on complete rationales due to the limitation on decision makers' mental skills, the extend of knowledge and information possessed, and values or conceptions of purpose which may diverge from organizational

goals (Simon, 1976). This is called bounded rationality by Simon (1976). As a consequence of bounded rationality, the decision maker will seek for sufficient or good enough solutions rather than seeking the optimal solution. A course of action is satisfactory if it exceeds some minimally acceptable criteria. Furthermore, the organization could simplify the decision making process by applying routines, rules, decision premises, and performance programs to define the saliency of information, provide criteria for evaluating information about alternatives, and specify channels of information sharing and communication.

According to Choo (1998), there are four modes of decision making. The *rational* model (Simon, 1976) is the one with clear goals and clear rules and routines to achieve the goals. The *process* model (Mintzberg, Raisinghani, and Theoret, 1976) is for situations with clear goals but there are multiple options and alternative solutions. The *political* model (Allison, 1971) elucidates the situation where there are conflicting goals from different parities and each party is pretty clear how to achieve its own interests. Finally, it is the *anarchy* model (Cohen, March, & Olsen, 1972) where both goals and procedures are unclear. In EA context, the information structure is closest to the process model. Most of the time, EA is used in situations where enterprises know what they want to be, but they need EA to help them figure out a way. The process model gives a structure to complex and dynamic decision-making activities.

Mintzberg, Raisinghani, and Theoret (1976) conceptualize the decision model into three phases with seven central routines by studying twenty-five strategic decision processes (see Appendix B). The three phases are identification, development, and selection. In addition, they note the existence of the three sets of routines that support the central phases as well as six sets of dynamic factors that help explain the relationship among the central and

supporting routines. The *identification* phase comprises of two routines: decision *recognition* in which opportunities, problems, and crisis are recognized and *diagnosis* in which management seeks to comprehend the evoking stimuli and determine cause-effect relationships for the decision situation. The *development* phase leads to the development of one or more solutions to a problem or crisis or to the elaboration of an opportunity. Development may be described in terms of two basic routines, *search* and *design.* Search is to find ready-made solutions, and design is to develop custom-made solutions or to modify ready-made ones. *Selection* is logically considered to be the last step in the decision processes. It comprises of three routines: *screen, evaluation-choice*, and *authorization*. Screen is used first to reduce a large number of alternatives to a few feasible ones and to a number that can be stored and handled by time-constrained decision making. Evaluation may use three modes: *judgment*, *bargaining*, and *analysis*. In judgment, one individual makes a choice in his own mind with procedures that he cannot explain; in bargaining, selection is made by a group of decision makers with conflicting goals; and in analysis, factual evaluation is carried out. This research focuses on analyzing potential solutions' impacts based on some systematic evaluation mechanism. Furthermore, the selection of strategic alternatives requires consideration of a great number of factors; most of them are "soft" or non-quantitative. Decisions need to be authorized when the individual making the choice does not have the authority to commit the organization to a course of action.

Beyond the basic seven routines, Mintzberg and associates (1976) also identify three sets of supporting routines: decision control, communication, and political routines. When facing a new decision situation, the decision maker attempts to establish a preliminary boundary on the decision space, a schedule for solution, a development strategy, and an

estimate of the resources he is planning to use to develop the solution. Communication activities dominated every phase of the decision-making process from identifying decision situations, to investigating relevant information, and to disseminating information about the decision making progress. Models could be used to facilitate communication to reach a common understanding. There is also considerable evidence that political activities are a key element in strategic decision-making. The political power can come from inside or outside an organization. Intentional modeling could be used to express the power distribution among stakeholders, to help clarify the power relationships in the organization, and to bring about consensus and mobilize the forces for the implementation of decisions.

The strategic decision-making process is also dynamic, which means it is subjected to interferences, feedback loops, and other factors. Due to these dynamic factors and interrupts, the decision making process is iterative. There could be loops within each stag and loops among stages.

In terms of information needs, based on Choo's (1998) study, the decision making process needs information to frame a choice situation in order to invent, develop, or design possible courses of action that can address the problem situation, information to define preferences and to select rules, and information about viable alternatives and their outcomes and contributions to organizational objectives. In terms of information seeking, it is a function of individual preferences, institutional values, and the choice situation's attributes. As the rate of change is escalating, managers normally develop a large number of alternatives, and they make the decisions by comparing alternatives with each other rather than examining each alternative in depth.

2.2.4 The Knowing Cycle

Even though each of the sense making, knowledge creation, and decision making is a distinct arena, they all play an important role in determining an organization's capacity to grow and adapt. Choo's (1998) knowing cycle concept integrates the three distinct arenas (See Figure 7). "The organization that is able to integrate sense making, knowledge creation, and decision making effectively may be described as a knowing organization ….The knowing organization is able to adapt itself in a timely and effective manner to changes in the environment; …mobilize the knowledge and expertise of its members to induce creativity; and focus its understanding and knowledge on reasoned, decisive actions" (Choo, 1998, p. 4). The knowing organization links the three strategic information processes into one continuous cycle of learning and adaptation. The cycle is called the knowing cycle.

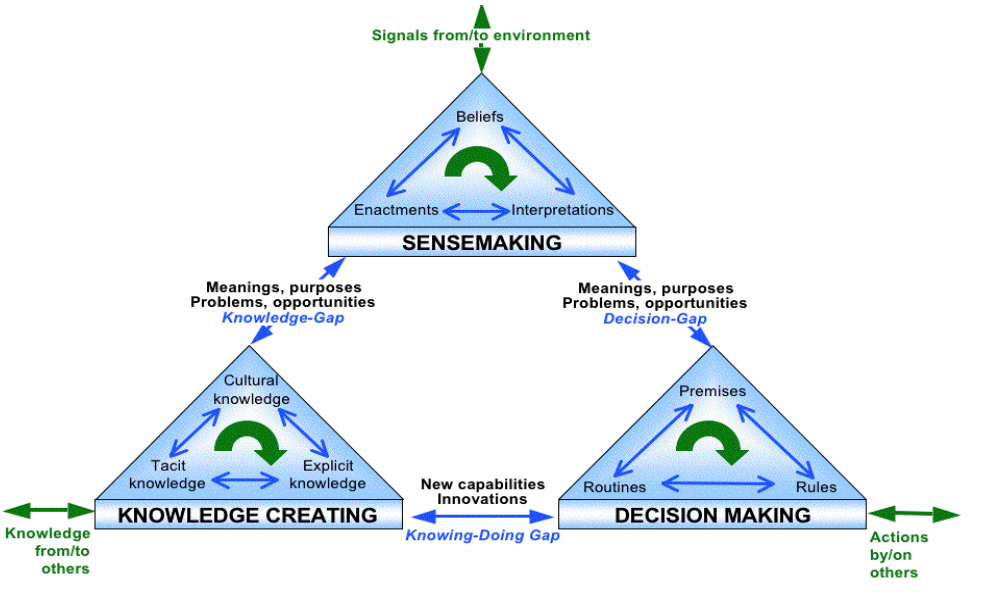


Figure 7: The knowing cycle (Choo, 1998)

Sense making brackets, labels, and connects stream of experience and provides enacted environments for organizational action. If the situation rendered by sense making is familiar

with the organization, then the organization can engage in decision making by invoking the appropriate existing rules or routines. If the situation is novel or unfamiliar so that no existing rules apply, the organization would need to generate new decision structures, including rules and premises from the enacted interpretation produced by sense making. The results of sense making may also indicate that the organization lacks some knowledge or capability to respond properly to the environment. The enterprise may need to create new knowledge through conversion of tacit or personal knowledge to explicit or external knowledge. The output of knowledge creation is new knowledge and capabilities which can be used to create new alternatives for decision making. However, the creation of knowledge may also suggest some new products or services which can satisfy new or unmet market demand, which may need sense making to gather information about the potential market. Once the organization has the understanding and knowledge, it is time to take actions. Through its decision making rules and routines, the organization will reduce risks and threats and increase strength and opportunity by specifying the kinds of information to be sought, the satisficing criteria to evaluate options, and by clarifying the goals and objectives. The output of a decision making is a set of actions which move the enterprise a step closer to its goals.

This research adopts the knowing cycle concept as it provides the enterprise a structure for the knowledge needed for each component. Having acquired the knowledge needed for change, it will not be hard to see how intentional modeling could help represent and manage the knowledge.

2.2.5 Knowledge Needs Identified in the Knowing Cycle

The above discussion of sense making, knowledge creation, and decision making has revealed the knowledge needed for each of the facets. For sense making, an organization needs the information that could enable it to answer the questions "what's happening here in the business and in the environment?", "why is this taking place?", and "what does this mean?" in a clear manner. Thus, the information gathered should include the dependencies between the organization and its environment as well as information about how the business is operated and why it is operated this way. For knowledge creation, as long as the knowledge is embedded in people's minds, it will be a challenge for the organization to manipulate the value of expertise. Normally, the knowledge about the organization's intentions is stated informally or remains tacit. Thus, making the knowledge about "why" explicit and organizing it according to a systematic EA framework would facilitate the creation of new knowledge to support change. For decision making, even though the organization cannot perform a completely rational decision making, it should collect enough information about the choice situation, the cause-effect relations, the organization's goals, feasible alternatives, possible outcomes of these alternatives, and their values to the organization to make an informed and well-supported decision.

2.3 Intentional Modeling

Models are central to all EAFs. The modeling techniques suggested in existing EAFs are traditional systems and business modeling techniques such as process, data and object modeling. Process-oriented modeling typically describes inputs and outputs of processes; data-oriented modeling describes entity and their relationships; and object-oriented modeling

sees the world as different kinds of objects and their relationships. These techniques are geared primarily towards routine work and reactive systems, and are not designed to deal with complex human and organizational issues (Molani, Perini, Yu, & Bresciani, 2003). They tend to focus on "what" and "how" rather than "why". In contrast, intentional modeling techniques focus on intentions, motivation, and reasons. The following gives the background and notations of two types of intentional modeling: the Business Motivation Model and the i* modeling framework.

2.3.1 Business Motivation Model

As claimed by the Business Rules Group (BRG, 2005), an enterprise should have rationales to prescribe a certain approach for its business strategies. The business motivation model (see Figure 8 for overview) is designed to provide a scheme or structure for developing, communicating, and managing business plans in an organized manner (BRG, 2005). It deals with the "motivation" cell (column 6) in the Zachman Framework. Motivation tells us "why" an enterprise has the business rules it has put in place to govern what it does with its products and services, its people, its locations, and its timing (BRG, 2005). The elements of business plans (goals, strategies, policies, etc.) that are supported by the BMM define the business purposes and help ensure the coherence of the processes, rules and responsibilities that are specified in more detailed models. The BMM has been proposed as a standard under the Object Management Group (OMG). The models are expressed using the widely-used Unified Modeling Language (UML) standard (see Figure 9 for detailed metamodels).

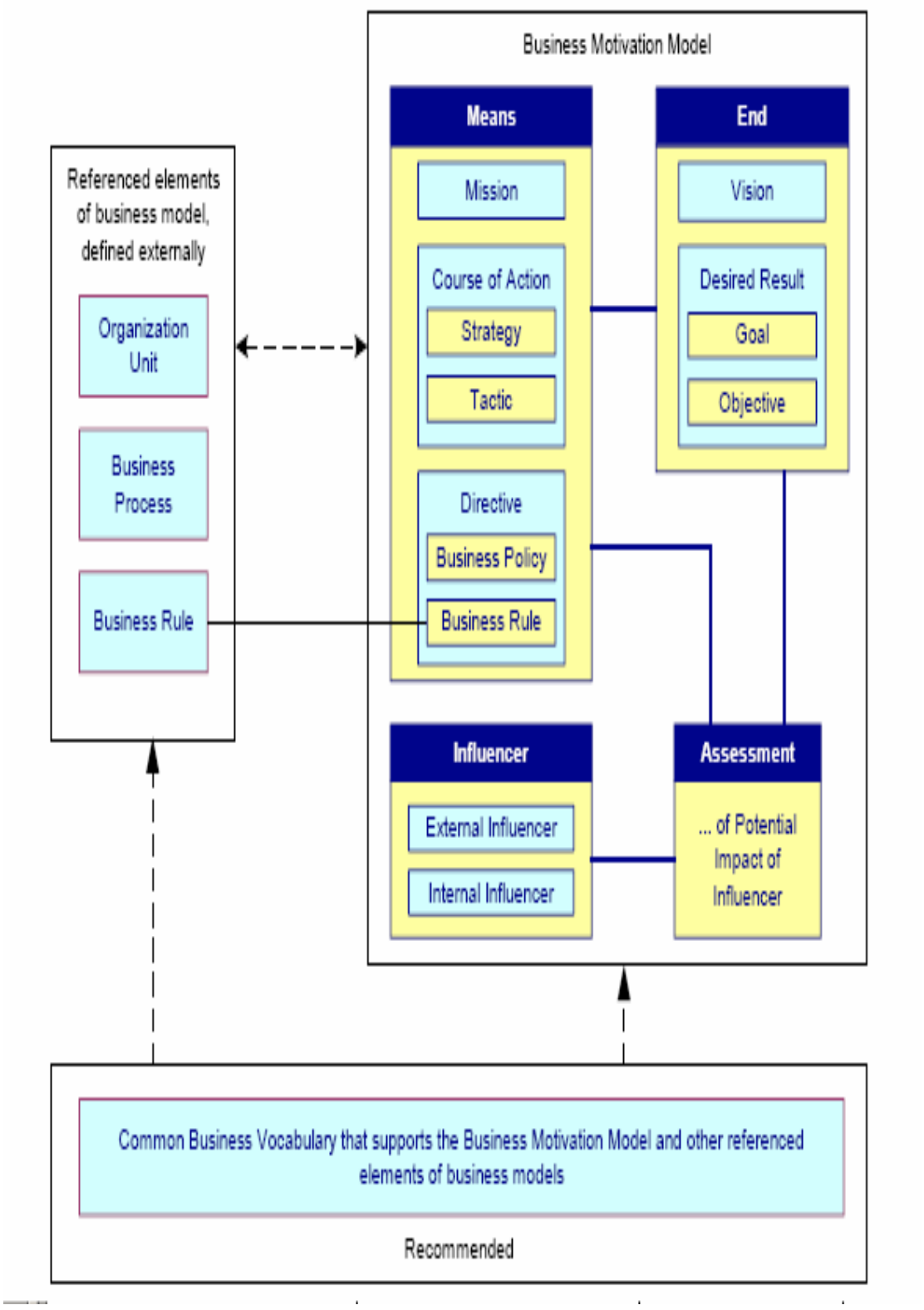


Figure 8: The Business Motivation Model Framework (BRG, 2005)

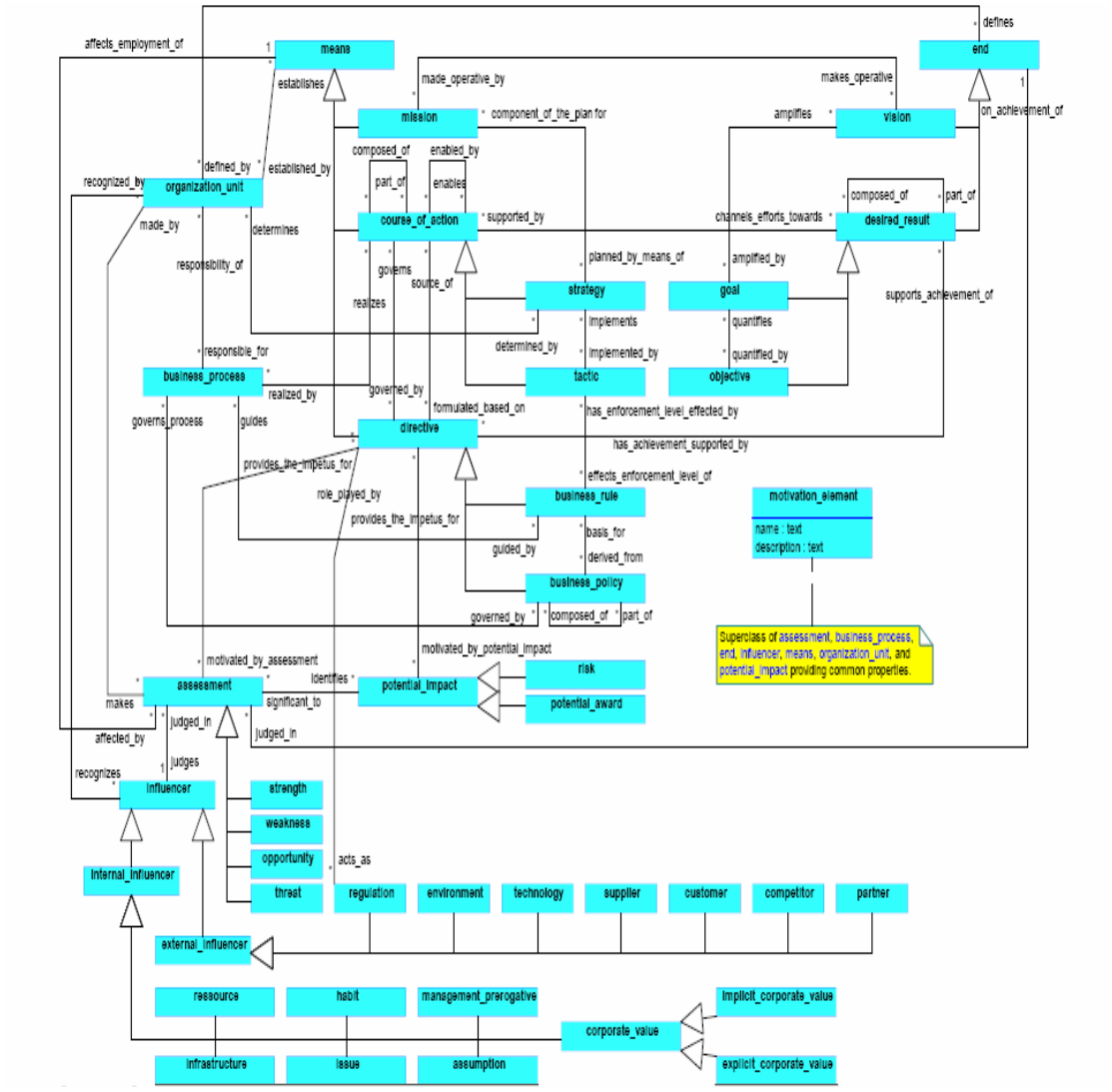


Figure 9: The business motivation metaModel in UML (BRG, 2005)

According to the BMM framework, *ends* are about what an enterprise wants to be. It could be developing new lines of business, moving into new markets, or maintaining its current position in the market. It does not say how the goals will be achieved. *Ends* are specialized as *vision* and *desired results*, and *desired results* as *goals* and *objectives*. A *vision* is an overall image of what the organization wants to be or become. *Desired results* - *goals* and *objectives* - are more specific. A *goal* tends to be long term, and defined qualitatively, and an *objec*t is a step along the way towards a goal and is quantitative.

Means are what the organization needs to do to achieve what it wants. "*Means* do not indicate either the steps (business processes and workflow) necessary to exploit them, nor responsibility for such tasks, but rather only the capabilities that can be exploited to achieve the desired *ends"* (BRG, 2005, p.11). It is organized into *missions, courses of actions,* and *directives*. A *mission* indicates the ongoing operational activity of the enterprise. Its definition should be broad enough to cover all *strategies* and the complete area of operations. *Courses of action* are what the enterprise has decided to do. It defines what has to be done, not how well it has to be done. Measures of performance are defined in o*bjectives*. *Courses of action* are categorized as *strategies* and *tactics*. *Strategies* tend to be long term and fairly broad in scope. Each *strategy* is implemented by *tactics*, which tend to be short term and narrow in scope. A *tactic* may contribute to the implementation of more than one *strategy*. Generally, *strategies* are selected to move the enterprise towards its *goals*, and *tactics* to ensure that it meets its *objectives*. However, the BMM is flexible for enterprises to make their own correspondence. Finally, *courses of action* do not necessarily have to support *desired results* directly; some are selected to enable other *courses of action*.

In the BMM, *directives* are categorized as *business policies* and *business rules*. *Business policies* exist to govern – that is, control, guide, and shape the *strategies* and *tactics*. They define what can be done and what must not be done, and may indicate how or set limits on how it should be done. Compared to *business rules*, a *business policy* tends to be less formally structured, and is not actionable. On the other hand, "*business rules*, which are derived from *business policies,* need to be defined and managed as such - tested for violation, enforced, managed for consistency and completeness" (BRG, 2005, p. 22). *Business rules* also provide specific remedies when a *course of action* fails, and specific resolutions to

conflicts that inevitably arise among the *ends*. It is expected that all *courses of action* should be governed by some *directive*, especially as the business plans evolve and become more coherent and complete. Any *course of action* not governed by a *directive* should be examined carefully to discover potential omissions. On the other hand, any business rules which addresses none of the influencers, means or ends, will be challenged. Does it perhaps support some older *means* or *end*s that are no longer relevant to the enterprise? Was it a workaround for some historical information system deficiency or organizational issue that is no longer relevant? Finally, "unstated" *directives* simply cannot be addressed in the model – quite literally, they can be recognized only by stating them. To be taken into account within the model, every *directive* must be explicit and recorded in an official manner. In addition, the BRG (2005）recognizes that to be workable, a practical methodology must address the reality of implicit *business policies* within the business.

An *influencer* is something that can cause changes that affect the enterprise in its employment of its *means* or achievement of its *ends*. *Influencers* may be internal, such as infrastructure, issues, assumptions, resource, habit, and implicit and explicit corporate value. *Influencers* could also be external, such as environment, technology, regulation, supplier, customer, competitor, and partner. Not all influencers could be documented, such as environment. Most of the *internal influencers* are tacit. An *assessment* is a judgment about the influence of an *influencer* on the enterprise's ability to employ its *means* or achieve its *ends*. The BMM suggests SWOT (Strength, Weakness, Opportunity, and Threat) as an example of an approach for making assessments, but enterprises can choose their own assessment criteria. It is important to notice that different people might make different assessments of a given influence on the same *ends* and *means* - perhaps even the same

people at different points in time. The model supports a record of which people made what a*ssessments* and when, providing an audit trail for future reference (not shown in the BMM metamodel). Furthermore, if an *assessment* is related to both a *means* and an *end*, then this suggests that the particular *means* is somehow related to the particular *end*. Specifically, if there is not a fact relating them, then careful consideration should be given to that omission. The model also includes *potential impacts* that can be identified to support *assessments. Potential impacts* are specialized as *risk* and *potential reward.*

Three concepts - *organization unit, business process and business rule* - have roles in the structure of the BMM but actually belong to other OMG standards. They are outside the scope of the model.

2.3.2 The i* Framework

In the Requirements Engineering community, a number of frameworks have been proposed to represent knowledge and to support reasoning (Dubois et al. 1986; Mylopoulos et al, 1991; Dardenne, van Lamsweerde, & Fickas, 1993). Majority of the frameworks focus on completeness, consistency, and automated verification of requirements and could be passed on to applications development team to adequately implement systems. These frameworks may be good for lower-level EA, but for business level EA, enterprises are more interested in answering questions like how we can meet organizational goals, why systems are needed, what alternatives might exist, and which one should be chosen at an early stage.
A number of techniques that have been developed to support reasoning at early phase of requirements analysis address similar questions to the ones enterprises would like to ask when using business architecture to deal with change. Examples of such techniques include

agent-oriented and goal-oriented techniques (Chung, Nixon, & Yu, 1995; Dubois, 1989; Yu & Mylopoulos, 1994). The major difference between these two techniques is that the goal-oriented technique does not distinguish which goal belongs to whom. In the case of dealing with change, enterprises need to consider multiple stakeholders' interests and complex relationships among them. Moreover, due to local autonomy, units of an enterprise may have different capabilities and responsibilities, interests and aspirations, backgrounds and resources, which could raise different perspectives and goals among different stakeholders. These relationships and differences are strategic in the sense that each party is concerned about opportunities and vulnerabilities, and seek to protect or further their interests. Therefore, it is beneficial for enterprises to use agent-oriented techniques to focus on their stakeholders and distinguish the ownership of a goal. However, neither goal-oriented nor agent-oriented modeling techniques have been applied to EA.

Yu (1995) recognized the above needs and problems and developed an agent-oriented i* framework for modeling and reasoning about organizational environments and their information systems. It was originally designed for early requirements engineering, but has been used in several EA related settings, such as knowledge management (Molani, Perini, Yu, & Bresciani, 2003), system architecture (Gross & Yu, 2001), and security and privacy (Lin, Yu, Mylopoulos, 2003). GRL, a version of i* modeling notation has been proposed for standardization under ITU-T Z. 150 series of recommendations. The i* framework is also the basis for the Tropos agent-oriented software development methodology (Bresciani et al., 2004). The essence of i* is that it sees each agent as a strategic actor who attributes intentional properties, such as goals, beliefs, abilities, commitments to each other and reasons about strategic relationships. This kind of intentional modeling links stakeholders'

goals to the decision-making process because it makes it possible to express the positive and negative impacts of decisions upon stakeholders' goals (Gross & Yu, 2001).

It introduces the notions of actor, goal, softgoals, task, and resource. An *actor* is used to refer generically to any unit to which intentional dependencies can be ascribed. Actors may be further differentiated into *roles, agents*, and *positions*. A *role* is an abstract actor embodying expectations and responsibilities. An *agent* is a concrete actor, human or machine, with specific capabilities and functionalities. An *agent* can play one or more roles. A set of roles packaged together to be assigned to an agent is called a *position*. A *goal* is a condition or state of affairs in the world that the stakeholders would like to achieve. In general, how the goal is to be achieved is not specified, allowing alternatives to be considered. A *softgoal* is similar to a (hard) goal except that the criteria for whether a softgoal is achieved are not clear-cut and *a priori*. The softgoal concept is based on an approach to the treatment of non-functional requirements in software engineering (Chung, Yu, & Mylopoulos, 2000). Softgoals should be properly modeled and addressed in design reasoning before a commitment is made to a specific design choice. *Tasks* are used to represent the specific procedures to be performed by agents. It may consist of sub-goals, sub-tasks, resources and softgoals. They are used to achieve *goals* or to "operationalize" softgoals. A *resource* is a physical or informational entity, about which the main concern is its availability.

The i* framework consists of two main modeling components. The Strategic Dependency (SD) model (see Figure 10 for an example of SD diagram and Figure 11 for metamodel for SD models) is used to describe the dependency relationships among various actors in an organizational context. A dependency could be a goal, softgoal, task, or resource

as shown in the figure. Dependency types are used to differentiate the kinds of freedom allowed in a relationship. A *goal dependency* indicates that the dependee has full freedom to decide how to achieve the goal, e.g., Health Care Client's dependency on Health Care Provider for Insured Services Be Provided. A *task dependency* means that the dependee follows a prescribed course of action, e.g., the dependency of Verify Services Received from Claims Processing Unit to Health Care Client. There is a routine that the unit sends verification letters to clients, and clients will report improper claims following the instruction on the letters. Thus, this dependency is a task dependency rather than a goal dependency. A *softgoal dependency* means the depender has no clear criteria of the achievement of the dependum from the dependee, e.g., Health Care Client *depends* on the unit to maintain the Privacy of His/Her Personal and Health Information. A *resource dependency*, e.g., Claims Payments/Reimbursements, means that the depended party (dependee) needs to make the resource available to the depender.

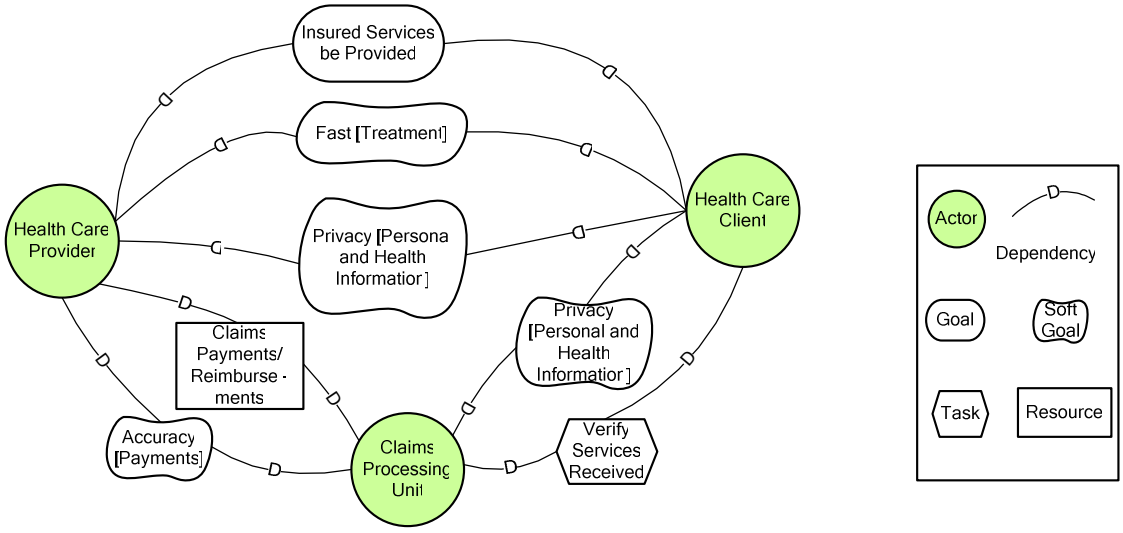


Figure 10: A strategic dependency diagram

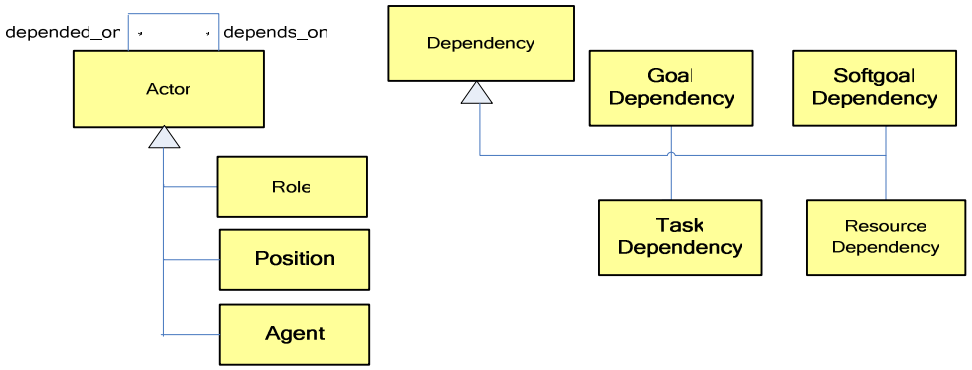
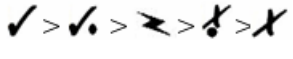


Figure 11: Metamodel of strategic dependency models

When the internal rationales of agents are made explicit, we call that a strategic rationale (SR) model (see Figure 12 for an example of the SR diagram and Figure 13 for metamodel for SR models). A *goal* can be accomplished in different ways. The *tasks* are connected to the *goal* through *means-ends* links which "provide understanding of why an actor would engage in some tasks, pursue a goal, need a resource, or want a softgoal" (Yu, 1997, p. 231).A task may be detailed into sub-goals, sub-tasks, resources and softgoals through *decomposition* links. All subcomponents of a task must be satisfied in order to accomplish the task. "*Task-decomposition* links provide a hierarchical description of intentional elements that make up a routine" (Yu, 1997, p.230). High-level abstract softgoals are reduced into low-level, more specific softgoals, or operationalized in terms of tasks through *contribution* links. "From the softgoals, one can tell *why* one alternative may be chosen over others" (Yu, 1997, p. 231). We choose this kind of representation rather than a tree structure because a tree structure, like a decision tree, does not allow contributions across sub-trees.

Compared to the BMM, i* offers specific categories to distinguish goals and softgoals and contribution links to link other elements to softgoals. This thesis will explore what potential benefits that different kinds of goals and links can bring to EA work.

Associated with each element is the notion of *satisficed* or *denied* presenting whether or not the element is accomplished given the set of satisfaction or denial values in the rest of the model. As softgoals do not have a precise definition of satisfaction, the term *satisficed* is used to refer to a judgment of sufficient satisfaction. Each element could have a label associated with it to show the satisfaction of its intention. The labels are defined as: *satisficed, weakly satisficed, conflict/irresolvable, unknown, weakly denied, denied* (see Table 1 for the label name and its corresponding graphic representation), and the labels can propagate to upper level goals through a qualitative i* evaluation algorithm. The algorithm is based on a procedure defined in the NFR Framework (Chung, Nixon, Yu, & Mylopoulos, 2000). The procedure is further refined by Horkoff (2006). The propagation rules for contribution links is shown in Table 1. The overall achievement of a higher softgoal is determined by the combination of each contribution link with personal judgments depending on which contribution link has a stronger impact on the softgoals. Thus, it is hard to automate this decision process. For means-ends links, the propagation takes the maximum value of the contribution elements, and for decomposition links the minimum, both using the ordering:  (Horkoff, 2006)

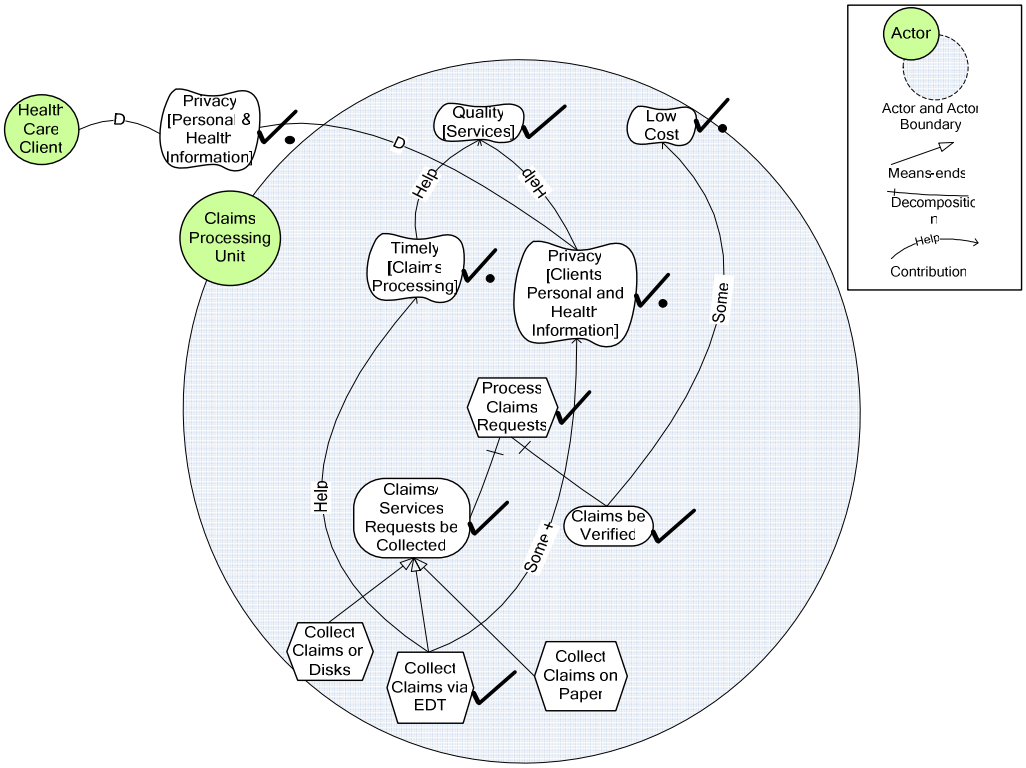


Figure 12: A strategic rationale diagram with evaluation labels

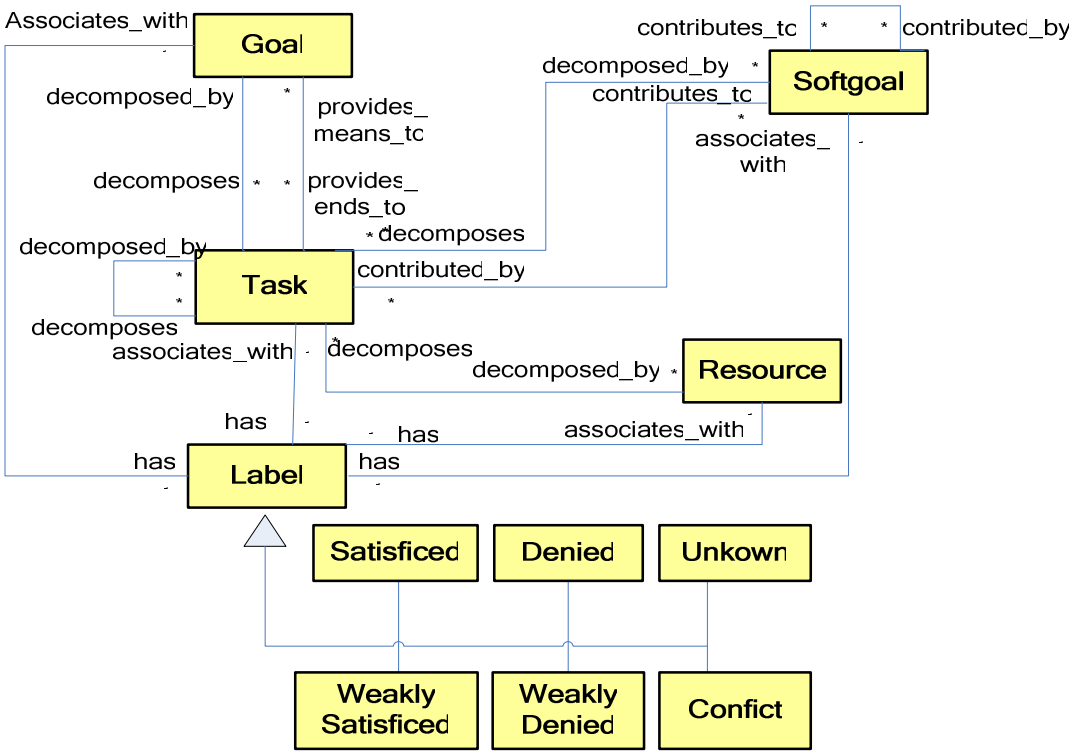


Figure 13: Metamodel of strategic rationale models

Table 1. Propagation rules showing resulting labels for contribution links (Horkoff, 2006)

Originating Label		Contribution Link Type						
Label	**Name**	Make	Break	Help	Hurt	Some +	Some-	Unknown
✓	Satisficed	✓	✗	✓.	✗.	✓.	✗.	?
✓.	Partially Satisficed	✓.	✗.	✓.	✗.	✓.	✗.	?
↯	Conflict	↯	↯	↯	↯	↯	↯	?
?	Unknown	?		?	?		?	?
✗.	Partially Denied	✗.	✓.	✗.	✓.	✗.	✓.	?
✗	Denied	✗	✓.	✗.	✓.	✗.	✓.	?

The suitability of i*'s application to EA could be addressed in several aspects. First, it puts all stakeholders in one picture which gives an enterprise a better idea of its environment and potential triggers of change. Second, softgoals are dealt. Sometimes, what triggers change are some non-functional requirements, and softgoals could also be used to evaluate solutions before one is committed. Softgoal refinement trees allow architects to be specific so that softgoals can be operationalized. Third, the identification of goals and elaboration of a goal using a means-ends hierarchy will reveal the answers to the questions of "why", "how" and "how else" (Yu & Mylopoulos, 1994). Alternate goal refinements provide the right level of abstraction at which decision makers can be involved for validating choices being made or suggesting other alternatives overlooked so far. In addition, Lamsweerde, Darimont and Letier (1998) state that "goals have been recognized to provide the roots for detecting conflicts among requirements and for resolving them eventually" (p.910). Moreover, a task refinement tree and its linkage to softgoals provide traceability from high-level strategic objectives to low-level, more operationalized processes (Lamsweerde, 2001). The above techniques ensure that the rationales for change could be explicitly presented and recorded in models for further reference.

Meanwhile, i* does not assume that all the motivation knowledge can be or will be made explicit. Agents are assumed to be autonomous in the world of uncertainties and openness (Yu, 2001a). “Active autonomous entities in the world have their own initiatives, and are not necessary compliant with external demands or desires, such as those from a system designer. Autonomous agents can choose to cooperate, or not, to varying degrees and on their on terms” (Yu, 2001a, p.216) Thus, incomplete and imperfect knowledge about an agent’s behaviors make it impossible to represent all knowledge the agent has, especially its tacit knowledge. However, the new realities of uncontrollable and unpredictable world suggest that one needs to be able to do analysis despite incomplete knowledge (Yu, 2001b).

2.4 Traceability

Traceability is the ability to follow the life of an object from its creation to its use. One of the problems being addressed in this thesis is the traceability between “why” knowledge and “how” knowledge. However, in current EA practice and EAF studies, few methodologies and tools have been developed to support traceability concerning about “why”. For example, the Zachman’s framework only lays out various “building blocks” of an enterprise without defining any traceable links among blocks on different columns and rows. Without traceability, it would be difficult to tell the “whys” of business and I&IT implementations and not easy to trace back in time why something is needed and where the needs come from.

The fundamental question comes down to what kinds of traceability an enterprise needs and how architects could represent the traceability in EA. Ramesh and Jarke’s (2001) has done extensive work on using reference models for requirements traceability in a software

development context. Even though their work focuses on software development, some points are valuable for representing traceability in the EA context. Based on their study on twenty-six major software development organizations, they summarize four categories of traceability links: *satisfies, depends-on, evolves-to,* and *rationale* links. They also discuss the main issues concerning the support of the links. For *satisfies* links, there is a need for providing a way to represent the fact that alternate ways may exist for satisfying a requirement and showing the degree of satisfaction. For *depends-on* links, the authors suggest that the ability to define different types of dependencies within a traceability framework and to develop support mechanisms to manage such dependencies will be very valuable. For *evolves-to* links, there is a need to trace back why the evolvement is needed and where it comes from. For *rationale* links, the participants of Ramesh and Jarke's study wish to maintain rationales for different types of artifacts and decisions at different levels of details. They also think it is useful to link rationales to sources and stakeholders.

These kinds of traceability are applicable to the EA context. *Satisfies* traceability could provide an enterprise a way to trace potential solutions and the problems the solutions are trying to solve. *Depends-on* traceability could reveal the relationships among the stakeholders. *Evolves-to* traceability could tell the historical reasons for the existence of some business elements and where the needs for these elements came from. Finally, *rationale* traceability is needed for decision making during the change process as well as linking the change initiatives back to the triggers of the change.

Intentional models have the capability to capture the four kinds of traceability in EA. The *mean-ends* links in the BMM and i* could provide *satisfies* traceability, and the different kinds of *dependencies* in the i* framework are good for providing *depends-on*

traceability. Both modeling techniques support explicit reasoning behind decisions and provide linkages between stakeholders/influencers and the business goals. Finally, intentional models, as an explicit presentation of motivation knowledge, could be easily maintained to provide *evolve-to* traceability for the future. The rest of the thesis will demonstrate how different kinds of links are utilized to provide different kinds of traceability for enterprises.

2.5 Summary of Literature Review

In conclusion, as business is becoming more and more complex and the rate of change is escalating, organizations have realized the importance to have a blue print to manage their structure, functions, and behaviors in order to deal with the change. EA has been recognized as a contribution in this regard. EAFs, such as Zachman's framework are helpful for constructing EA. In order to deal with change, EAFs have to be able to help enterprises construct both as-is and to-be architecture in order to identify migration strategies. Few EAFs have illustrated how the to-be architecture can be constructed in a way that motivation knowledge is captured sufficiently to identify alternate business models and select one of the models to support the new business vision.

This thesis identifies two obstacles for capturing motivation in EA. First, there is not enough clarification on what kinds of motivation knowledge are needed. The knowing cycle concept (Choo, 1998) provides a structure for the process to deal with change and the "why" knowledge needed for each activity of the process, namely sense making, knowledge creation and decision making. Knowing what knowledge is needed, the second obstacle is what kinds of modeling techniques architects can utilize to represent the knowledge. The

BMM (BRG, 2005) and the i* framework (Yu, 1995) are two intentional modeling techniques introduced in this paper to help with managing the knowledge about "why". The BMM's forward and backward traceability among elements of a business plan and influencers' impacts explicitly state why the enterprise is doing the business it is doing. The i* modeling which reveals strategic dependencies among stakeholders and the rationales behind the dependencies could be used to answer the "why", "how", and "how else" questions. Both techniques could be used to provide satisfies, depends-on, evolves-to, and rationale traceability. There are clear benefits for incorporating IM into the construction of to-be architecture, which this thesis is designed to address.

3. Research Methods

3.1 Design Science

The nature of this study is a problem-solution finding. It is about finding problems with existing enterprise architecture frameworks and their resulting enterprise architecture, and designing and building a framework to solve the problems. An accepted problem-solution finding approach is design science, a scientific research method which has its roots in engineering and the sciences of the artificial and which is well applied to Information Systems studies (Hevner, March, Park, & Ram, 2004; Glass 1999; Markus, Majchrzak, & Gasser, 2002). The essential goal of design science is solving problems by introducing new artifacts (March and Smith, 1995). March and Smith (1995) outline a design science framework with two axes, namely research outputs and research activities. Research outputs cover constructs, models, methods, and instantiations. This research emphasizes on the last three output types as the constructs for the two intentional modeling have already been developed. A *model* represents situations as problem and solution statements. A *method* is a set of steps used to perform a task. Methods are based on a set of underlying constructs and a representation of the solution space. An *instantiation* is the realization of an artifact in its environment. Instantiations operationalize constructs, models, and methods. In the case of this research, the artifact takes the form of a framework showing one way to applying intentional modeling to enterprise architecture with the demonstration of its usage in a health claims payments case. Research activities comprise building, evaluating, theorizing on, and justifying artifacts. This research focuses on building artifacts with some evaluating

processes and does not cover the other two. Building refers to the construction of the artifacts, and evaluating refers to the assessment of the output's performance against certain criteria (March & Smith, 1995). In this case, the researcher needs to build the framework as well as evaluate it based on the experience gained through the case study and feedback from expert practitioners with extensive experience in EA.

The first step of design science method was to understand how things are done currently and identify the existing problems. This was done by reviewing literature, analyzing documentations, and attending an EA open house event.

The literature provided the researcher with a theoretical ground. The materials reviewed included published journal articles, conference proceedings, book chapters, and websites in the fields of business transformation, EA/EAFs, knowledge management, and intentional modeling. After categorizing the literature, the researcher then highlighted important points for each piece of work and synthesized and summarized the major ideas that surfaced among each category. These ideas included what knowledge an enterprise needs to deal with change, how EA is used to implement change, the concepts of the knowing cycle, the concepts of IM including the BMM and that i*, and their applications in relevant fields. The literature review embodied the basis for the design of the framework.

3.1 Application of Design Science

To further explore how the theoretical work is applied in practice and to make sure that the construction of the framework works in practice, the researcher collected documentations of the usage of EA in real situations since summer 2005, such as Enterprise Architecture Method Handbooks. Documentations gave the researcher a thoughtful and

comprehensive representation of the situations. Part of the documents came from enterprises which have EA practice on site. Government organizations are leading adopter of EA, and they normally have comprehensive internal project documents on their architecture development and various cases of applying EA for transformation. The documents were collected directly from either the owners, developers, or administrators of the documents. In addition, documents were collected from publications, public websites, newspapers, and publicized case studies.

In addition to documentations, the researcher also attended an EA open house event organized by the EA working group under the CTO office of a provincial government organization in summer 2005. This event was attended by approximately 300 IT staff who served almost 30000 public services' staff. The event was aiming to promote the use of EA/EAFs, summarizing past EA work, and providing an opportunity for people to exchange experiences. Through attending presentations and seminars held in this event, the researcher gathered information about the importance of EA to organizational change, the problems practitioners encountered when constructing EA, and the latest thoughts and potential solutions to the problems. Attending this event also gave the researcher more ideas on what documents to collect from the government organization.

In this study, the data collected from documentations and the open house event underwent a series of reviews and comparisons in order to analyze the similarities of how enterprises use EA to deal with change, how target architecture is constructed in different contexts, what common problems are recognized and unrecognized by the enterprises, and what they think is necessary to address these problems. The data was used to confirm the researcher's understanding of the gaps between the knowledge for an enterprise to deal with

change and the knowledge captured by existing EAFs and its resulting EA, improvements that could be done to fulfill the gaps, and important components the proposed framework needs to include.

To strengthen the study, the researcher sought additional information and advice from experts in business transformation, EA/EAFs, KM, and system modeling fields. In June 2005, an un-structured interview was conducted with one head architect and one information and business architecture manager of a government organization. They were chosen because of their well-rounded competencies in relevant areas. Interviewing them at the same time allowed them to complement each other's ideas. Before the interview, the researcher did a pilot study based on the literature and documents collected by that time to convey the idea of the research and to introduce the concept of IM as they are not quite familiar with this modeling technique. In this initial interview, the researcher presented the pilot study to give the experts a general idea of the problems being addressed in this research, and received their feedback and suggestions on the direction of the research. Both the researcher and her supervisor participated in the interviews in order to validate the data collected. After the interviews, the researcher discussed with the supervisor about the major ideas conveyed by the interviewees and clarified misunderstanding.

After analyzing past literature and the documentations collected, gathering advice from experts, and summarizing the researcher's own knowledge and experiences, the researcher had already had a clear picture of how EA is currently used to deal with change, what difficulties enterprises encounter in reality that are not being addressed in current studies and how IM and KM concepts could help solve the problems. The researcher then developed the proposed framework. Since in EAF studies there is little theory defining how an EAF should

be designed, therefore, the proposed framework was designed based on the researcher's knowledge accumulated from the above processes.

As mentioned previously, another product of the design science paradigm is an instantiation. An instance could enlighten the illustration of the framework. A generic health claims payments instance is chosen because this case provides the right level of complexity and the researcher has some domain knowledge about it. The purpose of applying the proposed framework to the case is to self-evaluate whether the framework is capable and appropriate to solve the business problems often occurring in health claims payments systems. The majority of data was collected from some health care related websites, such as the Ontario Ministry of Health and Long Term Care (MOHLTC) website. Other data resources include a presentation on health claims payments presented at the EA open house event and email information requests to the project manager of a health claims payments project. The information gathered was analyzed to extract major issues of the case, to provide enough domain knowledge to illustrate the framework, and to evaluate the framework.

After the initial framework with the models and guidelines, prospective application instances were developed. The researcher evaluated them by taking them back to the experts and determining the applicability, accuracy, and completeness of these artifacts. In December and February, two rounds of semi-structured interviews were conducted for the purpose of the evaluation. This included interviews with the experts (also interviewed in the beginning), a consultant in EA area, and an application architect. The researcher revisited the experts because they are familiar with health care study and know how it would be treated under existing EAFs without using IM. Therefore, they can give the appropriate

comments about how they think about applying IM to EA and assessments about what potential benefits they see IM could bring to EA. Each interview lasted from one to one and a half hours, and the same validity techniques were taken as in the first round of interviews. The member checking, peer debriefing as well as triangulating different data sources definitely increased the validity of the research.

Throughout the research, the researcher followed a pre-approved ethics protocol to ensure that the rights, needs, values and desires of the participants were respected. There were several ethical issues arising from the research. While most of the documents were available on the organizations' websites and their publications, some organizations did treat some of their documents as internal-use only. In this situation, the researcher obtained the owners', developers' or administrators' consent before gaining access to these documents. The researcher made it clear that no intellectual properties, trade secrets, sensitive information about their employees, or any other confidential information were sought for this research. At the beginning of each interview, the researcher also got the participants' consent. The participants were introduced verbally and in writing the purpose of the study, the procedure of the study, the benefits and risks of the study, as well as the right to participate voluntarily and the right to withdraw. Confidential information about the participants or the affiliated organization was not sought. Throughout the study, the participants' anonymity was protected and the data collected was stored securely and only shared with the research supervisor.

4. Incorporating Intentional Modeling into Enterprise Architecture

This chapter presents the enterprise architecture framework incorporating intentional modeling.

The purpose of the research is not to reinvent the processes architects use to construct target architecture, but rather to provide them with extra tools and methods so that they could better capture and utilize the knowledge about "why".

Structuring the process from a knowledge management perspective is the first step since each component of the knowing cycle will require a special set of knowledge to answer a special set of questions. Table 2 summarizes how each step in the existing EA construction process (see Figure 6) falls into the knowing cycle as defined in Choo (1998) and what kinds of knowledge need to be constructed at each activity.

Table 2. Knowledge management concepts for the target architecture construction process

Knowing Cycle	Routine	Construction Activity	Knowledge Needs to be Constructed
Sense Making	Enactment	Articulate an Architecture Vision	• Answers to the questions of "what's happening in the business and in the environment?", "why is this taking place?", and "what does this mean?"
	Selection	Develop As-is Business Conceptual Architecture	
	Retention	(The models could be stored for future reference.)	
Decision Making (Process Model)	Recognition	(Done in sense making)	• Knowledge about the choice situation
	Diagnose	List Business Problems & Root Causes	• Cause-effect relations
	Development	Develop Alternate Business Configurations	• Information about feasible configurations.

	Selection	Select a Business Configuration and Complete Target Business Architecture	• Decision Preferences or rules based on organizational goals • Possible contributions of these alternatives to the organizational goals
Knowledge Creation	Combination Socialization Externalization Internalization	(The knowledge creation process is found in each of the above construction activities)	• Explicit "why" knowledge

"Articulate an Architecture Vision" is a step to organize the information that defines the total context and scope of the enterprise being presented in the architecture. The artifacts produced at this step collectively describe the scope in terms of the artifacts' relationships. An architect needs to selectively bracket elements concerning the business and change, label them, and look for their relationships. Thus, this is an enactment process. The researcher perceives "Develop As-is Business Conceptual Architecture" as a selection step. As described in the Literature Review section (Section 2.2.1), selection is the process by which people generate answers to the questions like "what is happening in the business and in the environment?", "why is it taking place?", and "what does this mean?" These are also the central questions the architect needs to answer through constructing the as-is architecture. Based on the equivocal data from the enactment process, the architect needs to select important data and give more detailed meaning to the data, i.e., how the business operates, what are the dependencies between the organization and its environment, and how the environment impacts the business' operations. The architect can take past interpretations, i.e., previous EA work, as a template and decide on an applicable meaning to the current situation. The result of this step is the as-is conceptual business architecture describing means-ends relationships of what the enterprise is doing, the enterprise's dependencies with its environment as well as cause-and-effect explanation for the rationale behind the business.

This process could be influenced by organizational culture, and the result could be constructed in such a way that fulfills the organization's political interests. The artifacts for the architecture are explicit documentations to be stored as part of the organizational memory to support future sense making.

The rest of the construction processes are a decision making process as there is a fairly good match between the EA construction process and the decision making process model. After understanding "what is going on here", the architect then needs to *diagnose* the business problems which are obstacles that prevent an enterprise from achieving its goals. After identifying the root causes, the architect should *develop* alternate business configurations. This could be done by searching for a ready-made solution, developing a custom-made solution, or modifying a ready-made solution. The final step is to define preferences or to select rules based on organizational goals and to analyze the potential outcomes of these solutions and their contributions to the goals. Then the architect can *select* a business configuration based on the configurations' relative contributions to the decision preferences. Based on KM research, the decision making process is supported by decision making routines and affected by dynamic factors (Mintzberg, Raisinghani, and Theoret, 1976).

The knowledge creation process takes place throughout the whole construction process. The architecture itself is a body of knowledge. The process of constructing it is a knowledge creation process: the architect needs to gather various documents, conduct workshops with domain experts, and construct the models to externalize their tacit knowledge, especially their knowledge about the business motivation. The documented knowledge could be retained and traced back when justifying past actions or revisiting decisions made. Finally,

members in the enterprise could use the architecture to better understand the business and the needs for change in order to carry out the transformation.

Having structured the EA processes from a KM perspective, the information needs for each activity and how the information is sought and used become clearer. Therefore, it will help clarify how IM could help find the answers.

This research utilizes two kinds of intentional modeling, the Business Motivation Model and the i* framework. The BMM, a recent submission from BRG to OMG, is designed for the motivation component of EA and shows that the importance of including motivation in EA is beginning to be recognized. The means, ends, influencers, their impacts, and their relationships provide traceability between business strategies, directives and business goals and traceability between influencers and their impacts on the business based on assessments done by the enterprise. Even though i* was not originally designed for EA, it has been explored widely in Requirements Engineering to address stakeholders' goals, abilities, and commitments to each other. Its task/goal/softgoal refinement, mean-ends/contribution/decomposition links as well as qualitative goal evaluation are helpful for identifying business problems and selecting a solution.

This research uses the two techniques in a complementary way. The BMM provides more explicit business ontology, such as business ends, means, influencers, and their assessments and impacts, and is good at providing traceability at a strategic level rather than detailed business processes level. Therefore, this research mainly uses the BMM for making sense of current business environment. However, the BMM is less adaptive for presenting interrelationships among stakeholders; provides weak relationships between business processes and objectives; and does not provide mechanisms to help decide to what extent a

goal is met. Thus, it is hard to use the BMM to find problems and come up with solutions. As a result, i* is used to further make sense of as-is business environment and to construct target architecture.

The following diagram explains in detail how the two modeling techniques are used in the framework. The processes consist of five activities as in Figure 6, but the inputs and outputs are enriched by incorporating IM with the process. The framework is process-oriented, that is, it focuses on incorporating intentionality in the process of constructing EA, rather than on incorporating intentionality into the end product. This is a reasonable approach because intentionality already guides, influences, and constraints model development during the entire model construction process.

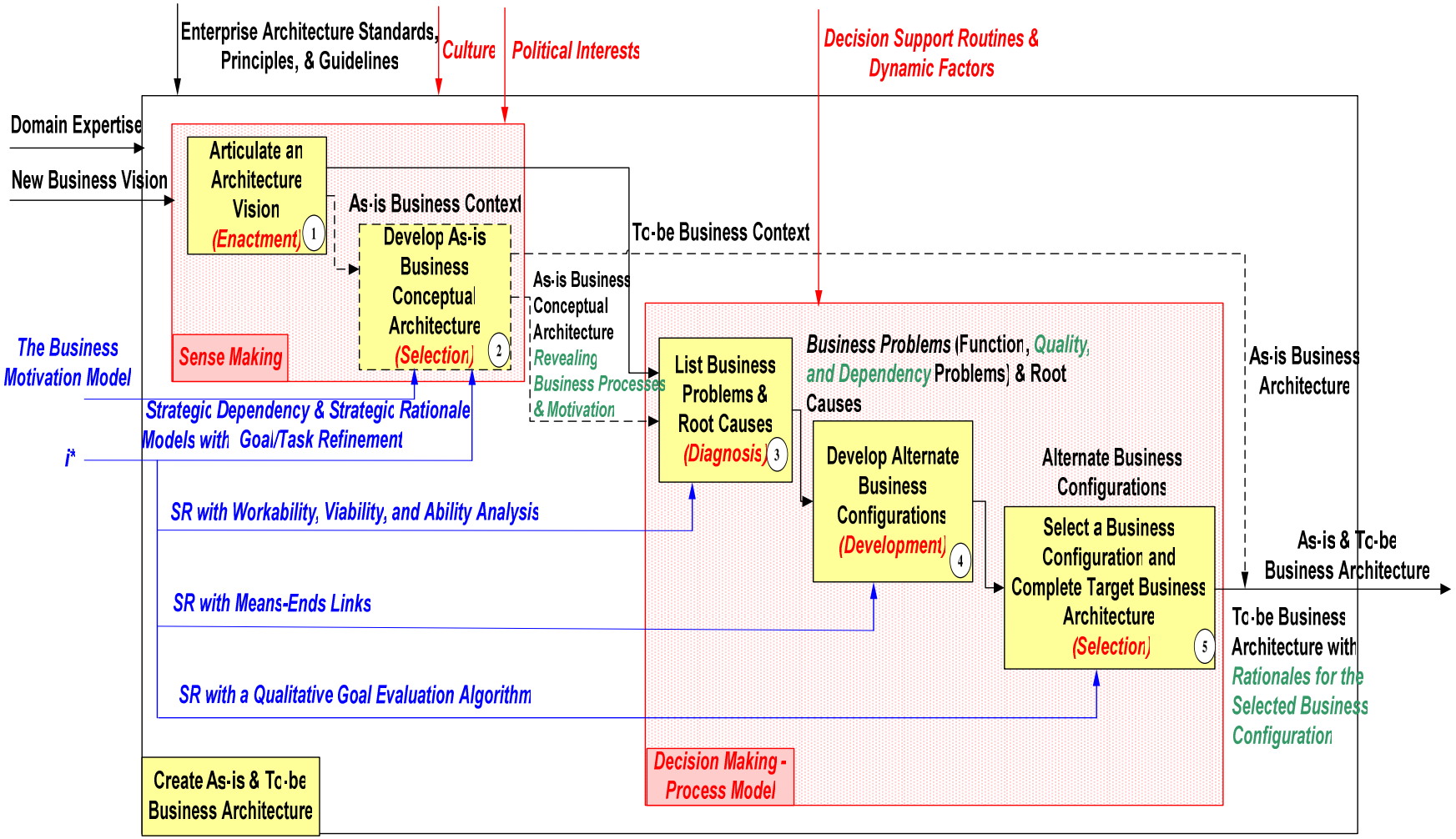


Figure 14: Framework for incorporating intentional models into enterprise architecture

Compared to the original process, the blue italic input(s) for each activity presents additional IM techniques that could help with the activity. The arrows are shown as entering from the bottom to indicate that the techniques serve as "mechanisms" for the activities, as in the SADT sense (Ross, 1997). They are not consumed by the activities. The red italics present new KM concepts applied to the process. The green italicized output(s) for each activity presents additional features of the artifacts produced by the activity with the help from new KM concepts and IM techniques. Again the dashed lines present optional activities as some change may not be based on as-is situation.

Triggered by a new business vision, the enterprise will "Articulate an Architecture Vision" (Activity 1 in Figure 14) which includes both as-is and to-be business context (i.e., Row 1 in Zachman's framework). This enactment process is where the enterprise chooses which part of the business vision the architecture will focus on, i.e., the business scope under considerations, participants to be solicited, and influence to be wielded.

Once the architect makes sense of its current business context, he/she needs to "Develop As-is Business Conceptual Model" (Activity 2 in Figure 14) based on the "As-is Business Context" to reach an agreement among stakeholders on how the enterprise works. This is a further sense making process as shared assumptions and experience formed through communication and socialization among members at this stage constrains the way that people in the organization perceive their world and their future decisions (Choo, 1998). To better construct the current business architecture, the enterprise needs to not only understand "what is going on in the business and the environment" but also "why this is taking place". The BMM could enhance the sense making process by exploring the rationales for applying a business process and business

rule. Moreover, the BMM could help make sense of the external environment by identifying external influencers and their impacts on the organization's means and ends. However, the BMM does not stress the importance of knowing the interrelationships among the influencers and does not provide specific connections to business processes. On the other hand, Strategic Dependency diagrams of the i* framework could help the enterprise better understand the strategic dependencies among the enterprise and its stakeholders. Strategic Rationale diagrams with detailed task decomposition could reveal business processes, some of which were often embedded in humans or machines. If the processes are not represented explicitly, then it becomes difficult to understand and extract the reasons behind the processes for further modification and inspection. The result of this activity is the "As-is Business Conceptual Architecture Which Reveals Business Processes and Motivation". With the "To-be Business Context" showing the possible business problems and opportunities, the enterprise is ready to construct its to-be business architecture.

Once the enterprise has "As-is Business Conceptual Model" and "To-be Business Context", it needs to "List Business Problems and Root Causes" (Activity 3 in Figure 14) to reason out why current business models will not work for the target business context. The problems could include functional deficiencies, dissatisfaction in quality requirements, and weakness in terms of fulfilling stakeholders' dependencies. These are referred to as business' "hurt points" in this thesis. Besides seeking domain expert's advice, the workability, viability, and ability analysis associated with SR diagrams would help the enterprise find out these "hurt points" and reveal the cause-effect relations required in this *diagnose* phase. The BMM has limitation for this step as it does not

formally state quality requirements as well as not illustrate business processes.

Then the enterprise could “Develop Alternate Business Configurations” to address the gap (Activity 4 in Figure 14). From the previous step, the enterprise should already have an idea of what goals, softgoals, stakeholders’ dependencies are not sufficiently achieved and where the problems occur, i.e., where “hurt points” are located. By identifying the “hurt points” and following the means-ends links originating from the “hurt points”, the enterprise should be able to develop a solution space with potential migration strategies.

Having all the potential strategies, the enterprise needs to “Select a Business Configuration” which balances goals, softgoals, and dependencies of all stakeholders (Activity 5). Based on the knowledge needs identified in KM research, the i* framework offers more comprehensive knowledge to facilitate decision making than other modeling techniques including the BMM. The i* framework explicitly defines the organizational quality goals, which is important for defining preferences or selecting rules. Using i*’s qualitative evaluation mechanism, the enterprise could systematically evaluate the potential outputs of available solutions as well as their contributions to the goals so that the enterprise can select a solution with explicit rationales.

As mentioned previously, decision support routines and dynamic factors will control the decision making process. In addition, culture plays an important role in both sense making and decision making processes. Shared assumptions and experiences in the sense making model constrain the way that people in an organization perceive their world, and people in different cultural environments may have different decision premises which control organizational choice making.

Even though loops are not presented explicitly in the diagram, due to the dynamic factors of change, the enterprise may go back from one activity to any of the previous activities to re-make sense of the environment, re-diagnose the problems, find new solutions, and/or re-evaluate available alternatives.

The five activities will be elaborated in the following sections. The focus is on the changes to the construction process after the application of IM. Each step will be illustrated using the health claims payments example.

4.1 Activity 1: Articulate an Architectural Vision

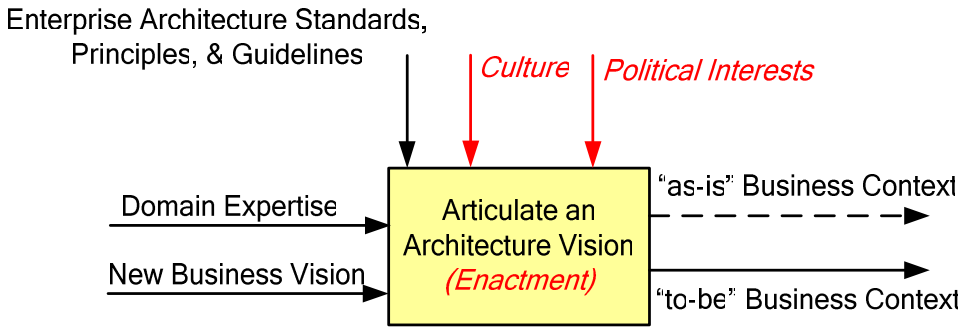


Figure 15: Articulating an architecture vision

The first step for an architectural change initiative is to articulate an architectural vision. From a KM perspective, the main purpose for this enactment step is to define the part of the environment the enterprise is facing and needs to attend to. To be more specific in the EA context, this step is:

- To ensure that the architecture being undertaken has proper recognition and endorsement from the corporate management of the enterprise, and the support and commitment from the necessary line management.

- To validate the business principles, business goals, and strategic business drivers of the organization.
- To define the scope of and to identify and prioritize the components of the current architecture effort.
- To define the relevant stakeholders and their concerns and objectives.
- To define the key business requirements to be addressed in this architecture effort and the constraints that must be dealt with.
- To articulate an architectural vision that demonstrates a response to those requirements and constraints.

To accomplish this step, the architect needs to bracket the information which only falls within the scope of the architectural work as well as make sure every important element is included. What information to be included is based on predefined architecture standards and guidelines as well as the organizational culture and political interests. The architect then needs to categorize these elements into different perspectives of the EA, i.e., what, how, who, etc., and then identify the relationships of the elements within each category or cross category.

This is a high-level business activity conducted on behalf of the business planner. The artifacts for this step consist of lists, tables, maps, and informal models in order to organize the information that defines the total context and the scope of the architecture work.

The following table summaries how changes in as-is business context will define a new business context which reveals the potential business opportunities, problems, and risks.

Table 3. Transformation from as-is business context to to-be business context

Artifact	As-is Business Context	To-be Business Context	Implication
What	Fundamental elements in the business environment, such as business goals and strategies	Change to the fundamental business elements	Changing business elements reflect new business definitions which may result from changing mandate, target groups and needs.
How	Current strategies for business	New strategies for business	Changing strategies reflect new approaches that the enterprise will take to meet its mandate. There are a number of drivers for new strategies including: changing mandate; fiscal constraint etc. Changing strategies lead to the definition of change initiatives to implement change.
Where	Current physical locations for the business	Change to the business locations	Changing locations reflect new target groups, new needs, or new strategies.
Who	Identifies target groups and sub-groups: client groups and interested parties	Change in target groups and /or change in sub-groups of client groups and interested parties	Change in target groups represents change in business mandate.
When	Current events and event cycles	New events or event cycles	Driver for changing events or event cycles may include new target groups, new needs, new strategies or new mandate.
Why	1. Current business outcomes, impacts and performance measures; 2. Identifies needs of	1. New outcomes, impacts and performance measure; 2. Reflects changing needs of target groups	1. Changes to goals (outcomes and impacts) will result from changing mandate, target groups, and needs;

	target groups to be met; 3. Defines the current mandate of the business.	as a result of observed trends; 3. Reflects change in mandate, usually the result of changing the authority source.	2. Changes in the needs of a target group have to be considered by the enterprise. May reflect a changing environmental driver; 3. Changing mandate requires new business definitions.

4.1.1 Business Context for a Health Claims Payments Case

Government health systems employ a claims payments program to pay doctors for providing insured services to eligible patients. The size of this program are growing. For instance, prior to 1975, in the Government of Ontario, a system was built to pay these claims submitted by doctors on a fee-for-service basis. The billing system has evolved to serve over 12 million eligible health care clients, over 26,000 licensed health care providers and over 156 million claims a year (MOHLTC, 2005a). In general, such a health claims payments program is also responsible for providing health encounter data to information users based on health claims. As the number of claims increases and information sources are getting more and more complex, the legacy systems employed by these programs are not able to meet stakeholders' needs. Incomplete or inconsistent information is provided to information users, and inaccurate payments are paid to health care providers. Lacking a business perspective, a Claims Processing Units could fail in its attempts to use advanced IT solutions to fix the problems. By adopting an EA approach, the Claims Processing Units could use business architecture as a structured tool to diagnose business problems including emerging requirements, unknown cost of service delivery, multiple clients with conflicting priorities, etc. The case aims to present a generic health claims payments program and demonstrates how a typical Claims

Processing Unit could apply the proposed framework to support business change.

Articulating the as-is and to-be business version for the health claims payments case is the task for Activity 1. Table 4 shows a partial sample of the produced artifact. Currently, there is no methodology guiding the transformation. The following table is just one way to do it for the case study.

Table 4. Business context for the health claims payments case

Artifact	As-is Business Context	To-be Business Context
How	Claim Stabilization and Strategic Planning; Alternate Channel Distribution Strategy; Information Management Strategy; Claims Service Delivery Operations.	Same strategy, but needs to change parts of the business to further achieve business goals. Building to-be architecture will help the enterprise come up the solutions to deal with the change.
Who	Health Care Client; Health Care Provider; Policy/Program Owner; Population Health Information User;	The same as as-is with increasing needs from each stakeholder.
Why	1. Target group Needs: · Payments for authorized health care services; · Population Health Information Access. In such a way that ensures *Accountability, Accuracy/Integrity* *Audibility, Availability, Choice* *Convenience, Efficiency, Privacy* *Reliability, Simplicity* 2. Business Mandate: Delivers quality processing of claims payments and/or reimbursements to a large number of physicians and other providers, diverse both in location and provider-type with low cost. The Unit is also responsible for the successful management of complex systems and information related to claims history, and effectively and efficiently pays health care providers entitled to submit	1. Changing needs of target group as a result of observed trends: increasing number of claims and increasing needs in terms of quality of services. 2. Need to be one step closer to business mandate.

	claims for insured services, while ensuring the necessary safeguards are in place to minimize errors, misuse and fraud.	

4.2 Activity 2: Develop As-is Business Conceptual Architecture

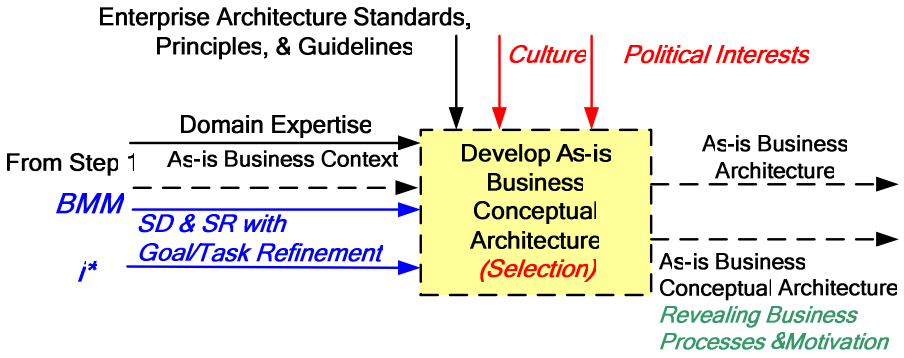


Figure 16: Develop as-is business conceptual architecture

Once the as-is business context has been constructed, further details about the enterprise are needed to reach agreement among stakeholders. The central questions concerning this sense making selection phase are "what is happening in the business and in the environment?", "why is this taking place or needed?", and "what does this mean?" In EA practice, enterprises often overlook the "why" question without considering the process from a KM perspective. While translating these knowledge needs to the EA context, the questions that the resulting as-is business architecture needs to reveal are:

- What is the organization doing to achieve its goals?
- Why does it do things the way it does it?
- What are the organization's dependencies with its environment?
- What impact does the environment have on the business?

To answer these questions, information about how the business operates, what are

the dependencies between the organization and its environment, and how the environment impacts the business' operations should be gathered. The architect can seek these kinds of information through broadly scanning the influencing elements, noticing special events to do further analysis, and interpreting them through verbal disclosure with domain experts or look up past business and architecture documents. Again, the nature and extent of the census developed through this process could be impacted by the organizational culture, and how the situation is interpreted could be impacted by the organization's political interests.

In the EA context, to answer the questions, the architect would need the knowledge about business goals, existing courses of action, business directives, and the motivation behind these elements. To further find the motivation, the architect needs to identify relevant stakeholders and their relationships with and their impacts on the enterprise. However, the required business knowledge is often located in people's minds or dispersed among many documents. Whatever explicit knowledge that might exist is too difficult to analyze in their current forms. As a result, it is hard for the architect to scan the environment and find out noticeable elements. The architect needs to make the knowledge explicit so that they can be analyzed. As introduced in the Literature Review section (section 2.3), most conventional modeling techniques are not suitable to help answer such questions. They tend to focus on "what" and "how" rather than "why".

4.2.1 Utilizing the BMM to Explicitly Express Business Motivation

BMM could be one suitable tool to reveal the motivation behind business in a systematic way. The enterprise can construct a BMM by instantiating the concepts in the

metamodel (see Figure 9) with adoption of the enterprise's own situation. The BMM contains information about three sets of concerns: means and ends; influencers, their assessments and potential impacts; and the impacts on the means and ends. All the links in the BMM are bi-directional. The forward traceability shows impacts of influencers on business strategies, business rules and organization's responsibilities, and the backward traceability demonstrates why the enterprise does what it does the way it does it. By following the links, the questions raised in the beginning of this section can be answered by the BMM either using a single set of concern or cross reference among the three sets of concerns.

1. What is needed to achieve what the enterprise wishes to achieve?

This question is answered by laying out the particular elements of a business plan. In another word, this refers to the *means* necessary to achieve the desired *ends*.

2. Why does each element of the business plan exist?

This question is answered by identifying the particular *ends* that each of the *means* serves. This is illustrated in the first set of concern, and the *influencers* that underlie the choices made in this regard is illustrated in the third set of concerns. This is what is meant by *motivation*.

4.2.2 Business Motivation for the Health Claims Payments Case

From the background description, we can construct the BMM for the health claims payments program using the UML notation (see Figure 9). The following BMM

diagrams (Fig 17- 20) show a sample format of presenting the BMM concepts and their relationships. In the diagrams, the tags (such as the one named Mission) represent concepts appearing in the BMM metamodel, and links between them are meta-level links types (such as *make_operative* and *made_operative_by* links, which are referred by using italics). The rectangle below each tag is an instance of the concepts (such as Claims Stabilization & Strategic Planning, in the following explanation, Arial Narrow is used to refer to an instance of a BMM concept) and a link between two instances is an instance of the link type between the two instances' meta-level concepts. If an instance links to a composite instance, it means it has relationships with all the composing instances. For example, the strategy Claims Stabilization & Strategic Planning *channels effort towards* the goal Delivery Quality Processing of Claims Payments means that the strategic planning *channels the efforts towards* both sub-goals of Delivery Quality Processing of Claims Payments. Note that the following diagrams contain only a small fragment of the information for the case study which is considered enough for illustrating the BMM. For industrial adoption, software tools need to be developed to facilitate interactive visualization and manipulation of the models.

The first set of concerns is about what the Claims Processing Unit wants to achieve and the means it uses to achieve them. The overall vision for the claims unit contributes to provide An Accessible Health System That Promotes Wellness and Improve People's Health of Every Stage of Their Lives as Close to Their Home as Possible. The vision is *made operative by* its mission, which is to Co-ordinate and/or Facilitate Payments and Reimbursements.

The claims unit has two major goals: Provide Quality Processing of Claims Payments to a Large Number of Health Providers and Successful Management of Complex Systems and Health

Information. The first goal could be *decomposed* into the following sub-goals: Timely and Accurately Processing of Payments to Health Care Providers, Diverse in Location and Provider Type and Low Operational Cost. The second goal could be *decomposed* into Enhancing and Augmenting Systems to Achieve Health Transformation Goals and Ensure the Necessary Safeguards are in Place to Minimize Errors, Misuse and Fraud. There are two strategies to support the achievement of the goals. The course of action Claims Stabilization and Strategic Planning *channels efforts towards* the first goal. The strategy Alternative Channel Distribution Strategy is aiming to Allow Claims Processing to Be Done in Diverse Locations and Provider Types. Information Management Strategy, as one of the major health transformation strategies, has three focuses: 1). making the data that describe cost, quality, and resources in the health system more accurate, readily available and comprehensive, while reducing the overall costs of data collection; 2). transforming the data into performance measures that will enable the Ministry to track progress against key goals; 3). integrating the data and measures into decision support structures that will enable the Ministry plan for further improvements in patient care and make decisions that are in the best interest of patients. It will definitely *channel efforts toward* the goal concerning system and health information management.

Directives also *support the achievements* of desired results. As in the health case, there are both federal, provincial, and claims processing specific directives. The directives are divided into three categories: act/legislation, policy and agreement. Health Insurance Act oversees the whole health claims processing. That's why it links to both of the major goals. Protection of Privacy Act is in place to protect the usage of certain information, such as clients' personal and some health information. I&IT Strategy is to

regulate and guide the management of health systems and information. The Result Based Plan is to help lead better results in the quality of the claims process, in terms of time, accuracy, agility of the services, and cost effective. The Interprovincial Billing Agreements and the Payment Agency Agreements are definitely helpful to achieve the goal of Providing the Claims Services in Diverse Locations and Provider Types.

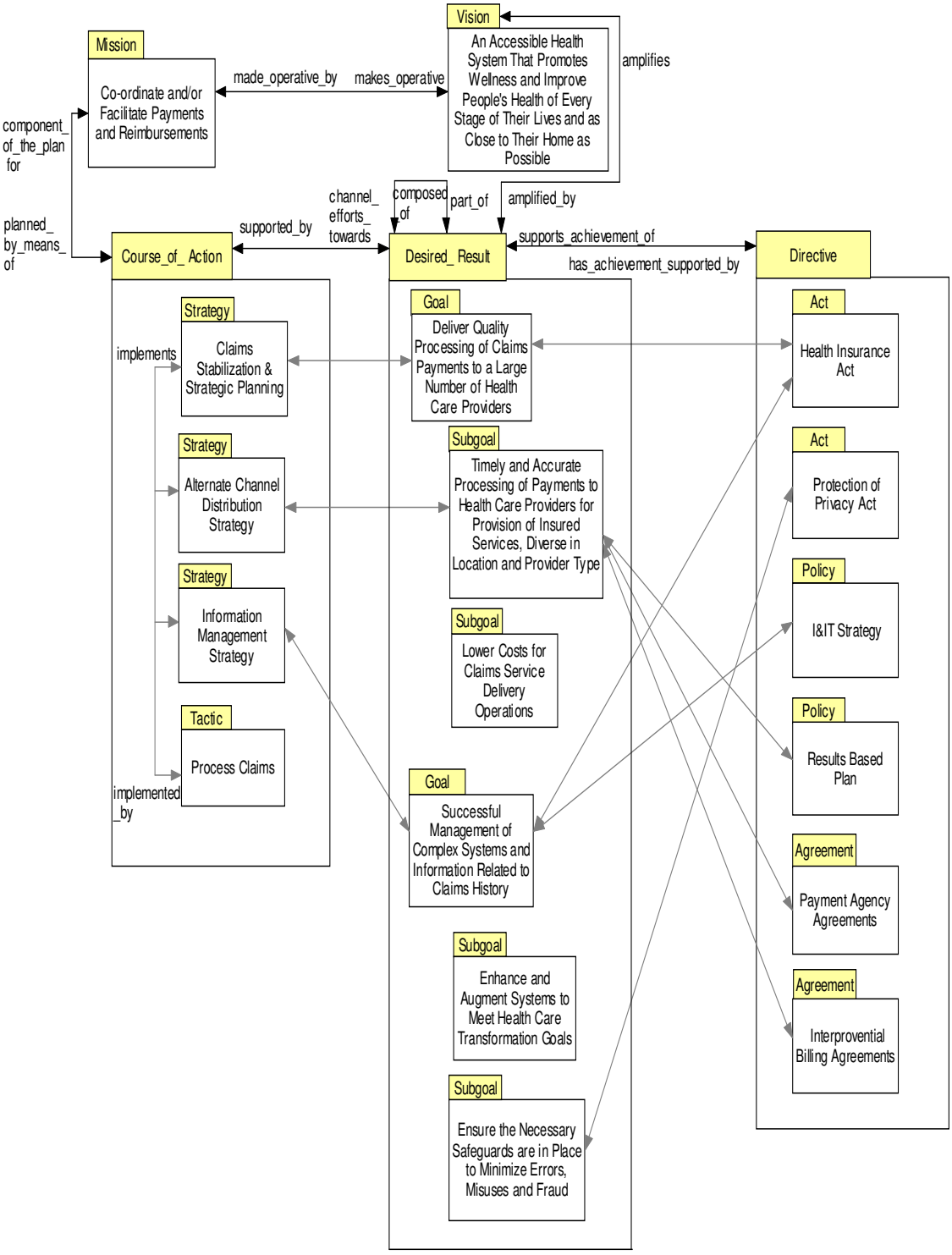


Figure 17: Business means and ends for the health claims payments case

Meanwhile, directives should *govern* courses of action as well as could be source of actions (see Figure 18).

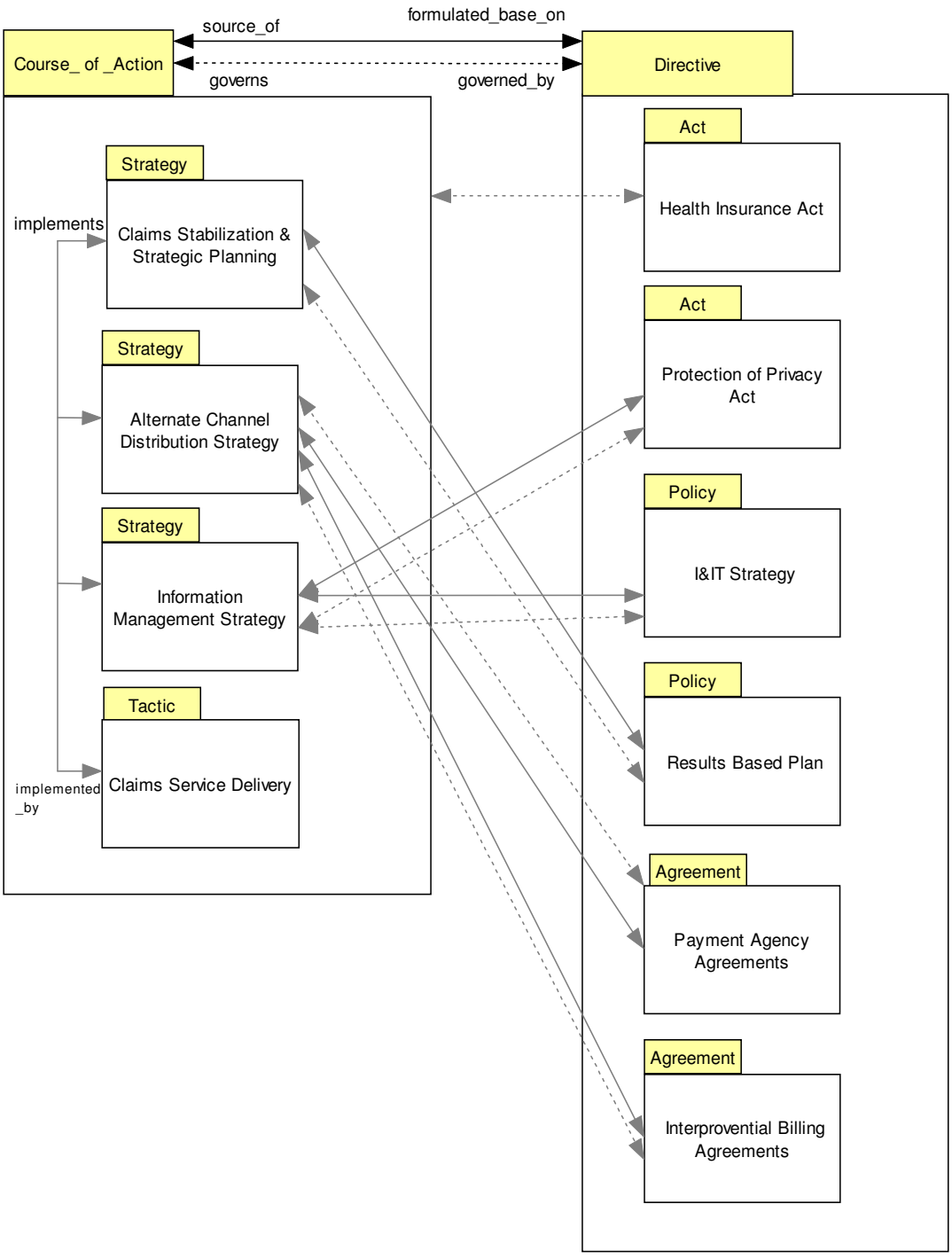


Figure 18: Directives and courses of Action for the health claims payments case

Influencers are vital if enterprises want to understand the business motivation. Figure 19 lists existing influencers, the Claims Processing Unit's assessments on them and their potential impacts.

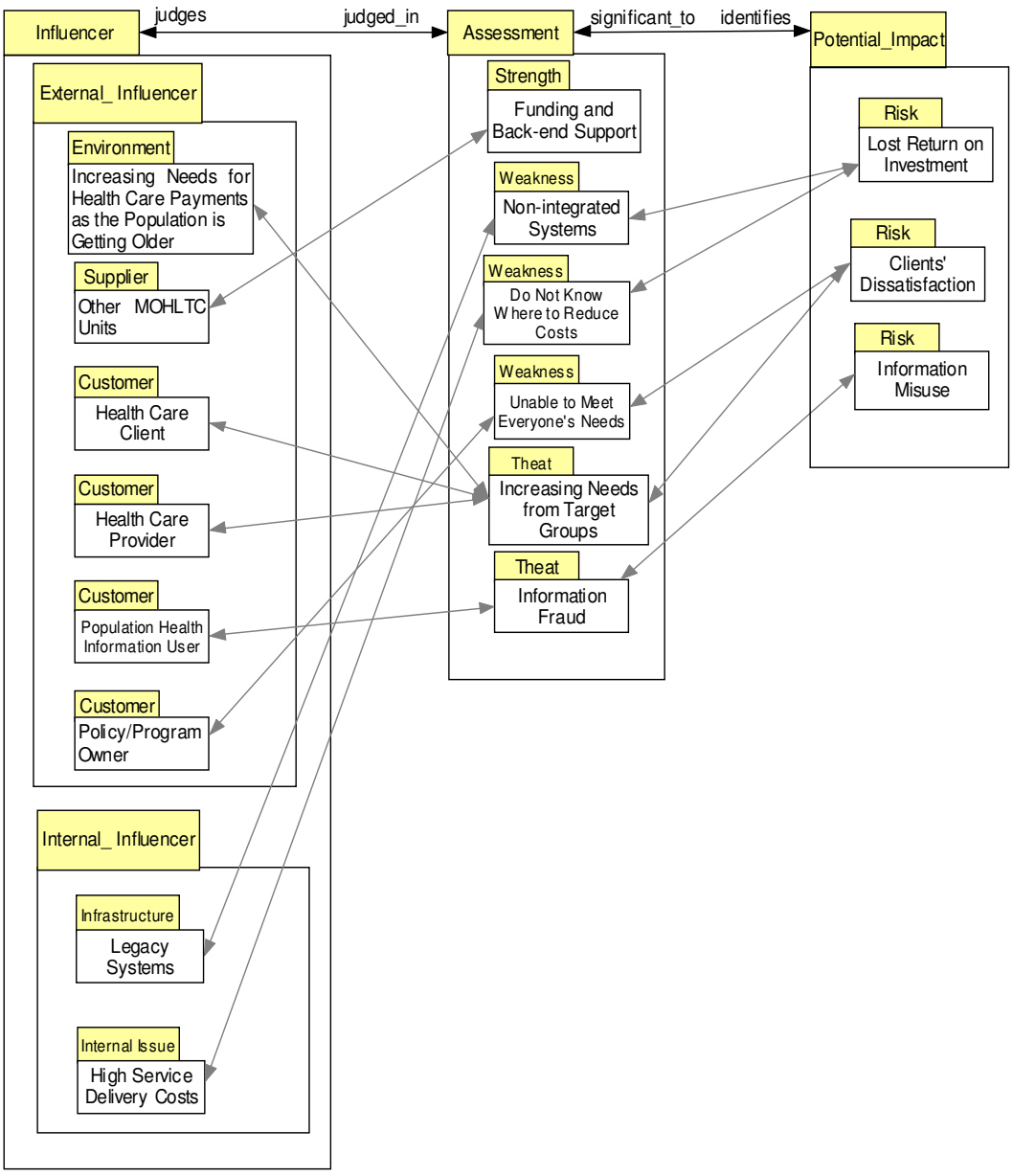


Figure 19: Influencers, assessments, and potential impacts

Not all influencers listed on the BMM have strategic influences on the unit. Some important external influencers including the environment – increasing needs for

healthcare, increasing number of claims and increasing requirements for health information; *suppliers*-Other Health-Related Unites, such as Financial Services Unit and Registration Services Unit, which provide back-end supports; customers- Health Care Provider, Health Care Customers, Population Health Information User, and Policy/Program Owner who depend on the unit to process payments. Internal influencers include two most concerned business issues: Unknown Service Delivery Cost and Legacy Information Systems. Influencers could present strengths and weaknesses, opportunities and threats. Strength is the support from other units. Weaknesses include Large Investment in Non-Integrated Systems and Unknown Service Costs. These weaknesses cause Potential Lost on Investment Return and stakeholders' needs not being met. Since the unit is responsible for many programs, the resources of the unit have to spread over all the programs. The priority is determined by the government. Therefore, not all programs will be given the same priorities. One threat that presents in front of the unit is Increasing Needs for the Services from Both Health Care Providers and Clients. Another threat is Information fraud from the information users, which could cause the risk of Information Misuse.

These influencers and their assessments and impacts are the fundamental motivation for the unit's means and ends (see Figure 20). The goals in the business plan could *be judged in* the assessments on the influencers. For example, the highlight in the following diagram shows that Ensuring the Necessary Safeguards is in place to address the threat Information Fraud. At the same time, influencer assessments and their potential impacts *provide impetus for* directives. For example, Protection of Privacy Act is *motivated by* Information Fraud and Misuse.

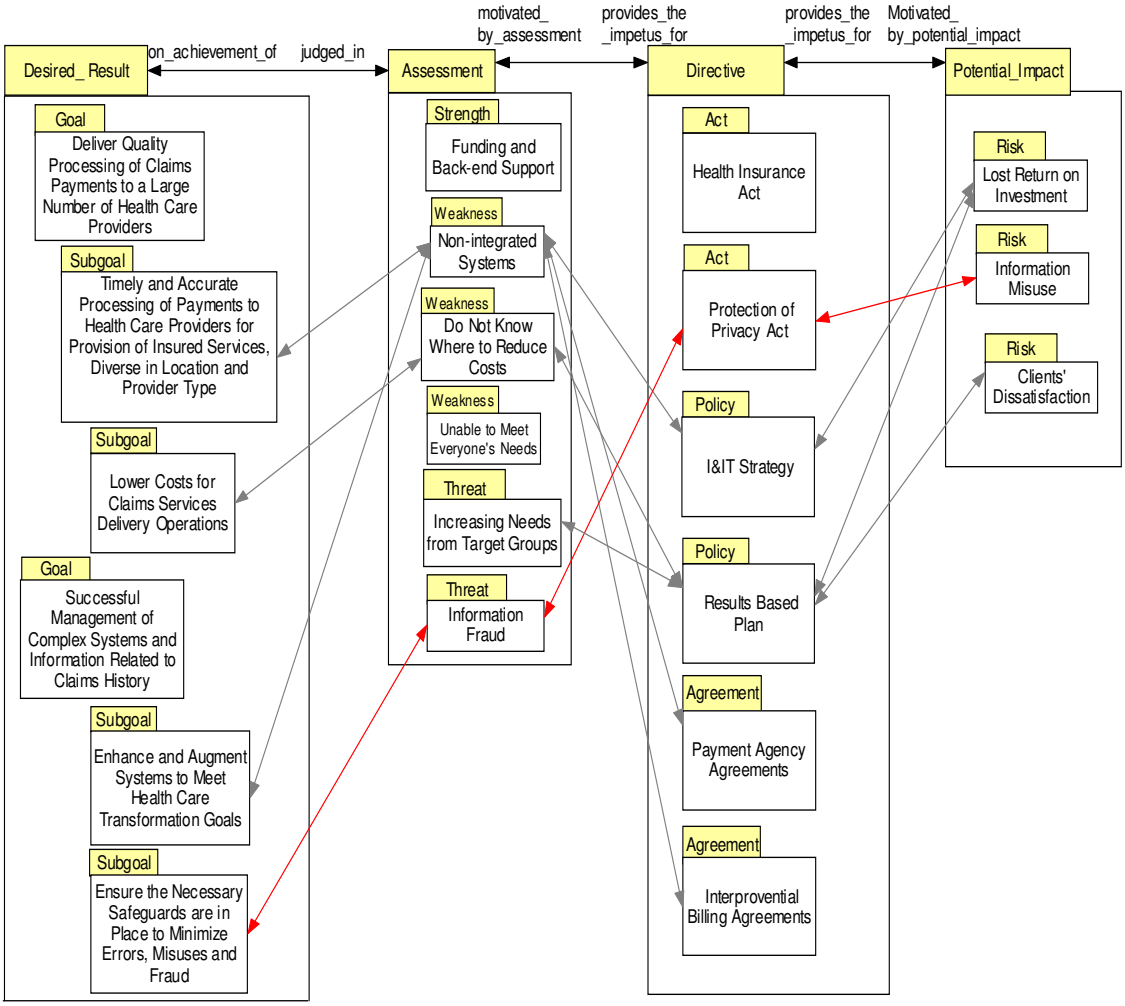


Figure 20: Assessments and potential impacts on means and ends

Now the unit gets more information to answer the questions: what is needed to achieve what the enterprise wishes to achieve and why does each element of the business plan exist?

In Figure17, the courses of action which realize an end and the directives which support the achievement of the end are exposed by following links emanating out from the end. The courses of action and the directives connecting to the high-level goals indicate the effect on all of the sub-goals. For example, considering the action Ensure the Necessary Safeguards are in Place to Minimize Errors, Misuses, and Fraud, the architect can follow the link coming out of the goal and see that the Claims Processing Unit needs to

follow the Protection of Privacy Act. In addition, to achieve the information and system management goal as a whole, we need the support of Information Management Strategy as well as I&IT Strategy.

In Figure 20, by traversing the links from the desired results to assessments, we can see why a goal exists. By following links from a directive, we can find out what assessments and potential impacts provide impetus for the directive. The relationships between influencers and their impacts (see Figure 19) will help further find out which influencer causes a specific assessment and potential impact. The goals Augment and Enhance Systems and Place Safeguard in Place are to address the assessment Information Misuse on Population Health Information User. At the same time, the assessment *provides impetus for* I&IT Strategy as well as Protection of Privacy Act. Figure 17 shows that all the assessments have reflection either on directives or ends, or both, except that the weakness Unable to Meet Everyone's Needs is not reflected anywhere. This raises the need to further analyze who is having what kinds of conflicts with whom.

To further the analysis, the architect could identify some improper elements of the business plan by following some of the constraints stated in the BMM (BRG, 2005).

First, the architect can see whether a business rule is unused and therefore superfluous. Any business rule which addresses none of the influencers, means or ends, will be challenged. Does it perhaps support some older means or ends that are no longer relevant to the enterprise? Was it a workaround for some historical information system deficiency or organizational issue that is no longer relevant? Figure 20 shows that all directives address some assessment, and Figure 19 shows that every directive addresses some influencer.

Second, according to the BMM definition, if an assessment is related to both a means and an end, then this suggests that the particular means is somehow related to the particular end. If there is not a link relating them, then careful consideration should be given to that omission. Figure 20 demonstrates which means and end relate to the same assessment, and Figure 17 tells whether the means and the end are related to each other. For example, the assessment Information Fraud *provides impetus for* Protection of Privacy Act and it is an achievement of Ensure necessary Safeguards in Place to Protect Information from Error, Misuse, and Fraud (See the highlight in Figure 20). Then from Figure 17, this directive actually supports the achievement of the end. On the other hand, the assessment of Do Not Know Where to Reduce Cost is *on achievement of* the end Lower Cost of Payments Operation and *provides impetus for* Result Based Plan. However, there is no link relating the means and the end because the unit has difficulty in finding where the cost occurs, and therefore could not provide a specific directive. There is a need to further analyze the cost problem, which is done later in this research.

4.2.3 Strategic Dependencies among Stakeholders

Business change deals not only with new products and services per se but also changes in the role of the various actors and in the relations among them. “Business enterprise is, increasingly, a question of organizing and co-coordinating the interaction between various resources and resource bearers” (Wikstrom & Richard, 1994, p18). Therefore, it is important for an enterprise to have a clear picture of the interconnected network among different parts of its environment. Some changes to the inter-relationships may also cause adjustment to the enterprise’s means and ends. For

example, some previous partner may align with some competitor. Then should the enterprise still treat the partner as a partner or a competitor? Will this cause serious risks? These will definitely have impacts on the enterprise's goals and strategic relationships with the stakeholders, but these kinds of inter-relationships are not expressed in the BMM.

In the i* framework, the SD model sees each agent as a strategic actor who attributes intentional properties, such as goals, beliefs, abilities, and commitments to each other and reveals the distribution of responsibilities among actors. It can be used to understand the situation from multi-stakeholders' perspectives.

The SD diagram can further elaborate on the stakeholders identified in the BMM as external influencers. For each stakeholder, the architect will ask what goals, tasks, softgoals, or resources dependencies they have and on whom they depend. An influencer's dependencies on the enterprise could be taken from the *assessment* and *potential impacts* identified in the BMM and assigned with proper dependency types. However, not all elements in the business plan could be directly applied without further refinement. For example, Increasing Needs from Target Groups should be further refined to more specific needs according to deeper knowledge about these groups. The enterprise's dependencies on others could be taken from the *ends* in BMM, especially those that could not be achieved by the enterprise' own means. Furthermore, to analyze the dependencies among the influencers, the architect may need to use his/her experiences and communicate with others to gain the knowledge. Again, not only goals, tasks, and resources but also softgoals need to be taken into consideration. Softgoal dependencies are needed when there are quality requirements associated with some "hard" tasks or

goals. This modeling process will help the enterprise make more comprehensive assessments about its influencers.

4.2.4 Task Decompositions for Revealing Business Processes

Moreover, to understand "what is going on here", the enterprise needs to reveal what business processes are delegated to achieve its goals. As business becomes more complex, process knowledge is often embedded into the process performers (e.g. humans or computers) so tightly that the reasons, rules, services, relationships and flows became difficult to understand or extract for modification or inspection. Means in the BMM do not indicate either the steps (business processes and workflow) necessary to exploit it nor responsibility for such tasks, but rather only the capabilities that can be exploited to achieve the desired Ends. The *business processes* concept in the BMM is actually a placeholder for processes, and it refers to other notations for modeling business processes, such as the OMG's Business Process Definition Metamodel which is still in the process of being developed (BRG, 2005).

Task-decomposition links in SR models could provide a hierarchical description of intentional elements that make up a *routine*. The *means-ends links* in the SR could provide understanding about *why* an actor would engage in some tasks, pursue a goal, need a resource, or want a softgoal.

From the BMM, the enterprise has already known the top level business goals, strategies and tactics to achieve the goals. To ease the difficulties of revealing processes stated above, we need to further refine the goals, strategies, and tactics into detailed business processes, i.e., subgoals, operational tasks, and/or resources. This is a process

revealing detailed processes and linking them ("how" knowledge) to business functional goals ("why" knowledge). There are also other models to present processes, like data flow diagrams. Different from these diagrams, i* allows different levels of details to be shown in one picture. Moreover, i* task decomposition diagrams allow an architect to do workability analysis of a high-level process to decide whether there is a workable routine for carrying out the process, which is not available in other modeling techniques.

Note that there is an option to model a process either as a goal or as a task. This provides the architect design freedom. On one extreme, making each process a goal will make whole design have the maximum freedom to consider alternatives; on the other extreme, making each process a task will limit the alternate solutions. Most of the times, the architect will use a combination of tasks and goals. If the enterprise is doing a process in alternate ways, or the architect anticipates there will be an alternative, such as the way competitors are operating, then the architect could model it as a goal. If the architect could not anticipate or the enterprise does not want an alternative when the enterprise is satisfied with the current way of carrying out the process, then the architect can model it as a task. Later on if the enterprise finds that the process does not actually work the way it wants, the architect can always come back and change the task to a goal and consider possible alternatives.

4.2.5 Strategic Dependencies and Business Processes for the Health Claims Payments Case

The initial focus is on the dependencies between the Claim Processing Unit and each of the other stakeholders. There are eight other stakeholders based on the influencer

analysis from the BMM: Health Care Provider, Health Care Client, Population Health Information Use, Policy/Program Owner, Financial Services Unit, Registration Services Unit, and Relevant Health Agency. The SD diagram in Figure 21 shows an overview of the major stakeholders involved in the claims payments case and their strategic dependencies on the Claims Processing Unit. Each of them will be considered in turn.

The Claims Processing Unit *depends on* Health Care Provider, the doctor, to Submits Claims Requests Including Health Encounter Data, and the provider *depends on* the unit to pay Claim Payments/Reimbursements. As described before, the number of claims is increasing. The services should be provided in such a way to ensure Accountability, Accuracy of Payments, Auditability of Incorrect Payment, Availability of the Service, Convenience, and Efficient Processing Time. At the same time, the Claim Processing Unit *depends on* the Health Care Provider to be Accountable for Claim Information Provided.

The patient, Health Care Client, *depends on* the Claims Processing Unit to maintain the Privacy of Personal and Health Information. The unit *depends on* the patient to verify whether they did receive the services from the doctor (Verify Services Received).

The Population Health Information User is the requestor of information gathered and held as a result of the claims processing services. He/she Submits Information Requests to the unit and *depends on* the unit to provide Accountable Health Information, as well as, is expected by the unit to Abide by Health Information Usage Regulations. There are various kinds of Health Information Users, the Public, Researchers, Other Public Service Sectors, and Health Decision Making Organizations.

The Policy/Program Owner is any organization that is accountable for Developing Insurance Policies/Programs. At the same time, it *relies on* the unit to process payments

Abiding by the Policy. Finally, the Financial Services Unit provides Disbursed Payments to the claim unit; the Registration Services Unit is the unit where doctors and patients register for the insurance program. The unit provides Client and/or Provider Registration Information; Relevant Health Agency is responsible to send Reports and Complaints of Providers to the claims unit.

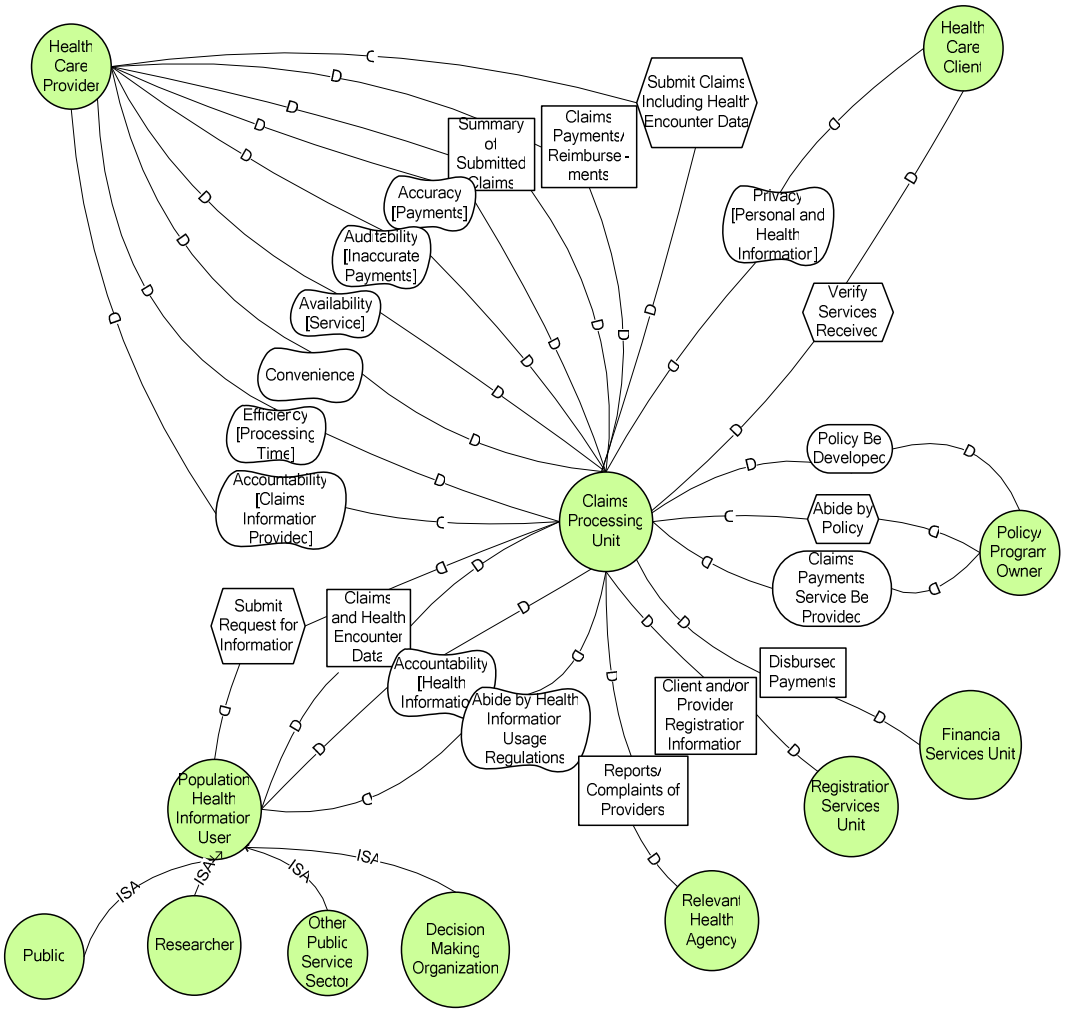


Figure 21: Strategic dependencies between the Claim Processing Unit and other stakeholders

Now it is time to look at dependencies among the other stakeholders (see Figure 22). These dependencies are important because non-fulfillment of the dependencies could also trigger change and have impacts on how the business reacts to the change. The gray

parts are direct relationships between each stakeholder with the unit, which are taken form Figure 21. The Health Care Client needs Insured Service Be Provided by the doctor, illness to be treated as fast as possible (Fast [treatment]), and personal and health Information be kept private (Privacy [Personal & Health Information]). As the population is getting older, there is Increasing Needs for Treatment. The doctor needs the client to provide Insurance Information to submit claims. At the same time, both the doctor and patient need to Abide by Policy set by the Policy/Program Owner. Since the health policies are strictly defined, a task dependency is more appropriate than other types of dependencies. The patient also wants the policy to be beneficial to them (Beneficial [Program/Policy]), such as the agility of service, location and service diversity, and increased coverage. To improve a policy, the Policy/Program Owner will need the Population Information User to provide improvement suggestions (Policy Improvement Be Suggested). The quality of the suggestions will *depend on* the Accountability and Availability of the information provided by the unit.

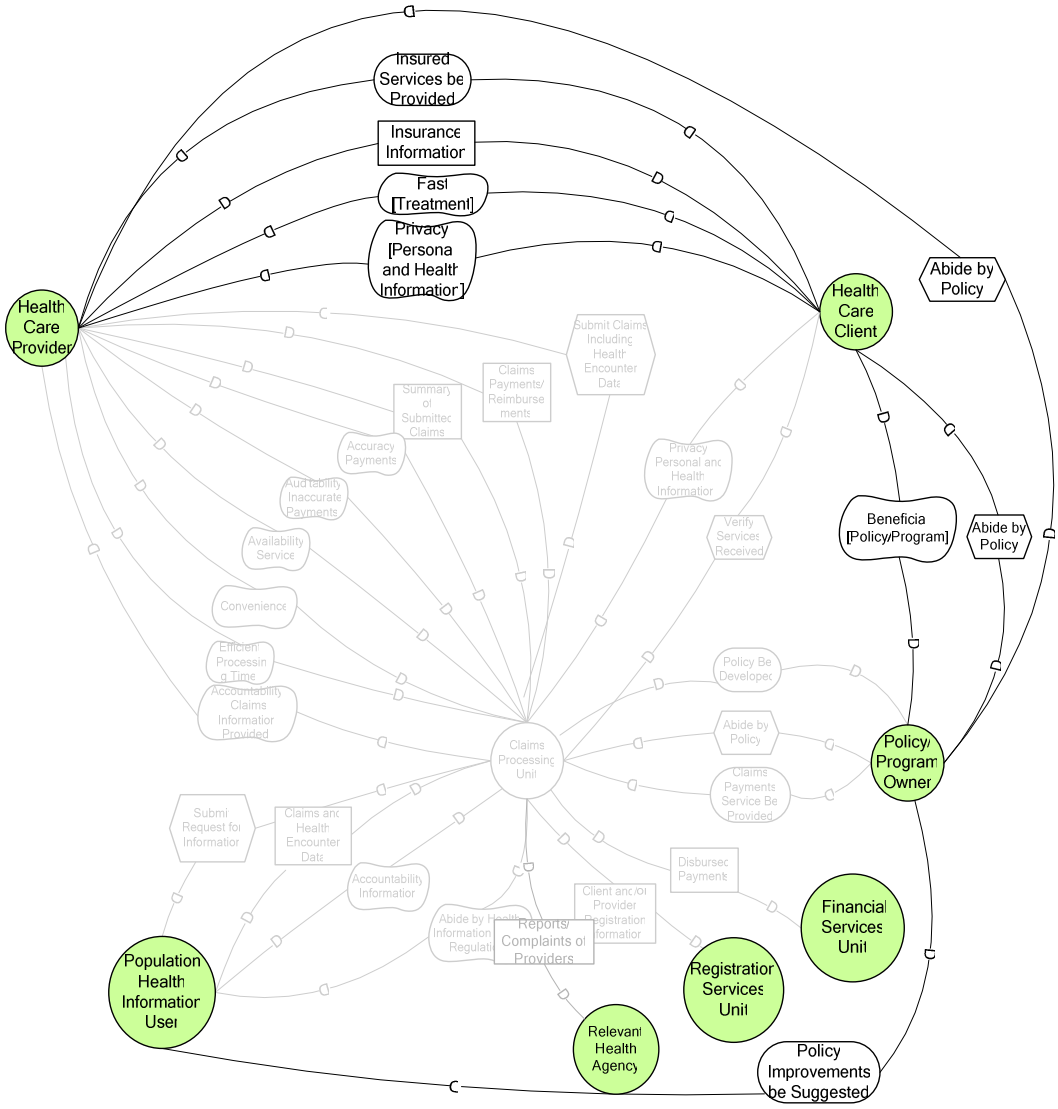


Figure 22: Additional dependencies among stakeholders

Having laid out the dependencies, it is time to go one step further to investigate how business processes are arranged to fulfill the responsibilities of the enterprise. We can use the strategic rationale models from the i* framework to represent the processes.

In the health claims case, the unit's top task is Claims Processing which includes sub-tasks Process Claims Requests and Provide Claims & Health Encounter Data. At the same time, the unit wants Quality Services and Low Cost (see Figure 23).

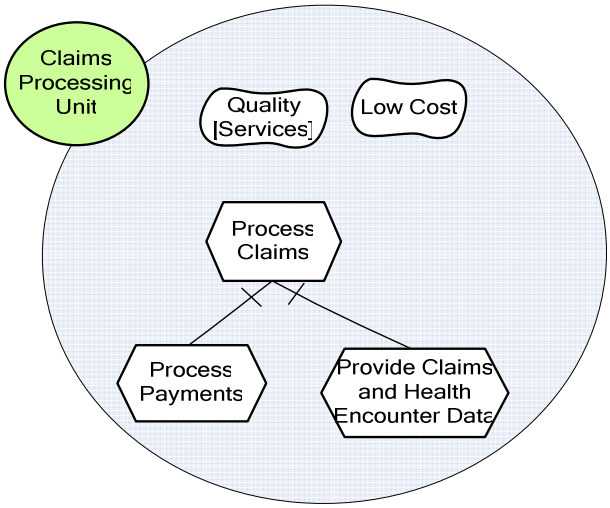


Figure 23: High level business tasks

Then the architect can go one step further to refine the top tasks (see Figure 24). To Process Claims Requests, the unit needs to Collect Claims, which could be done in one of the three ways: Collect Claims on Disk and on Paper, which are two conventional ways and Collect Claims Requests via Electronic Data Transfer (EDT) (MOHLTC, 2005b). EDT allows the unit to Place Safeguards to The System, only to allows authorized users to submit claims (Claims be Collected from Authorized Users). Currently, claims are collected from doctors, but there are other ways like collecting claims from patients. Therefore, Claims be Collected from Authorized Users is a goal to give modelers space to anticipate exploration of alternatives. Then the claims should be verified. Prior to payment, claims undergo a computer screening process to assess the amounts payable. Detection of Improper Claims Post Payment is done in one of the three ways (MOHLTC, 2005b):

1) Send Verification Letters to Patients: Every month, patients are randomly chosen and the claims summary is sent to them.
2) Further Computer Screening: Various sophisticated computer tools are used to screen all physician claims.

3) Get Complaints/Reports from Other Health Agencies: Complaints or reports are gathered from other internal or external sources, including observations of Ministry claims, staff and medical consultants, specifically requested ad hoc statistical reports, complaints from the public, health care providers and health care workers, and other resources.

After computer screening, the unit needs to Disburse Payments and Summarize Paid Claims for the purposes of sending the summary to the doctor and analyzing the encounter data. To Provide Claims & Health Encounter Data, the unit Collect Service Requests, Process the Required Data, and Make the Data Available. Some of the tasks further depend on other stakeholders, such as Collect Claims from Doctors *depends on* the doctor to Submit Claims Including Health Encounter Data.

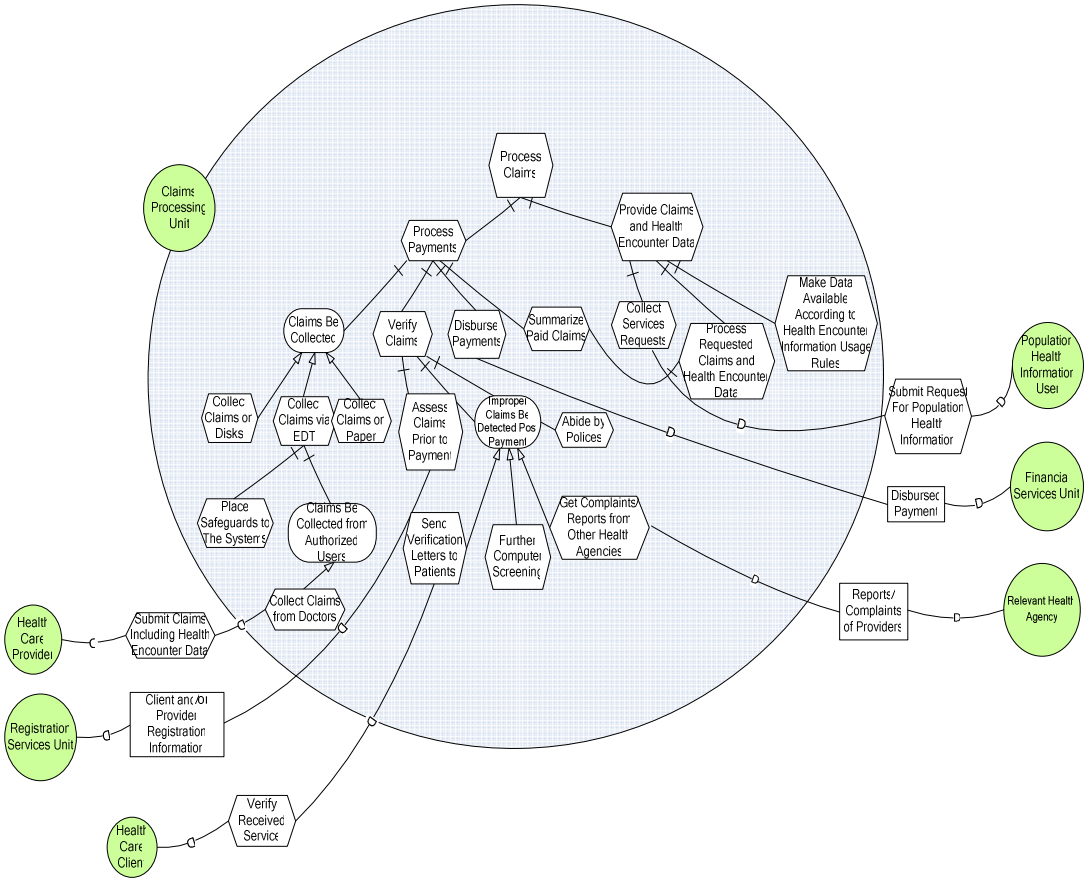


Figure 24: Process decomposition

Even though this study presents both the BMM and i* with the BMM implemented first, it is just one scenario of using the modeling techniques. There is no suggestion that it is mandatory to follow this process. The enterprise should be clear about what problems they are trying to address and adapt the techniques in a way that is most suitable for solving the problems.

To summarize, in Activity 2, we used intentional modeling to understand the business motivation in order to build "as-is" business architecture. The BMM offered high-level business means, ends, and influencers with their impacts. The i* framework offered a comprehensive dependencies among the enterprise and its stakeholders. The task decomposition model helped reveal the business processes which could be used to diagnose business problems.

4.3 Activity 3: Diagnose the Gap between As-is Business Processes and To-be Business Context

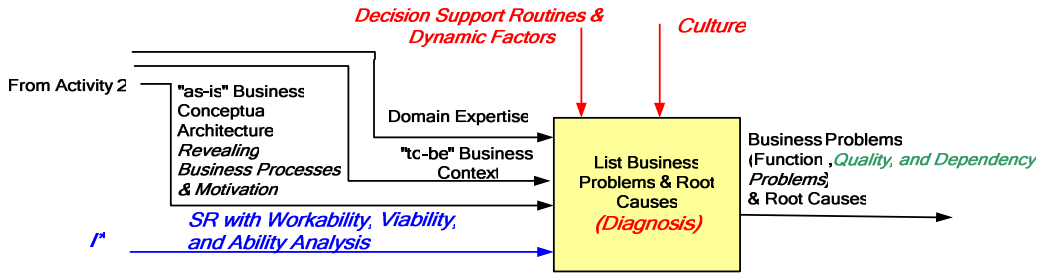


Figure 25: Diagnose Problems and Root Courses

Once an architect has the as-is business conceptual model and the target to-be business context, it is time to diagnose where the gaps between the as-is business processes and the to-be business goals are located. At this step, "management seeks to comprehend the stimuli initiating decision as well as the cause-effect relations relevant for the decision situation" (Choo, 1998, p.177). As in the EA context, gaps are not

limited to insufficient achievement of internal business functional requirements but also include quality concerns. Moreover, the gaps could come from insufficient ability to take on external stakeholders' dependencies. Thus, it is important for the architect to identify the cause-effect relations for all function, quality and dependency gaps.

Even though the BMM supports the analysis of weakness, it does not distinguish weaknesses in meeting functional requirements from those relating to quality requirements. Moreover, it does not specify to what extent the goals are not satisfied and which business processes are sources of weaknesses. Thus, it is hard to diagnose the problems and identify root causes. The same problems occur in other existing EA models and practice.

The decomposition, means-ends, and contribution links in the i* framework can help decision makers in "tapping of existing information channels and the opening of new ones to clarify and define the issues" (Choo, 1998, p. 179) and link low-level business processes to high-level business goals, both "hard" and "soft" ones. Once the architect has the linkages, he/she could do *workability, viability*, and *ability* analysis to determine the "hurt points" which cause the three kinds of gaps, respectively. "Hurt points" could be any node that makes other node unsatisfied. In this case, the researcher is looking for the lowest level of business processes which "hurt" top-level goals. The following sections will begin by explaining these types of analysis and then illustrate their application to the Health Claims Payments case study.

4.3.1 Workability Analysis

Workability is a concept introduced in i* to provide a simplified analysis of i*

models, ignoring the impacts of quality concerns expressed as softgoals.

A goal/task is workable if there is a workable routine for doing so. To determine workability, one needs to look at the workability of each sub-element of a goal/task. An element is workable if each sub-element of the goal/task can be judged to be primitively workable. If the workability of a sub-element could not be judged primitively, then it needs to be further elaborated through *decomposition* or *means-ends links*. A goal/task can also be workable by ways of external dependencies on other actors (Yu, 1997). By doing the workability analysis, the architect can find what processes exist and whether a higher level goal or task is workable by implementing those lower level processes. If a task/goal is not primitively workable, the architect can follow the links to trace down to the points causing the problem.

Based on the reduction of the top business goals into operational business processes, workability analysis helps an architect reveal answers to the following questions:

- Are existing business processes workable?
- What are the "hurt points" for unworkable processes?

4.3.2 Viability Analysis

The viability analysis offers a more detailed analysis by including softgoals in the evaluation. It is said that "a routine that is workable is not necessarily viable" (Yu, 1997, p. 230). Non-functional requirements (NFRs) (Chung,1995), such as performance, security, accuracy, reusability, interoperability, time to market and cost are often crucial for the success of a business solution or an information system and needs to be analyzed, specified, and enforced during solution implementation. Thus, the architect also needs to

analyze the viability of current processes. When softgoals are not satisficed, we say that the routine is not viable. The BMM does not clearly separate NFRs from other concepts and does not provide a mechanism to refine unclear softgoals. Therefore, it is hard to take the right actions to improve the quality requirements. In traditional modeling techniques, focus is more on functional requirements and quality attributes are typically omitted. *Softgoals* should be properly modeled and addressed in design reasoning before a commitment is made to a specific design choice. This problem is addressed in i* through distinguishing goals and softgoals, refining softgoals, and linking softgoals to low-level business processes through *contribution* links. Note that a routine which is not viable from one actor's perspective may be viable from another actor's perspective. Different people have different assessments, and even one person can have different assessments at different analysis stages.

The architect needs to first define the top softgoals and then refine them. The softgoals should be refined to a degree that problems could be identified. At the same time, the architect needs to trace back to where the softgoals coming from by scanning dependencies from other stakeholders to the enterprise. This goes one step further than the BMM in the sense that it provides traceability from influencers to non-functional requirements for the enterprise. Having the softgoals well defined, the architect can carry out viability analysis by linking the concrete operations identified in the workability analysis to softgoals. In some cases, a selected operation may introduce negative contributions to the softgoals. These contribution links provide traceability from "how" to "why".

Once the architect has the contribution relationships from tasks to softgoals, he/she can assign satisfied/denied labels to the tasks, and see how the softgoals are impacted by the operations by following the label propagation algorithm introduced in Section 2.3.

If a softgoal is not achieved to a sufficient degree, the architect can trace which operation(s) causes the dissatisfaction. If one high-level softgoal is not achieved, the architect can see exactly which low-level softgoal(s) causes the dissatisfaction and then further trace the operation(s) which causes the dissatisfaction of the low-level softgoal (s) by following contribution links. The dissatisfaction could be caused by a denial element which has positive contribution to the high-level softgoal, or by a satisficed element which has a negative contribution to the high-level softgoal. Viability analysis helps the enterprise answer the following questions:

- What quality requirements are important to the enterprise? Whose needs do they serve?
- How are they operationalized into specific processes?
- To what extent do current courses of action meet these quality requirements?
- What are the obstacles for the enterprise to achieve the quality requirements?

4.3.3 Ability Analysis

Moreover, the architect could also do ability analysis to see whether the organization unit (i* actor) has sufficient ability to take on stakeholders' dependencies. This could be done by following *dependency links* coming out from each stakeholders and going into

the enterprise and to see whether the dependencies are sufficiently satisfied by checking whether the dependency links to the business elements are satisficed or not. The ability analysis will reveal answers to the following questions:

- To what extent are the target groups satisfied with the enterprise's services?
- Whose and what dependencies are not sufficiently carried out so that change could be triggered?
- How is the enterprise supposed to react to the change?

4.3.4 Workability, Viability, and Ability Analysis for the Health Claims Payments Case

By applying the evaluation algorithm to Figure 24, the task Process Claims is determined to be workable since each low-level process is primitively workable either by having the work done inside the unit, such as Summarize Paid Claims or by having the work done outside the unit, such as Collect Claims from Doctors is made workable by the task dependency Submit Claims on doctors.

Figure 26 is the workability analysis result for the case, and figure 27 presents a sequence of reasoning when determining the workability of the goal Claims Be Collected.

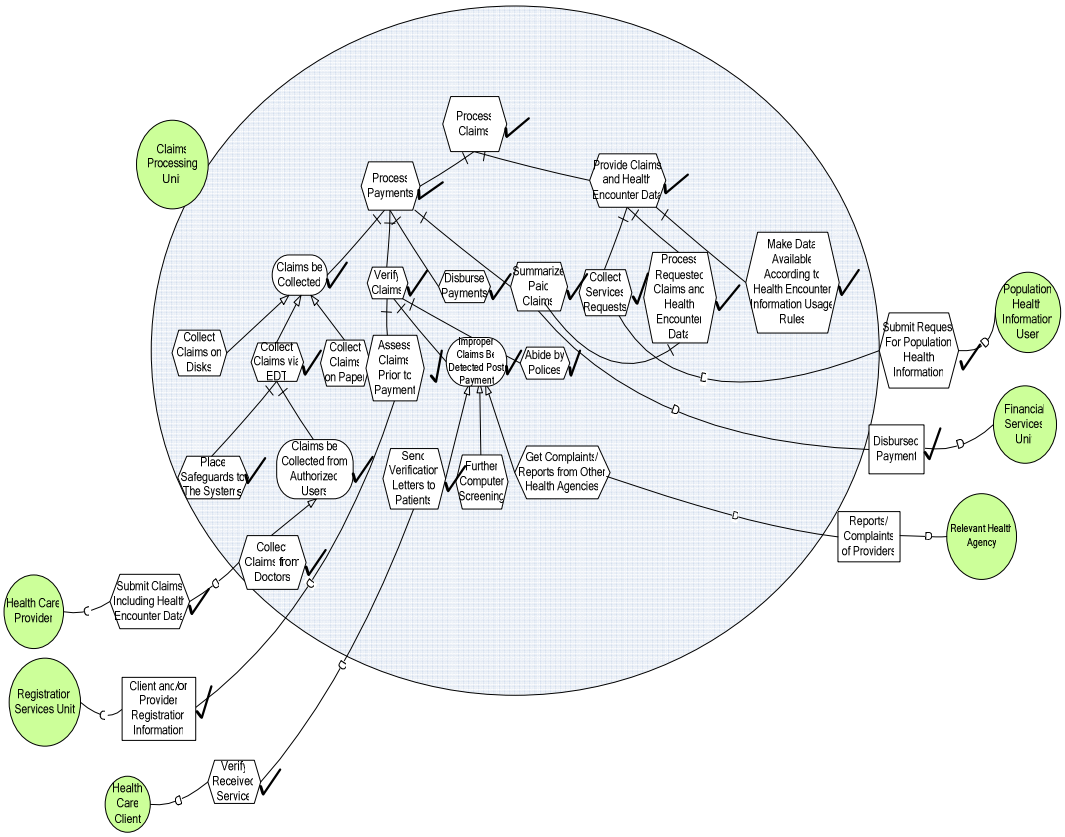


Figure 26: Workability analysis

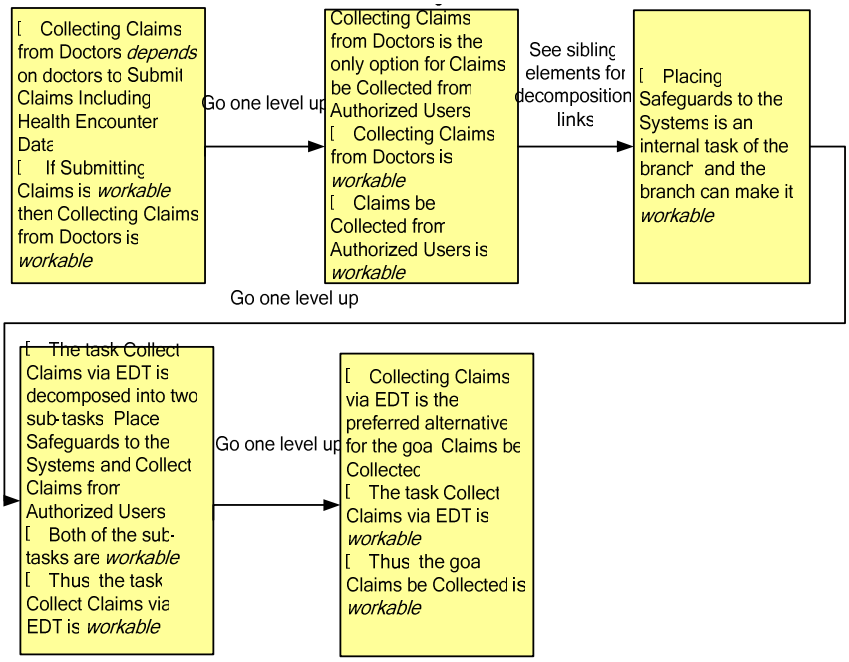


Figure 27: Sequence reasoning in workability analysis for Claims Be Collected

We now apply the viability analysis, from which the claim unit could find out the

needs for quality requirements, their operations, the extent they are achieved by the courses of action, and causes for the inadequate satisfaction of the requirements.

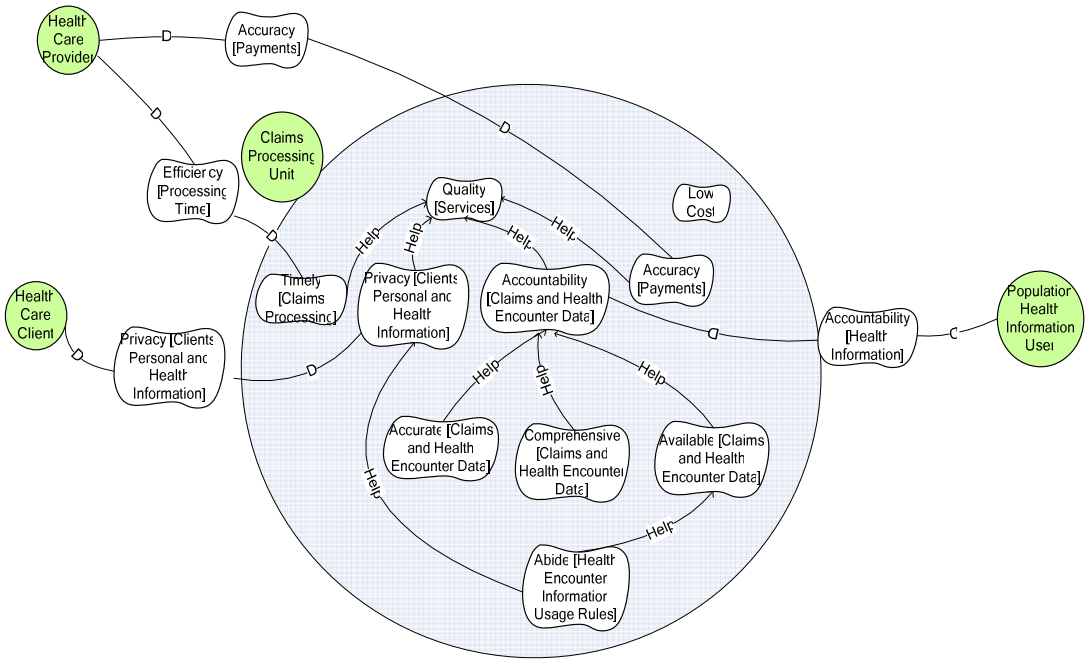


Figure 28: Softgoal decompositions

As previously identified in Figure 23 of Activity 2, the unit has two major softgoals, Quality of Services and Low Cost. Now in Activity 3, the architect needs to further refine these softgoals and use them to analyze gaps. Later in Activity 4, the architect could use these softgoals to guide in the exploration of new alternatives.

From Figure 28, we can see this top softgoal is decomposed as follow. Quality of Services implies Timely Claims Processing, Accuracy of Payments, Privacy of Customers' Personal and Health Information, and Accountability of Health Information. Furthermore, Accountability of Health Information means Accuracy, Comprehensive, and Availability of the information. Health encounter information usage rules regulate what kinds of information the unit needs to be made accessible to the public and what kinds of information should be maintained confidentially. However, it is hard to decide to what

extent privacy requirements are met. Thus, a softgoal is used to represent this requirement Abide by Health Encounter Information Usage Rules, and it *helps* Availability and Security of Health Encounter Data. From the diagram, we can also determine why the enterprise has such softgoals by tracing the dependencies coming from external stakeholders. For example, Privacy of Customers' Personal and Health Information comes from the Health Care Client's concern for Privacy for his/her Personal and Health Information.

After refining the softgoals, the unit can then link business processes to softgoals through contributions links. This is a critical step in determining the viability of business processes. The top half of Figure 29 is based on softgoal decomposition in Figure 28, and the bottom half is based on task decomposition in Figure 24. Again, the contributions and the evaluations which will be introduced shortly are based on the researcher's judgments.

Collect Claims via EDT (1) *helps* improve Timely Processing. Place Safeguards to The Systems (2) *ensures* the Privacy of Clients' Personal and Health Information. Collect Claims from Doctors (3) *helps* the Accuracy and Comprehensive of the information, but the process is judged to be too costly. Access Claims Prior to Payment (4) *reduces* the time for claims verification compared to manual check. Sending Verification Letters to Patients (5) verifies improper claims and has the unfortunate side effects of having more effort spent after claims are paid and more retroactive claims. Thus, when linking this process to softgoals, there are two additional softgoals the unit wants to meet: Less Effort Spent after Claims are Paid and Fewer Retroactive Claims. Sending verification letters has strong negative contribution (*break*) to the two softgoals, but these two additional softgoals *help* Low Cost and Accurate Claims and Health Encounter Data, respectively. Make Data Available According to Health Encounter Information Usage Rules (6) *helps* Abide by Health Information Usage Rules,

which further *helps* the Privacy of Clients' Personal and Health information.

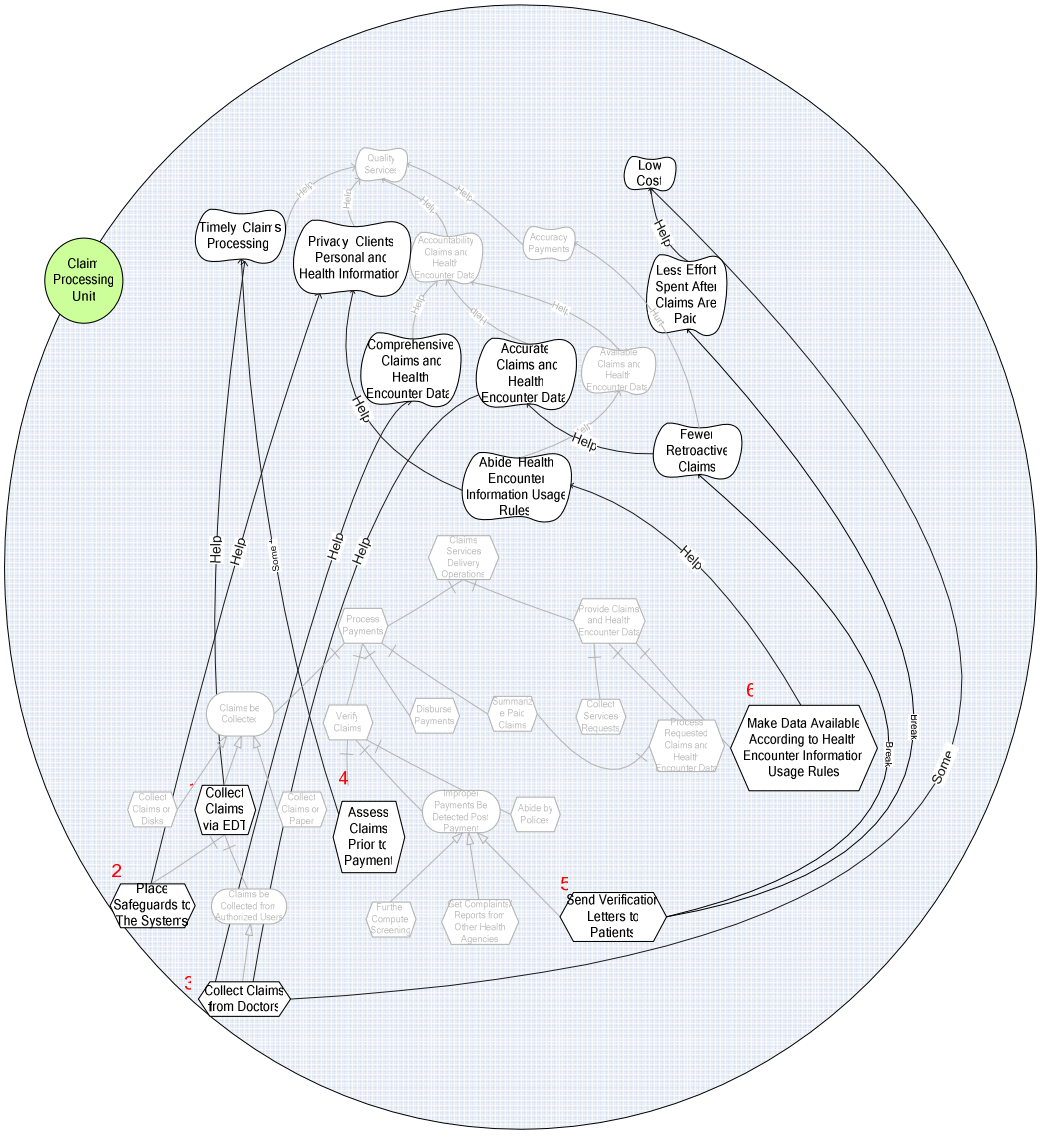


Figure 29: Link processes to softgoals

(The number in the diagram is used for referencing in the text, and they are not part of the modeling notation.)

Having linked the business processes to the relevant softgoals through contribution links, the unit can evaluate the achievement of the softgoals by assigning labels to the processes and propagate evaluations through the quantitative evaluation algorithm introduced in section 2.3. This is illustrated in the following i* diagram (see Figure 30). We start by assuming that Sending Verification Letters to Patients is properly carried out

(check mark). For example, since Fewer Retroactive Claims is "*broken" by* this verification process, it has a cross mark (i.e., denied). Furthermore, Fewer Retroactive Claims *help* Accuracy of Claims and Health Encounter Data. With the combination of the help from the denied softgoal Fewer Retroactive Claims and satisficed task Collect Claims from Doctors, the achievement of Accuracy of Claims and Health Encounter Data is *in question* (the unknown symbol - question mark with a dot on top). This process is where the architect's judgment comes into play to decide what kind of label should be assigned for each element.

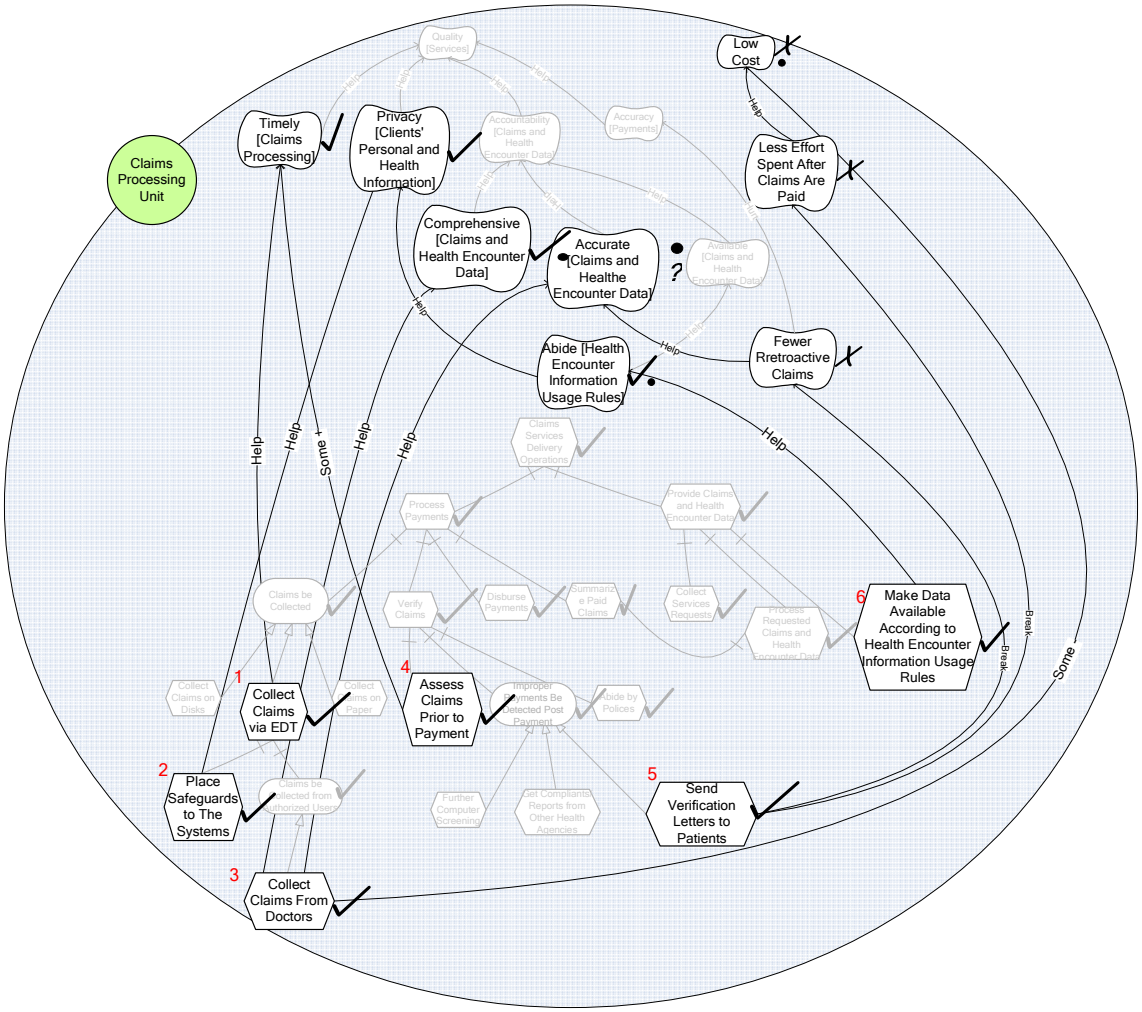


Figure 30: Viability analysis – Part 1

Figure 31 is the high-level softgoal evaluation for the health claims payments case based on the result of low-level softgoal evaluation shown in Figure 30.

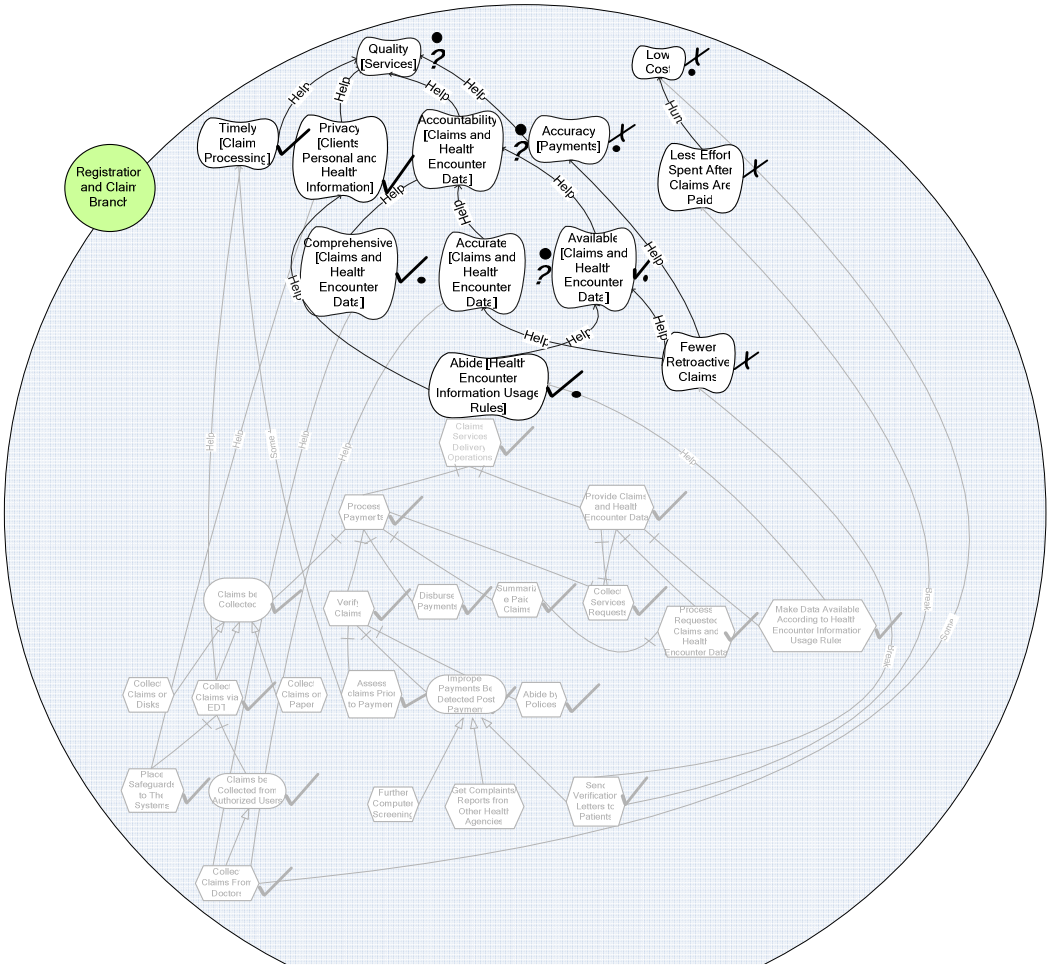


Figure 31: Viability analysis – Part 2

Combining both Figure 30 and Figure 31, the unit can identify unsatisficed softgoals and trace back to the root causes by starting from high-level softgoals to its associated low-level softgoals, and down to the contributing business processes. Figure 32 shows the steps of the reasoning process of finding “hurt points”, and Figure 33 presents a decomposed SR model to show how the unsatisficed softgoals are traced down to “hurt points”.

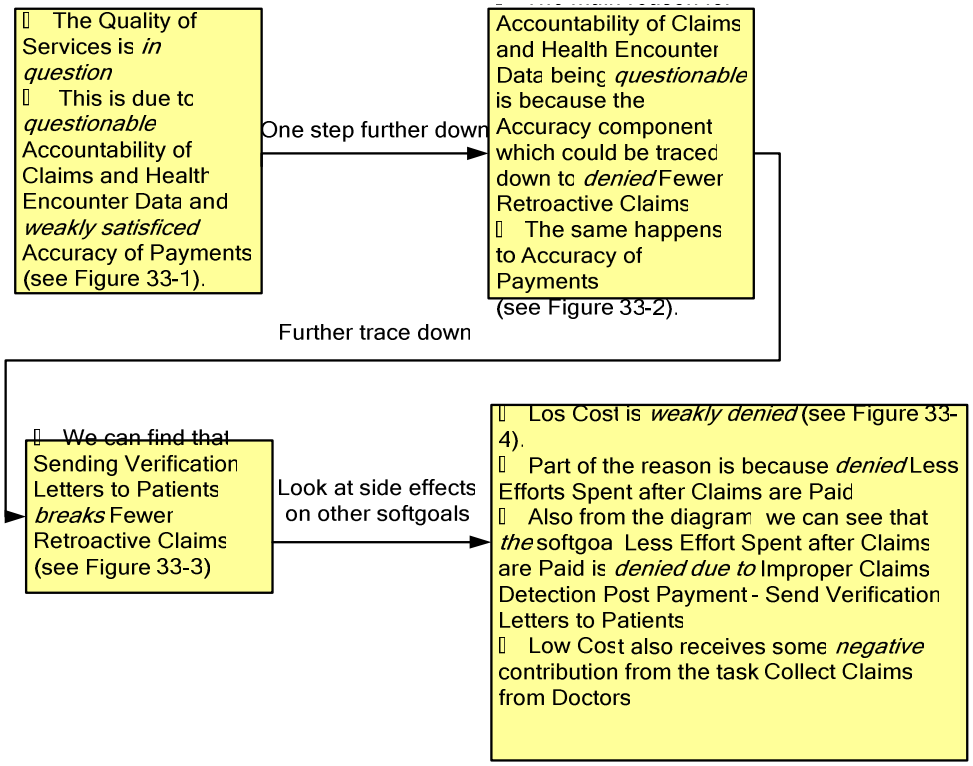


Figure 32: The logic to find "hurt points" to the unsatisficed softgoals Quality of Services

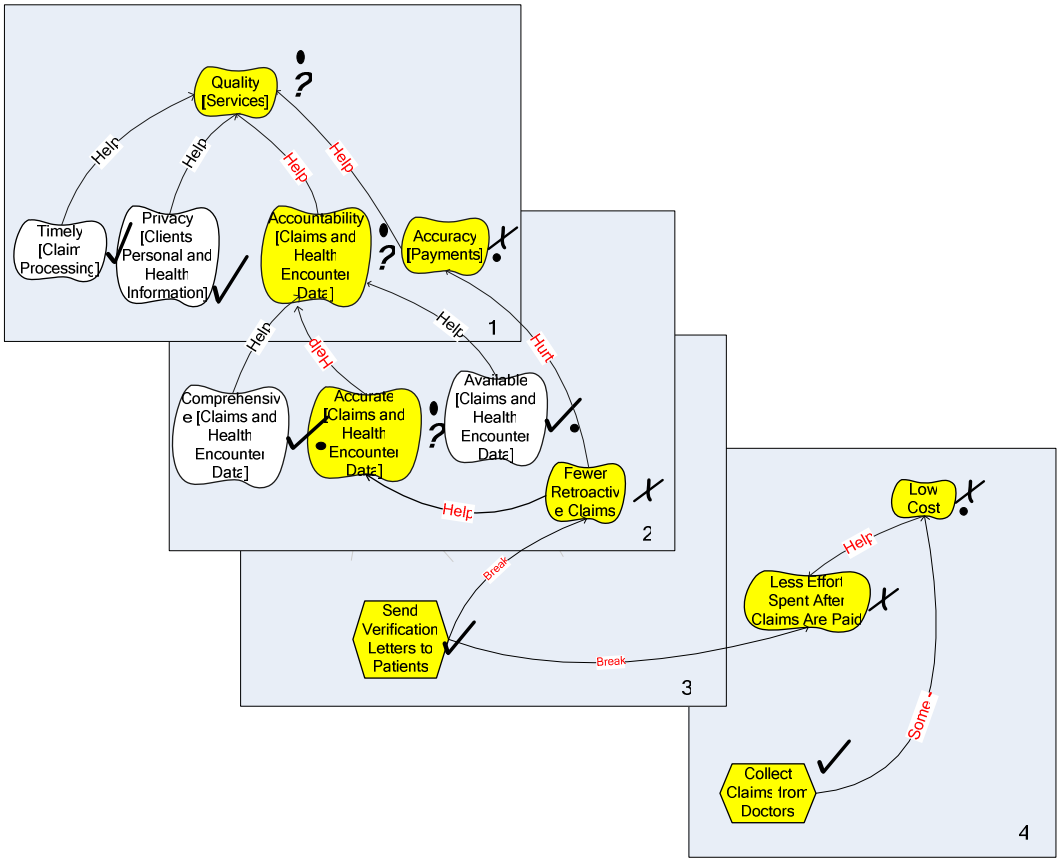


Figure 33: Finding "hurt points" to the unsatisficed softgoals Quality of Services

In summary, Send Verification Letters to Patients and Collecting Claims from Doctors are two major "hurt points" for the achievement of Quality of Service and Low Cost. From both the workability and viability analysis, we can partially diagnose the needs for change and the cause-effect relationships to find specific points that need to be diagnosed.

Having conducted workability and viability analysis, the next step would be to analyze the ability of the enterprise in terms of fulfilling other actors' dependency on it.

The following diagrams are based on Figure 31 showing the dependencies from stakeholders. Two dependencies are not sufficiently fulfilled.

- Health Care Provider (see Figure 34) - The softgoal Accuracy of Payments is *weakly denied* because Accuracy of Payments inside the claim unit is *weakly denied* which is caused by Sending Verification Letters to Patients after reimbursements have been paid.
- Population Health Information User (see Figure 35) - Accountability of Health Information is *in question* because Accountability of Claims and Health Encounter Data inside the enterprise is *in question* which is also caused by Sending Verification Letters to Patients after reimbursements have been paid.

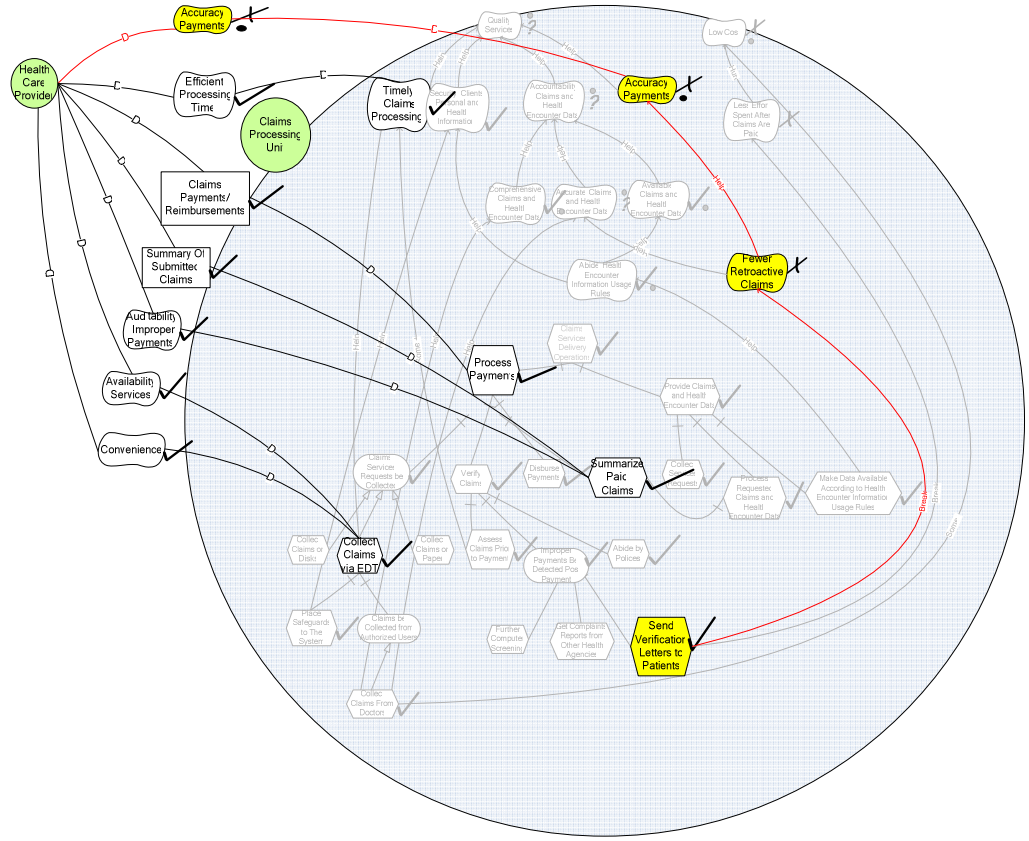


Figure 34: Ability analysis – Health Care Provides perspective

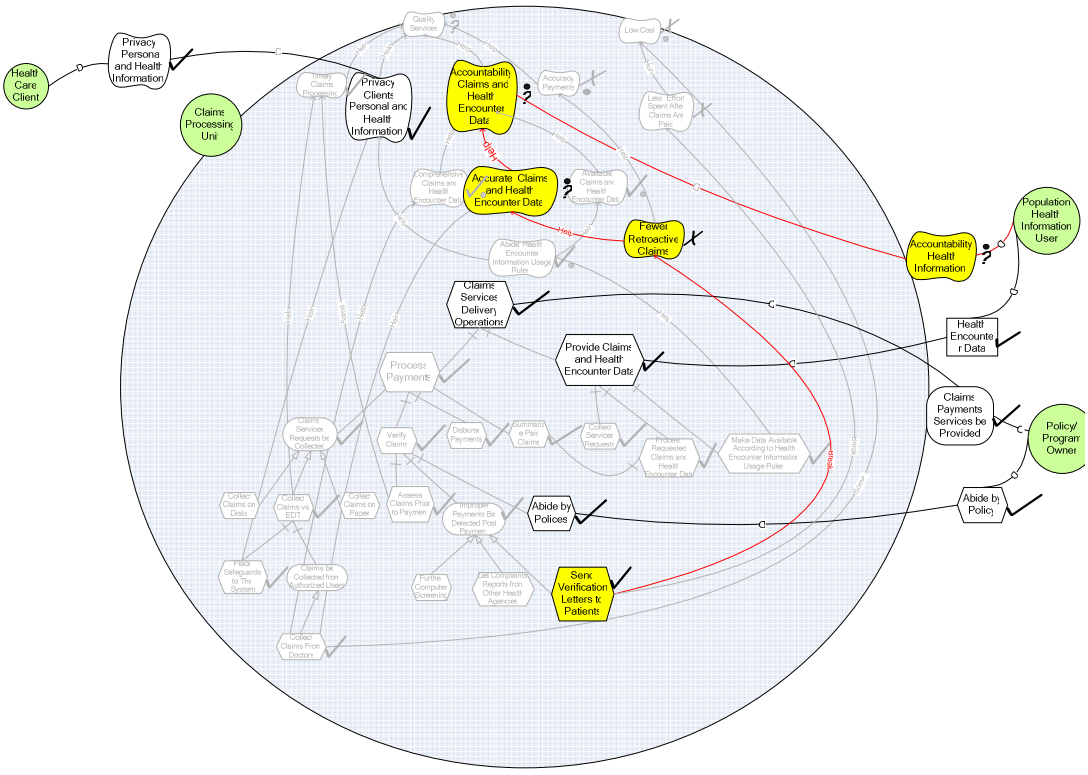


Figure 35: Ability analysis – Health Care Client, Information User, and Policy/Program Owner perspectives

Again as discussed above, interrelationships among actors could also trigger change.

In the health claims case,

- Client - regulation developer - population information user (see Figure 36 - Dashed Circle 1): The client wants his/her insurance to be really beneficial. The Policy/Program Owner needs some improvement suggestions for making changes to the policy/program from the Population Health Information User as he/she will analyze the information gathered and have some suggestions on insurance programs. To make sure the suggestions reflect reality, the information user needs accountable information, but it is uncertain whether this is satisfied.
- Client - Provider - Unit (Figure 35 - Dashed Circle 2): Since the unit needs to Collect Claims from Doctors, doctors could make Possible Secondary Use of Data, which *hurts* Privacy of Patient's Personal & Health Information. According to the researcher's analysis, this privacy requirement is *weakly denied*.

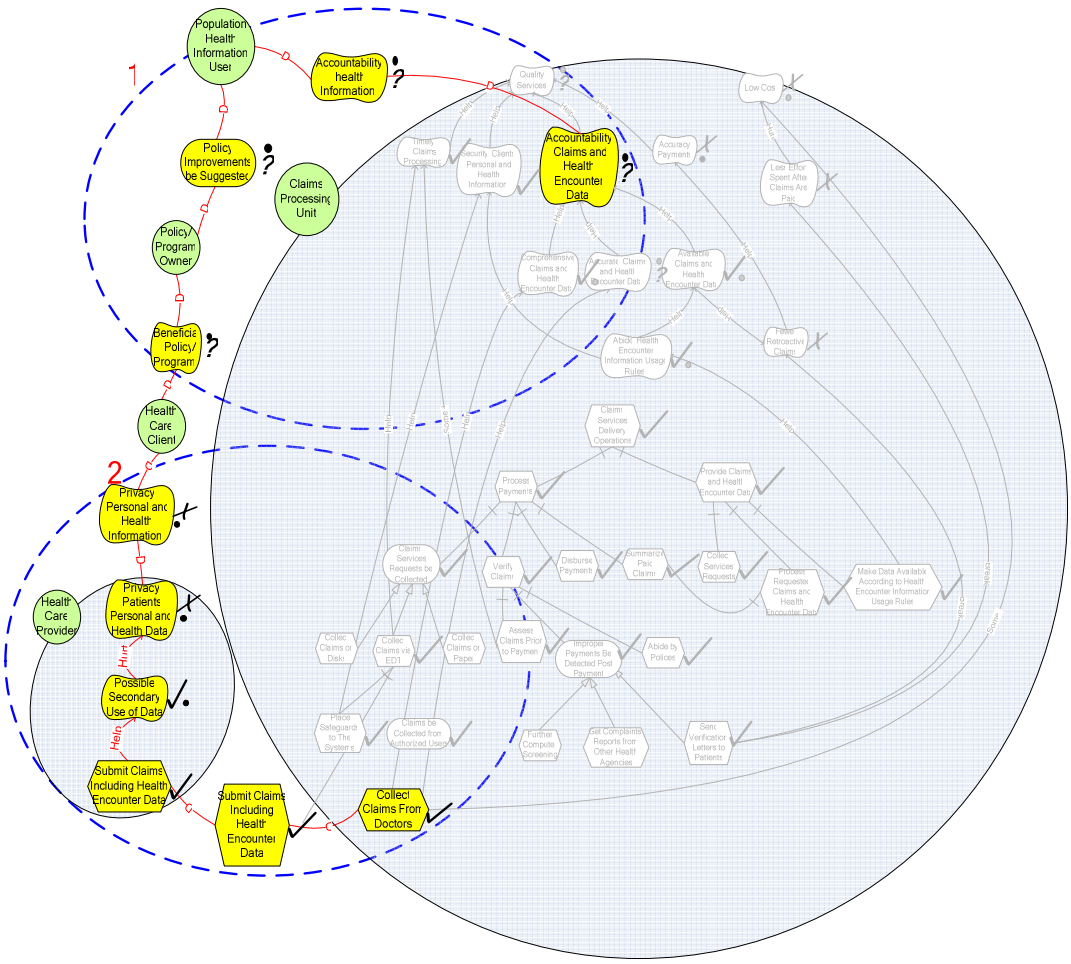


Figure 35: Ability analysis – indirect relationships

By doing ability analysis, the enterprise could tell where and how to react to change by following the links (contribution, decomposition, and mean-ends links) to identify processes that are sources of the ability problem.

4.3.4 Summary of Workability, Viability and Ability Analysis

From the workability, viability and ability analysis, we can see the advantages of refining tasks, goals, and softgoals for revealing what an enterprise is doing and the motivation behind the operations of the enterprise. To determine where changes need to occur, the combination of goal evaluation with different links provides answers to questions such as what are the problems, how serious are the problems, and what are

the root causes.

From the above analysis, we can see there are two main "hurt points" that need to be deal with in the case study:

1) Low Cost, Accuracy of Payments, Accountability of Health Encounter Data are *weakly satisficed* because of Improper Claims Be Detected Post Payment.

2) Privacy of Patients' Personal and Health Information is *weakly satisficed* due to Possible Secondary Use of Data, which is caused by the requirements that doctors need to collect the encounter data and the doctor's desire to make secondary use of patients' data.

4.4 Activity 4: Develop Alternative Business Configurations

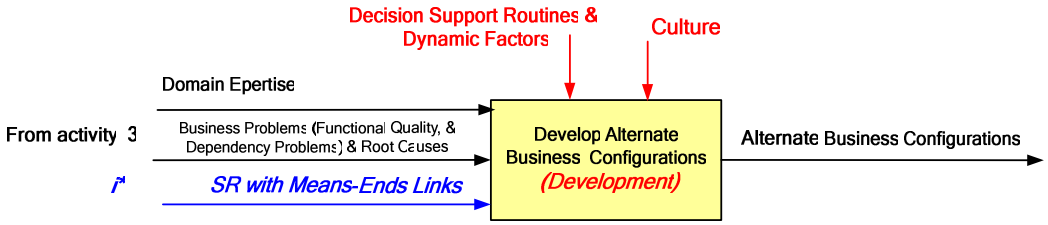


Figure 36: Develop alternate business configurations for target service delivery

"In the development process the information is required about possible solutions" (Choo, 1998, p. 192). According to the decision making process model (Weick, 1979), the development phase consists of two routines: search routine and development routine. The enterprise could search for a ready-made solution, develop a custom-made solution, or modify a ready-made solution. This thesis focuses on how to develop a solution. Based on Choo's (1998) study, the information required to develop a new solution or modify an existing one is more tentative and less structured and defined than information required to evaluate a ready-made solution. This thesis is one step towards providing a

structure to develop solutions, evaluate them, and select one.

The BMM identifies links between desired results and course of action. By following these links an architect could think of different courses of action to achieve the desired results. Furthermore, the architect could come up with the business processes which implement the course of action. However, as mentioned before, the BMM does not provide clear connections between business processes and goals. Without knowing the specific “hurt points”, it will be difficult to come up the alternate solutions which really solve the problems. Moreover, it is hard to assess the alternatives’ contributions to organizational goals.

On the other hand, SR diagrams help the architect search and develop strategies and identify the outcomes and contributions of these alternatives. Once the architect has found the “hurt points”, he/she can use mean-ends links as “solution generators” to produce alternatives for each point, and these alternatives can be further developed and integrated with each other into strategies that are then evaluated and compared. In the situation where a process is identified as a “hurt point” and there is no mean-ends links to follow, the architect needs to go one level(s) up to see whether some higher level task should actually be a goal, where the enterprise may not have realized the flexibility of the process when doing the initial analysis. With the help of i* model, the architect are able to explore a space of design alternatives of considerable size. Based on the research on decision making (Choo, 1998), Organizations which attempt a custom-made solution pursue only one fully developed alternative, whereas those that choose read-made solutions typically select from multiple alternatives.

This activity with Activity 5 (will be explained shortly) are iterative as the first round of analysis may not generate a solution balancing all criteria or may introduce new unsatisficed goals. Then the architect could start the iteration again - combining the advantages of each solution to generate a new one or exploring new solutions following mean-ends links and re-evaluating the new solutions.

4.4.1 Alternate Business Configurations for the Health Claims Payments Case

In the example case, there are two ends for which we can generate means to improve the quality of service the claim unit provides to its clients: the Improper Payments Be Detected Post Payments, and Collect Claims from Doctors. To study further, the first "hurt point" hurts because little effort is spent prior to payment and more effort is spent post payment. In this research, we will refer to it as "Thin" Claims Assessments Prior to Payment & "Fat" Detection of Improper Claims Post Payment. Even though it is a process, we can go one level further and see that Verify Claims could actually be a goal, which allows the Claims Processing Unit to think about another two alternatives: "Fat" Claims Assessments Prior to Payment & "Thin" Detection of Improper Claims Post Payment and Outsource the Verification Process to an Intermediary Clearing Agency. For the second "hurt point", the unit could have Collect Claims from Doctors vs. Collect Claims from Patients. Therefore, at the initial interaction, there are six potential configurations in total including the one currently being employed:

Configuration 1: "Thin" Claims Assessments Prior to Payment & "Fat" Detection of Improper Claims Post Payment + Collect Claims from Doctors (currently being implemented)

Configuration 2: “Thin” Claims Assessments Prior to Payment & “Fat” Detection of Improper Claims Post Payment + Collect Claims from Patients

Configuration 3: “Fat” Claims Assessments Prior to Payment & “Thin” Detection of Improper Claims Post Payment + Collect Claims from Doctors

Configuration 4: “Fat” Claims Assessments Prior to Payment & “Thin” Detection of Improper Claims Post Payment + Collect Claims from Patients

Configuration 5: Outsource the Verification Process to a Clearing Agency + Collect Claims from Doctors

Configuration 6: Outsource the Verification Process to a Clearing Agency + Collect Claims from Patients

4.5 Activity 5: Selecting a Business Configuration and Complete the Target Business Architecture

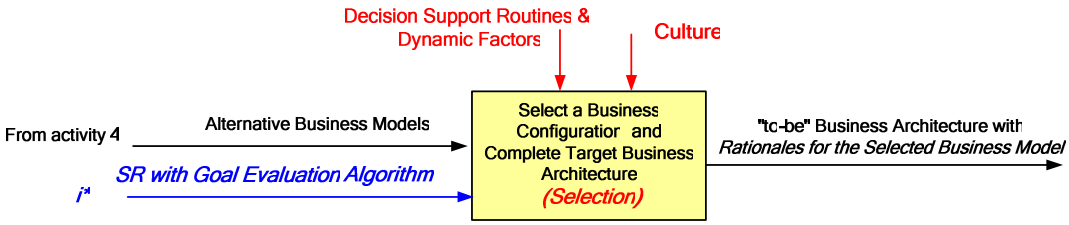


Figure 37: Select a business configuration

Having developed various potential solutions, an architect needs to choose one from them. In current practice, the enterprise normally performs a cost-benefits analysis to decide which one to choose. For this stage, based on KM concepts, the architect would first need to understand organizational goals in order to define preferences and to select rules. The architect also needs information to locate, elaborate, and analyze alternatives in terms of their outcomes and information to compare relative contributions of these

solutions (Choo, 1998). Based on the information needs, the architect needs to construct answers to the following questions in the target EA:

- What organizational goals the solutions are aiming to achieve?
- To what extent does each of these solutions contribute to the organization's objectives, both functional and qualitative ones?
- To what extent does this solution fulfill stakeholders' dependencies?
- Comparatively, which solution works better?

When comparing the solutions, the architect can either rank alternatives according to their overall contributions to the enterprise's goals, or according to one specific preference, premise, or rule. Note that, sometimes, the introduction of new solutions may make those already achieved goals not achieved anymore. For example, Collecting Claims from Patients may *hurt* the Comprehensiveness of Health Encounter Data due to lack of professional knowledge. In this kind of conflicting situations, the enterprise needs to find a solution which offers the best balance among decision criteria.

4.5.1 Qualitative Evaluation of Alternatives

Considering the presence of some external domain constraints, not all of these alternatives are feasible. The enterprise needs to screen out these kinds of solutions. Then a systematic analysis process could be taken to select one solution.

The BMM evaluates performance according to objectives defined in a business plan. The objectives are associated with quantitative measurement, which is easy to map to the results. However, at initial analysis stage, quantitative values are hard to get. An architect rather narrows down to small number of alternatives before he/she performs quantitative

evaluation. Moreover, there is often no formula for combining the quantitative values assigned to each evaluation criteria of a solution. Thus, it is hard to guide the selection of alternatives. Finally, quantitative evaluation is not easy to detect trade-offs and synergies among requirements.

The qualitative goal evaluation mechanism in the i* framework helps evaluate the achievement of different stakeholders' intentions, compare the achievement of goals, and select a better one. Issues of stakeholders that are *cross-impacted* may be discovered during this process, and can be raised so that trade-offs can be made.

4.5.2 Solutions Evaluation for the Health Claims Payments Case

In the health care case, the Claims Processing Unit focuses on the goals that are not achieved in a sufficient manner, such as Low Cost, Accuracy of Payments, Accuracy of Health Information, and Privacy of Patients' Personal and Health Information.

The first solution is the one that the unit is currently employing. It shows several disadvantages already. The second solution will also have problems associated with high cost and inaccuracy of health information and payment and can be screened out. Therefore, we have solutions 3, 4, 5, and 6 left to be analyzed. The unit could analyze these solutions either by judgment, analysis, bargaining, or all of them. For this research, the focus is analyzing which solution to be chosen using i* models for the reasons stated above.

For each potential solution, the unit could reconstruct the SD and SR diagrams accordingly, explore the dependency and rationale changes, and reevaluate it against the predefined criteria.

Solution 3: "Fat" Claims Assessments Prior to Payment & "Thin" Detection of Improper Claims Post Payment + Collect Claims from Doctors

In this solution, the patient will verify the provision of services when treatment is given on site. This could be done by entering some authorization code, such as his/her health number and password. Entering and validating data on claims prior to submitting them reduce potential denied or suspended claims and resubmissions. For each doctor, there will be various records from different health agencies. Any improper behaviors reported by these agencies for the doctor are detected in real time when the claims are verified (see Figure 39 which groups processes into the stakeholder who executes the processes and shows the data exchange among the processes. Only major stakeholders are illustrated in the diagram). This could significantly reduce the time and efforts spent on post payment check.

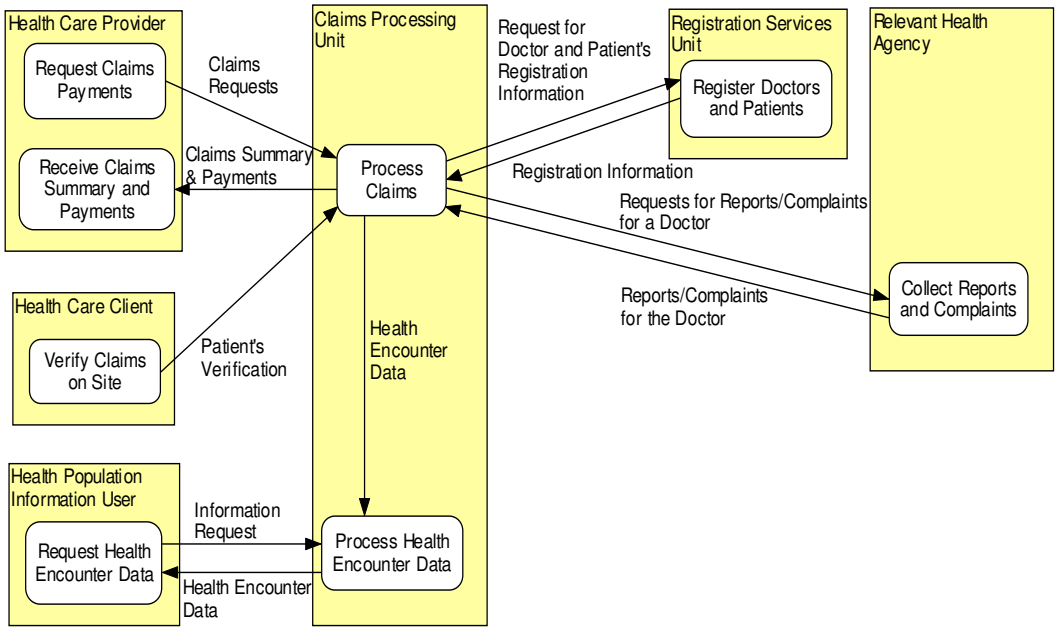


Figure 38: Solutions 3 (data exchange model)

Figure 39 shows partially the strategic dependencies among stakeholders for this

new solution. The highlighted elements show the business configuration changes. It is based on the original SD diagrams in Figure 21 and Figure 22, but only shows the elements and changes concerned with the new business configuration. The rest remains the same as in Figure 21 and Figure 22. Based on the gaps analysis, the rest elements have no impacts on the gaps. Thus, they are omitted in this diagram. The same rule applies to the following SD diagrams.

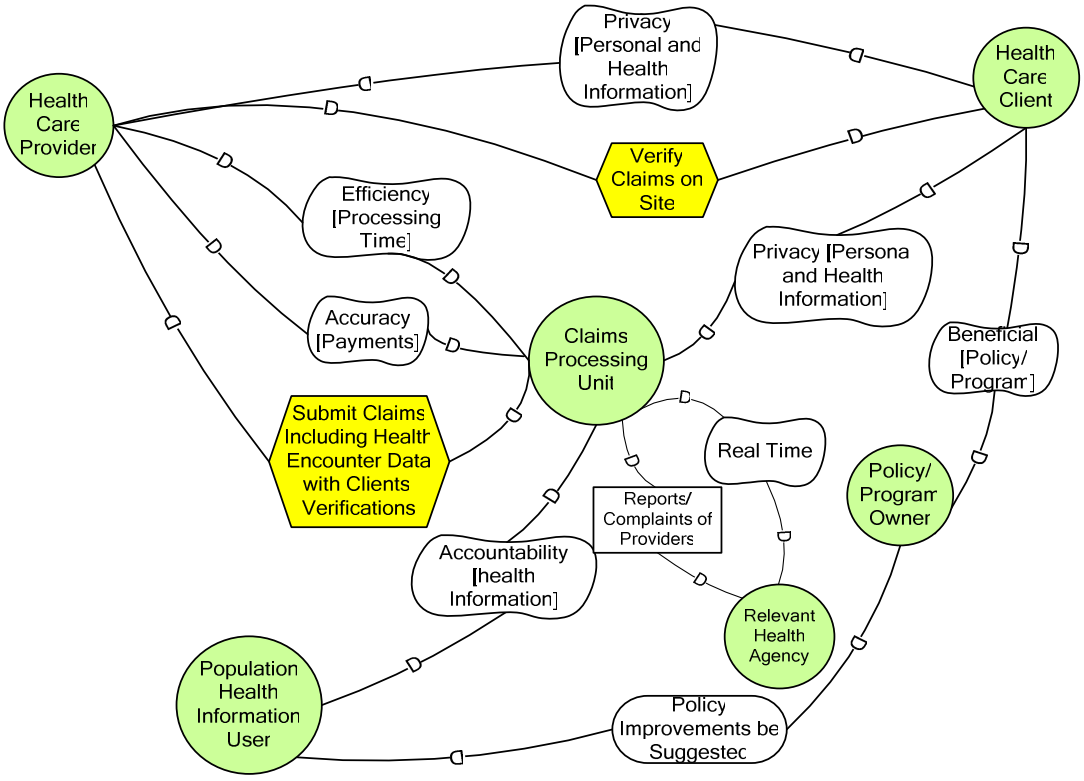


Figure 39: Strategic dependencies diagram for solutions 3

Figure 40 gives a bird's eye view of how actors' internal rationales are changed by this new business configuration. The major changes are illustrated in detail with yellow highlights in Figure 41.

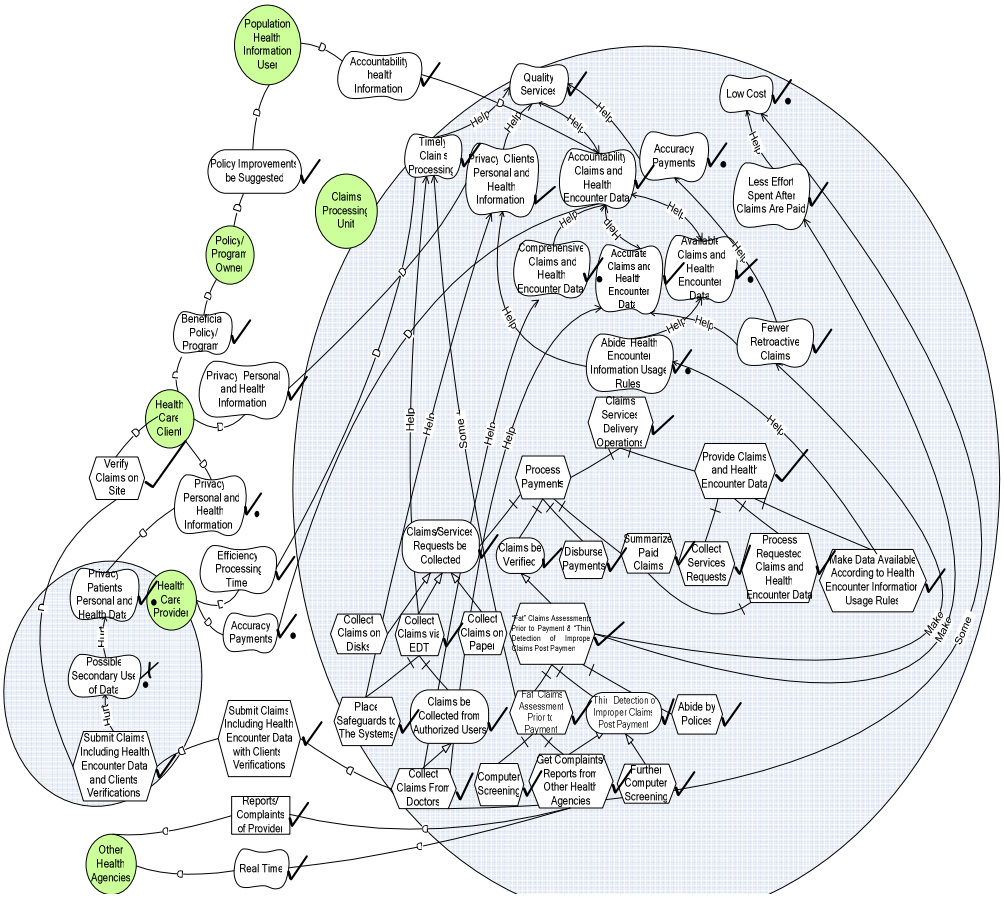
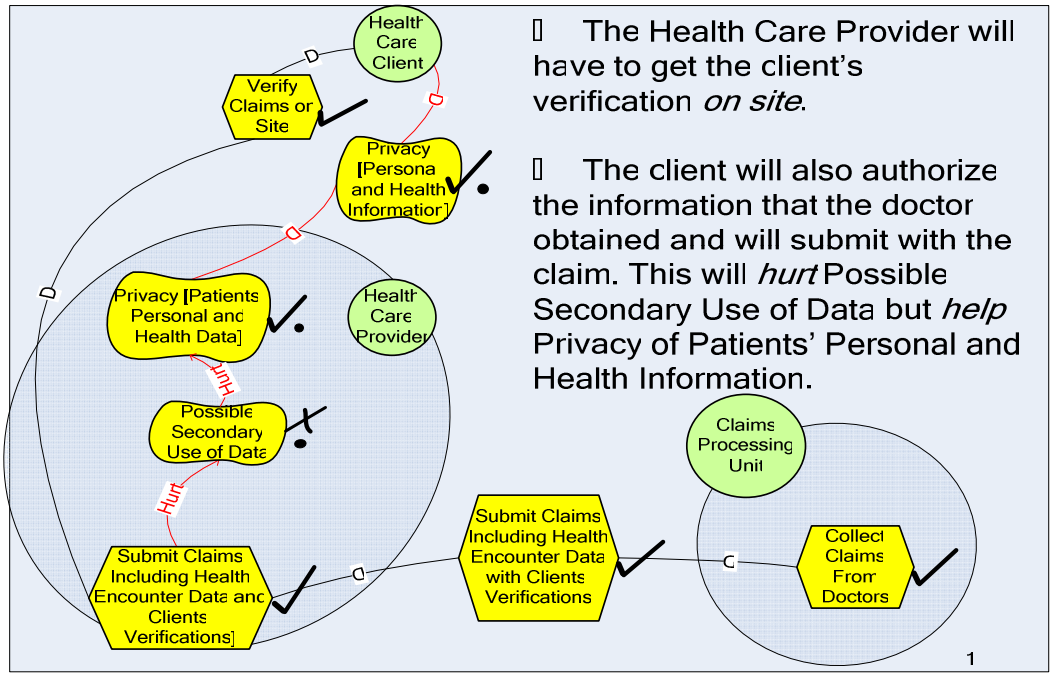


Figure 40: Strategic rationales diagram for solution 3



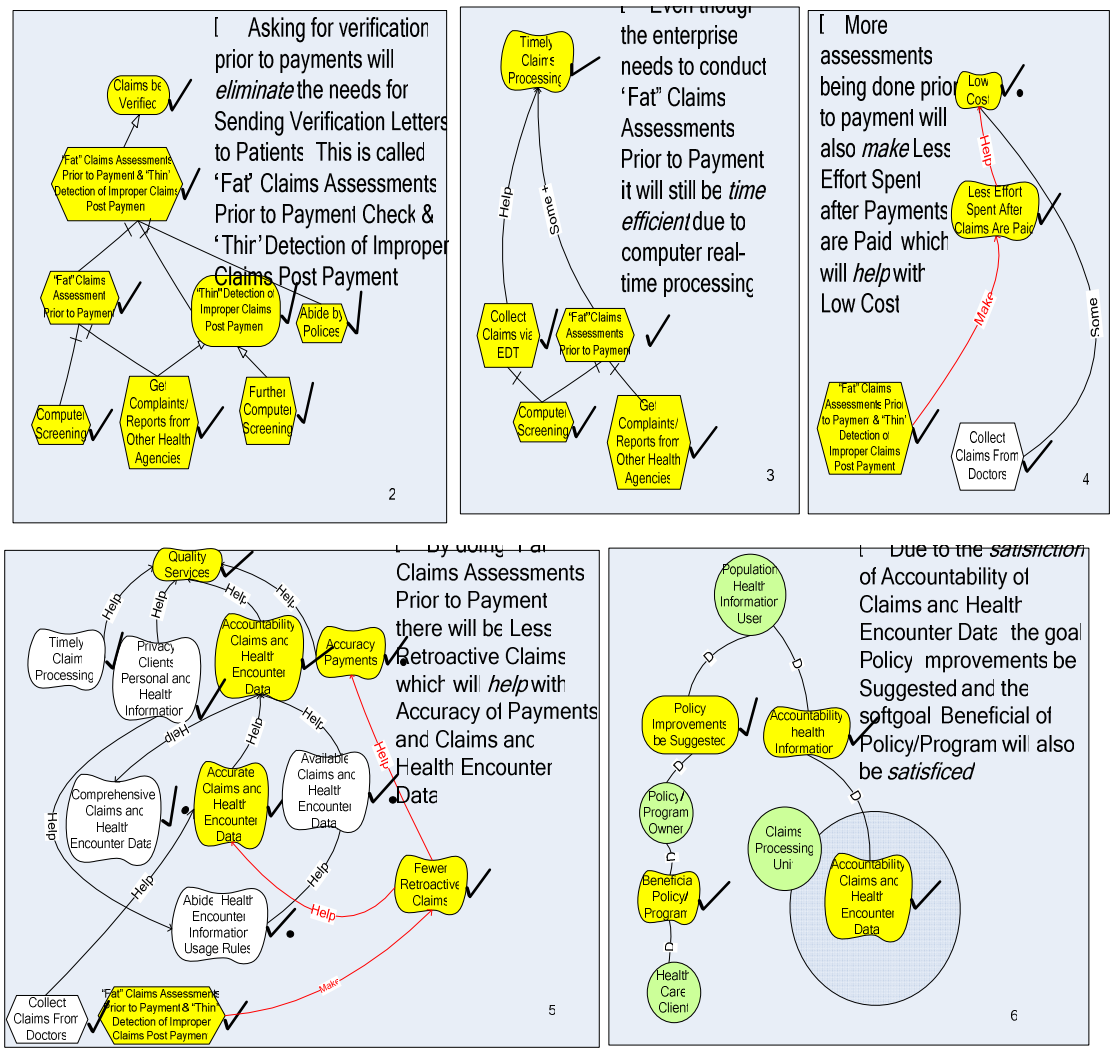


Figure 41: Changes introduced by solution 3

By illustrating a new business model, we can see how the new solution could be plugged into existing business model and see both the dependency and rationale changes triggered by the new solution. The re-evaluation process will allow the enterprise to see the potential results before it commits to one solution. The architect could do the same to other alternatives. It is found that the i* modeling technique has more capabilities assessing possible results than non-intentional modeling techniques.

The following shows the same procedure applied to the other three solutions.

Solution 4: Let patients submit claims.

In this solution, the patient is responsible for paying the services' fees. Everything is the same as the original process except that patient will pay the doctor when he/she receives the services, and then he/she will submit the claims for reimbursements. Figure 42 highlights the changes.

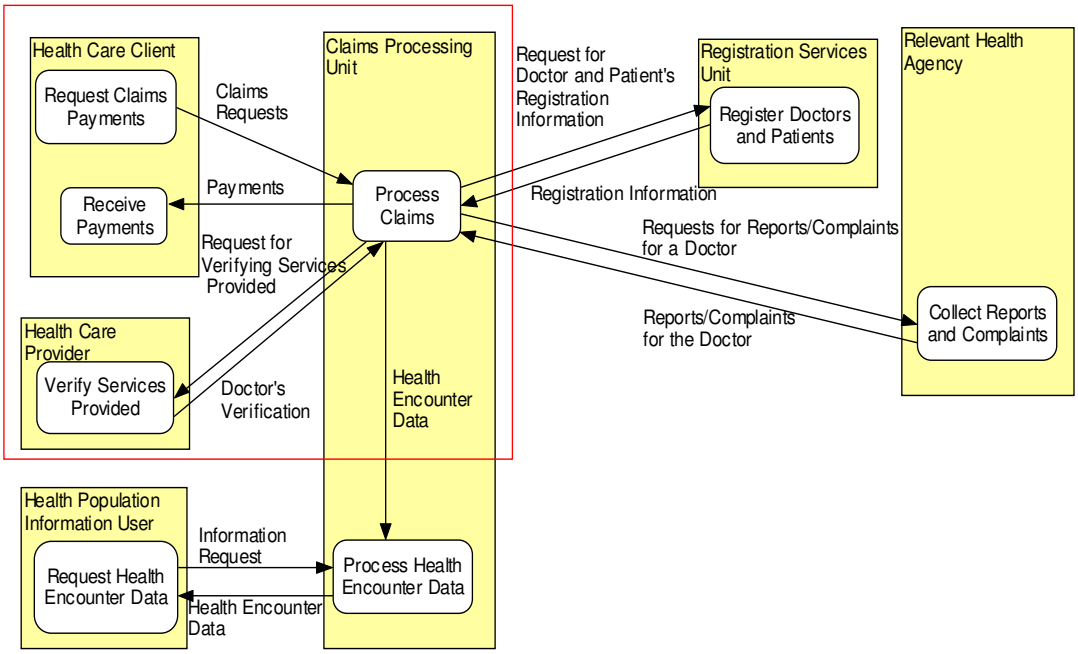


Figure 42: Solution 4 (data exchange model)

Figure 44 shows, partially, the strategic dependencies among stakeholders for this new solution. Figure 45 gives a bird's eye view of how the dependencies and their internal rationales are changed by the new business configuration. The major changes are illustrated in detail in Figure 46.

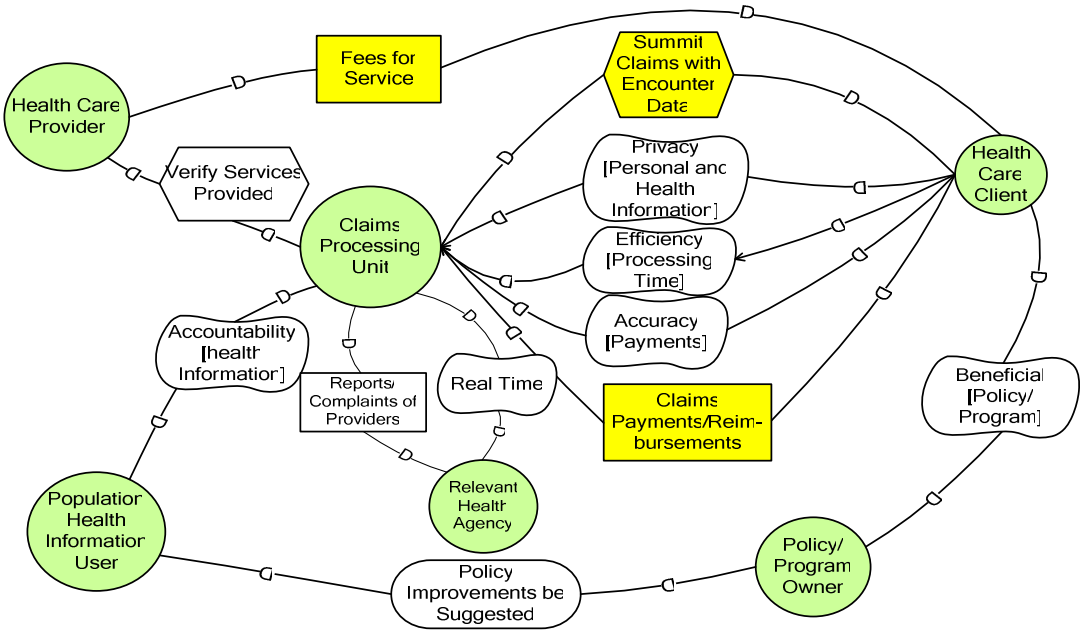


Figure 43: Strategic dependencies diagram for solution 4

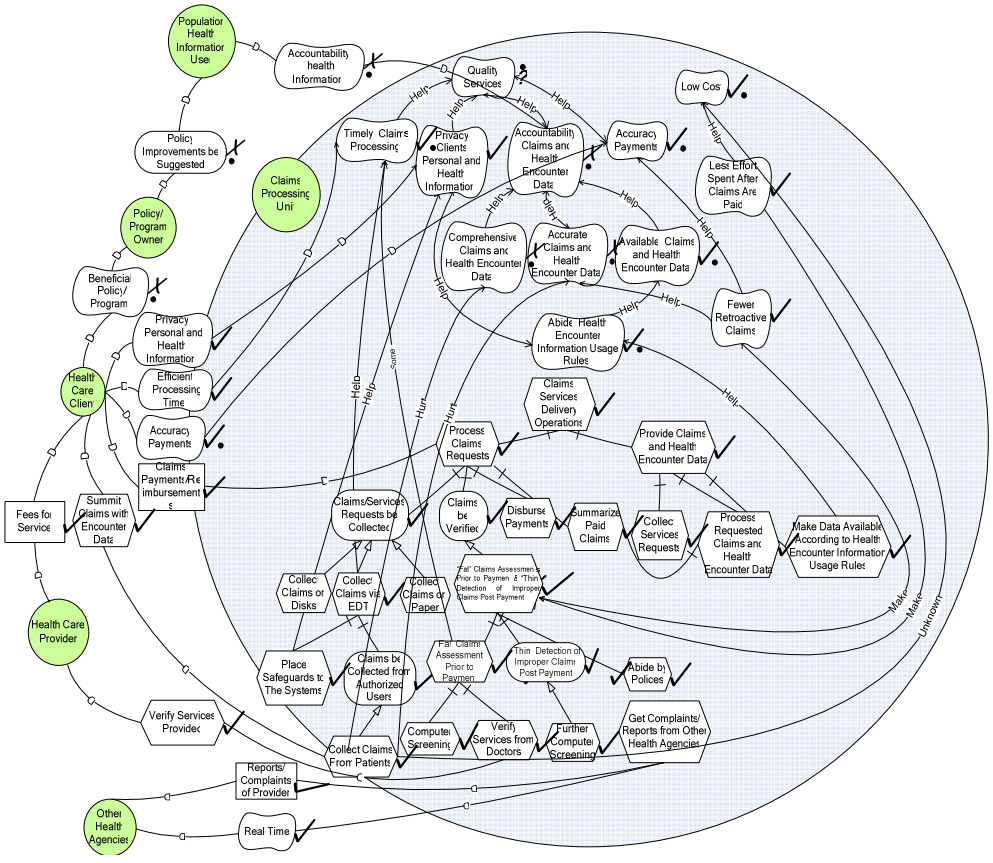


Figure 44: Strategic rationale diagram for solution 4

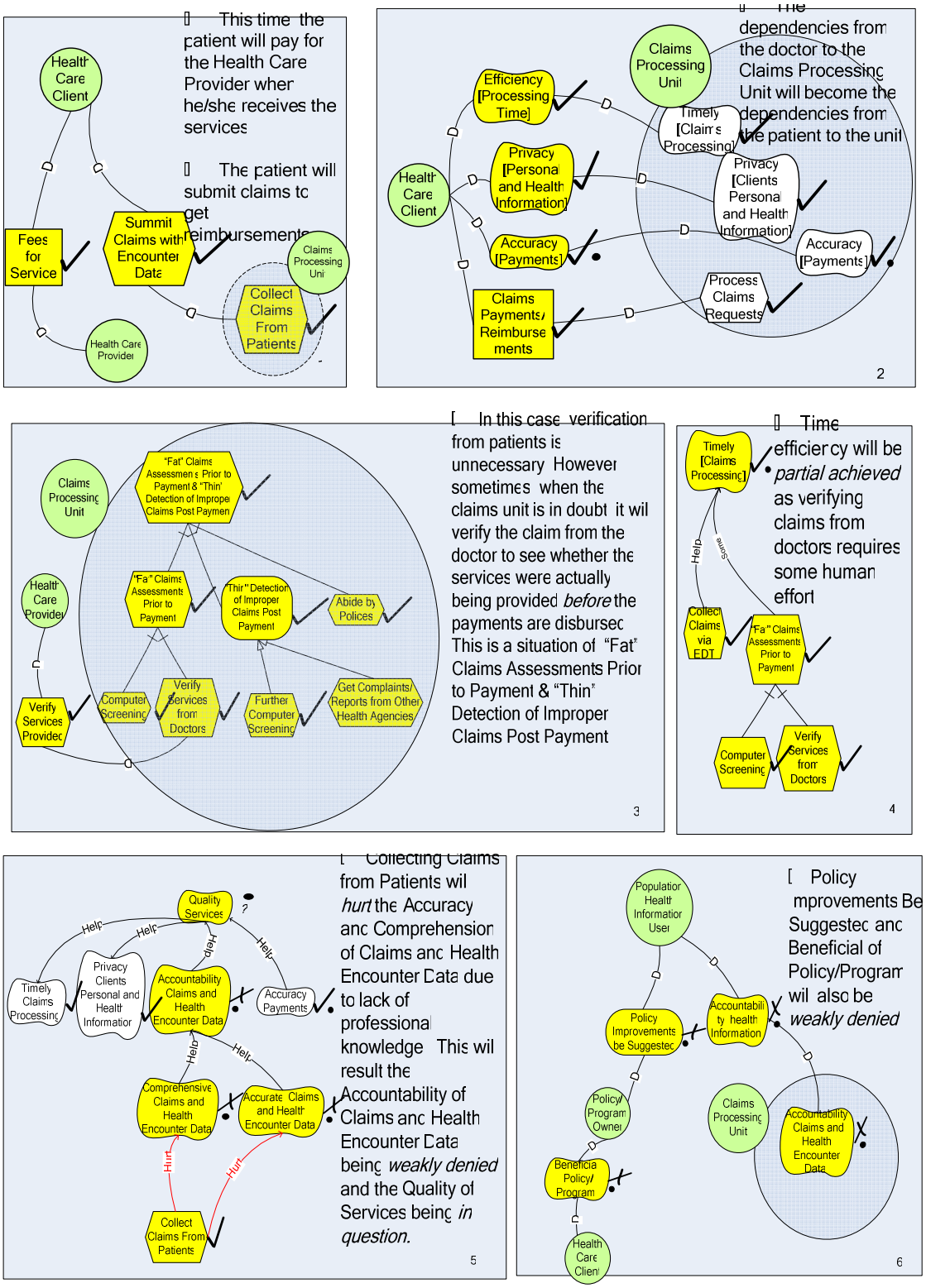


Figure 45: Changes introduced by solution 4

Solution 5: Outsource the Check Process to A Clearing Agency+ Collect Claims From Doctors

Companies often outsource costly and inefficient processes to other companies who are specialized in performing these processes in a more cost-effective way. Thus, it is worth considering letting a clearing agency carry out the claims verification process and examine whether this solution works in this claims payments setting. The intermediary agency will verify the claims following the same procedure as solutions 3 and send summaries to both the doctor and the unit. The unit will pay the doctor.

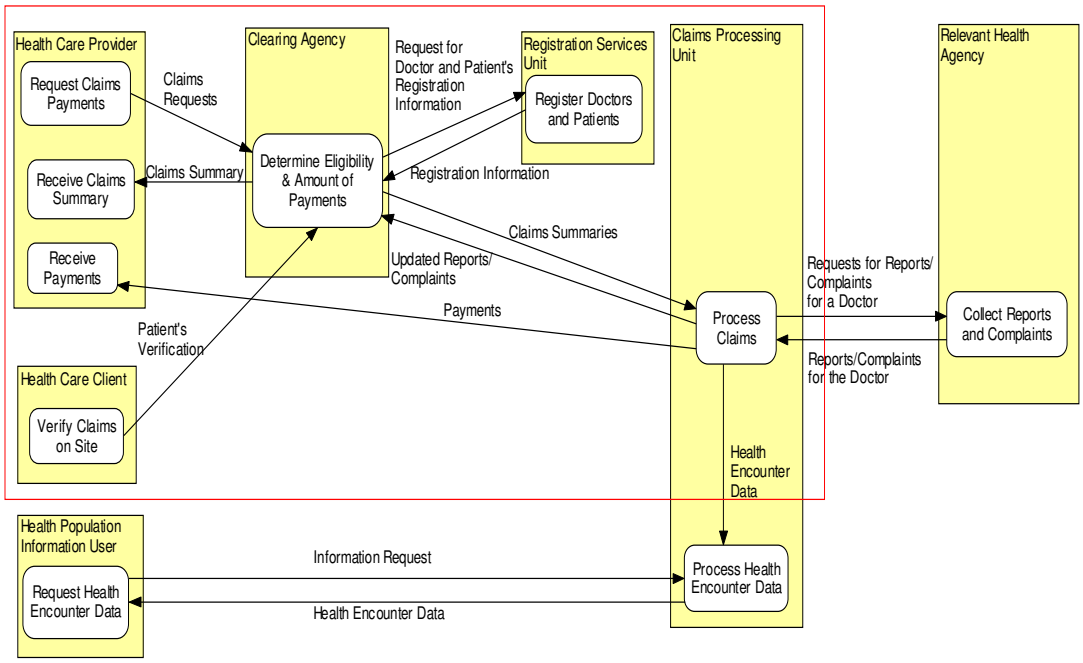


Figure 46: Solution 5 (data exchange model)

Figure 47 shows partial of strategic dependencies among stakeholders for this new solution. Figure 48 gives a bird's eye view of how the dependencies and their internal rationales are changed by the new business configuration. The major changes are illustrated in detail in Figure 49.

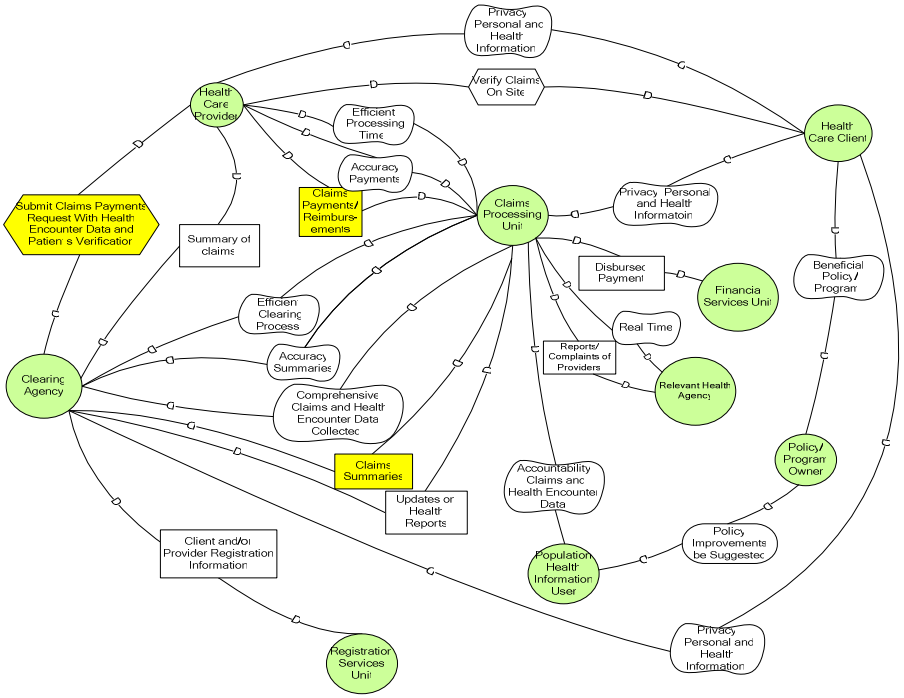


Figure 47: Strategic dependencies diagram for solution 5

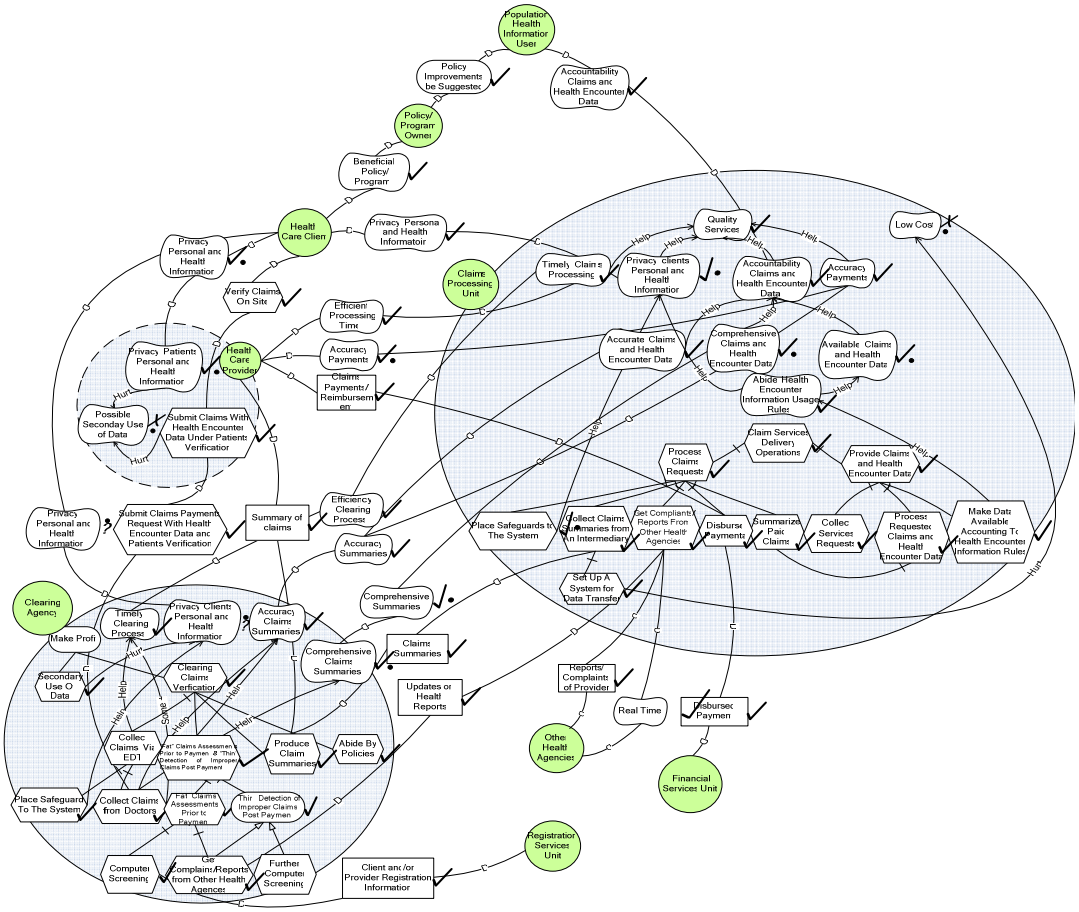
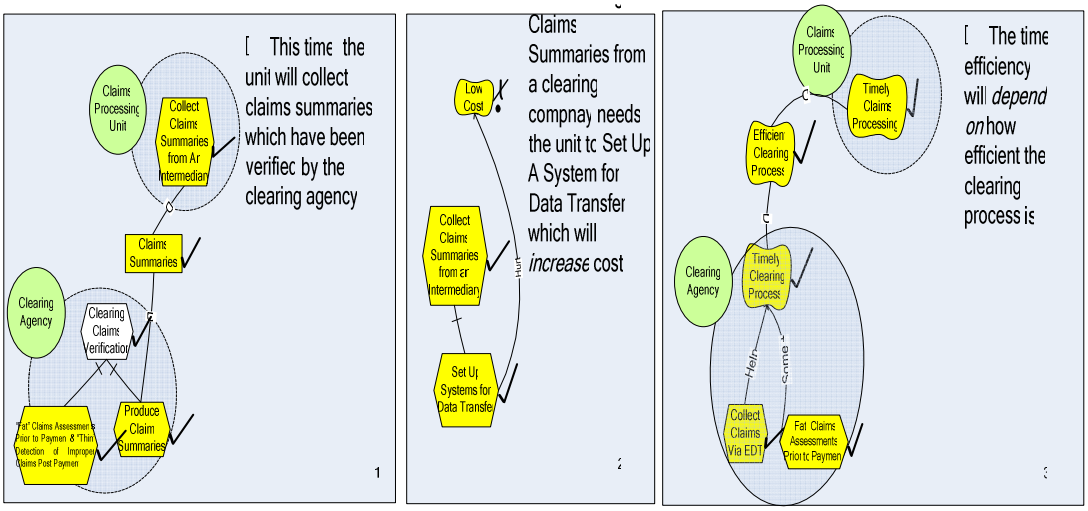
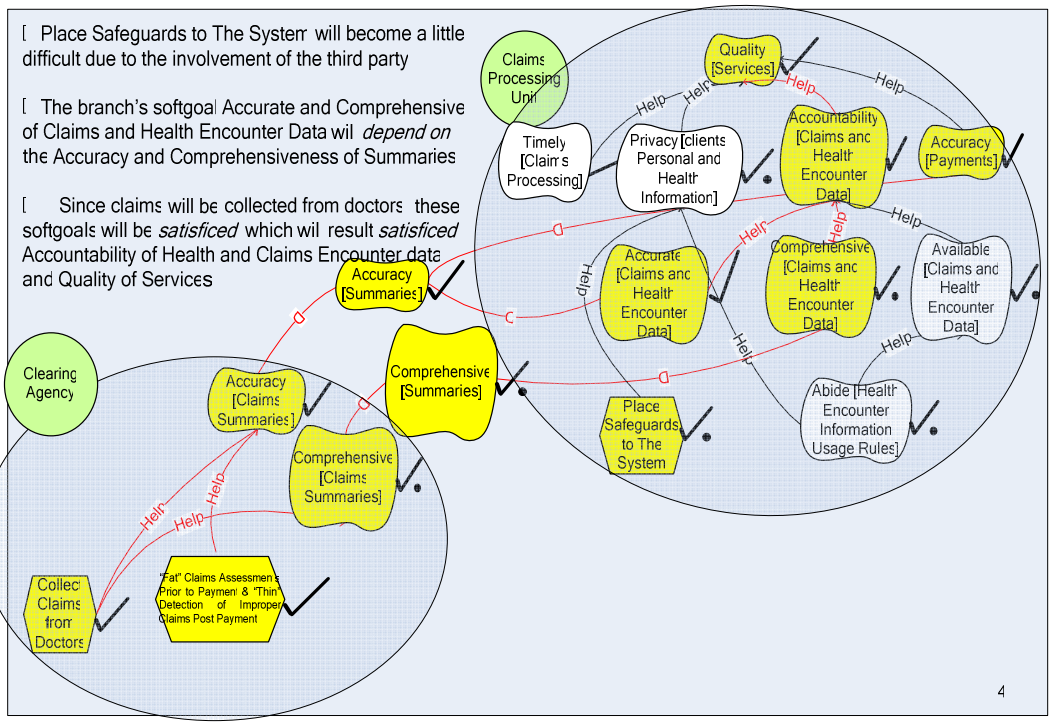


Figure 48: Strategic rationale diagram for Solution 5


[This time the unit will collect claims summaries which have been verifiec by the clearing agency
Claims Processing Unit
Collect Claims Summaries from An Intermedian
Claims Summaries
Clearing Agency
Clearing Claims Verification
Produce Claim Summaries
1
Claims Summaries from a clearing compnay needs the unit tc Set Up A System for Data Transfer which will increase cost
Low Cost
Collect Claims Summaries from an Intermedian
Set Up Systems for Data Transfe
2
[The time efficiency will depend on how efficient the clearing process is
Claims Processing Unit
Timely Claims Processing
Efficien Clearing Process
Clearing Agency
Timely Clearing Process
Collect Claims Via EDI
Fat Claims Assessments Prior tc Paymen
3


[Place Safeguards to The System will become a little difficult due to the involvement of the third party
[The branch's softgoal Accurate and Comprehensive of Claims and Health Encounter Data wil depend on the Accuracy and Comprehensiveness of Summaries
[Since claims will be collected from doctors these softgoals will be satisficed which wil result satisficed Accountability of Health and Claims Encounter data and Quality of Services
Claims Processing Unit
Quality [Services]
Timely [Claims Processing]
Privacy [clients Personal and Health Information]
Accountability [Claims and Health Encounter Data]
Accuracy [Payments]
Accurate [Claims and Health Encounter Data]
Comprehensive [Claims and Health Encounter Data]
Available [Claims and Health Encounter Data]
Accuracy [Summaries]
Comprehensive [Summaries]
Place Safeguards to The System
Abide [Health Encounter Information Usage Rules]
Clearing Agency
Accuracy [Claims Summaries]
Comprehensive [Claims Summaries]
Collect Claims from Doctors
"Fat" Claims Assessmen Prior to Paymen & "Thin" Detection of Improper Claims Post Payment
Help
4

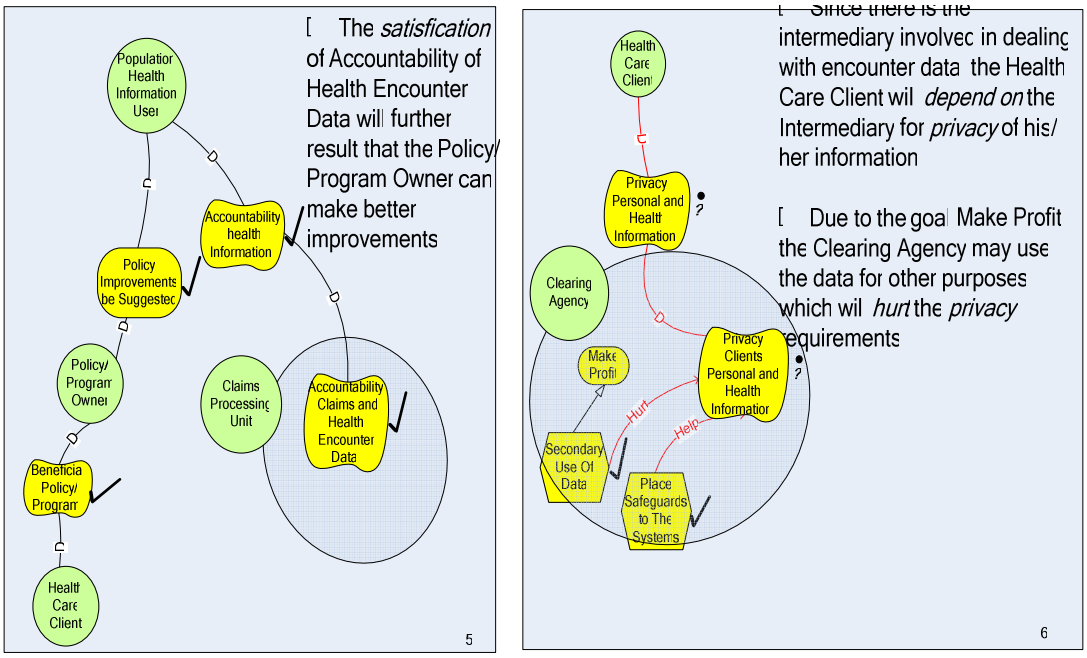


Figure 49: Changes introduced by solution 5

Solution 6: The clearing agency collects claims from patients.

The patient will submit claims to the Intermediary. Then, the clearing agency will verify the service claimed by asking the doctor and send a summary to both the patient and the claims unit. The unit will pay the client for its insured and verified services.

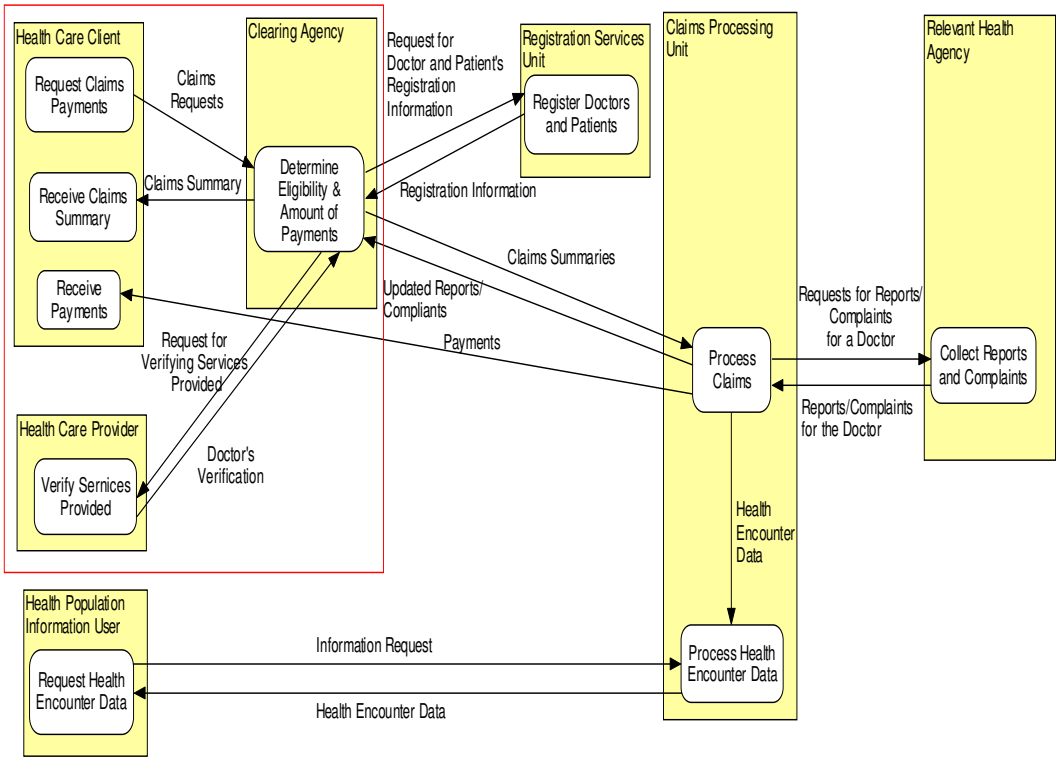


Figure 50: Solution 6 (data exchange model)

Figure 52 gives a bird's eye view of how the dependencies and their internal rationales are changed by the new business models.

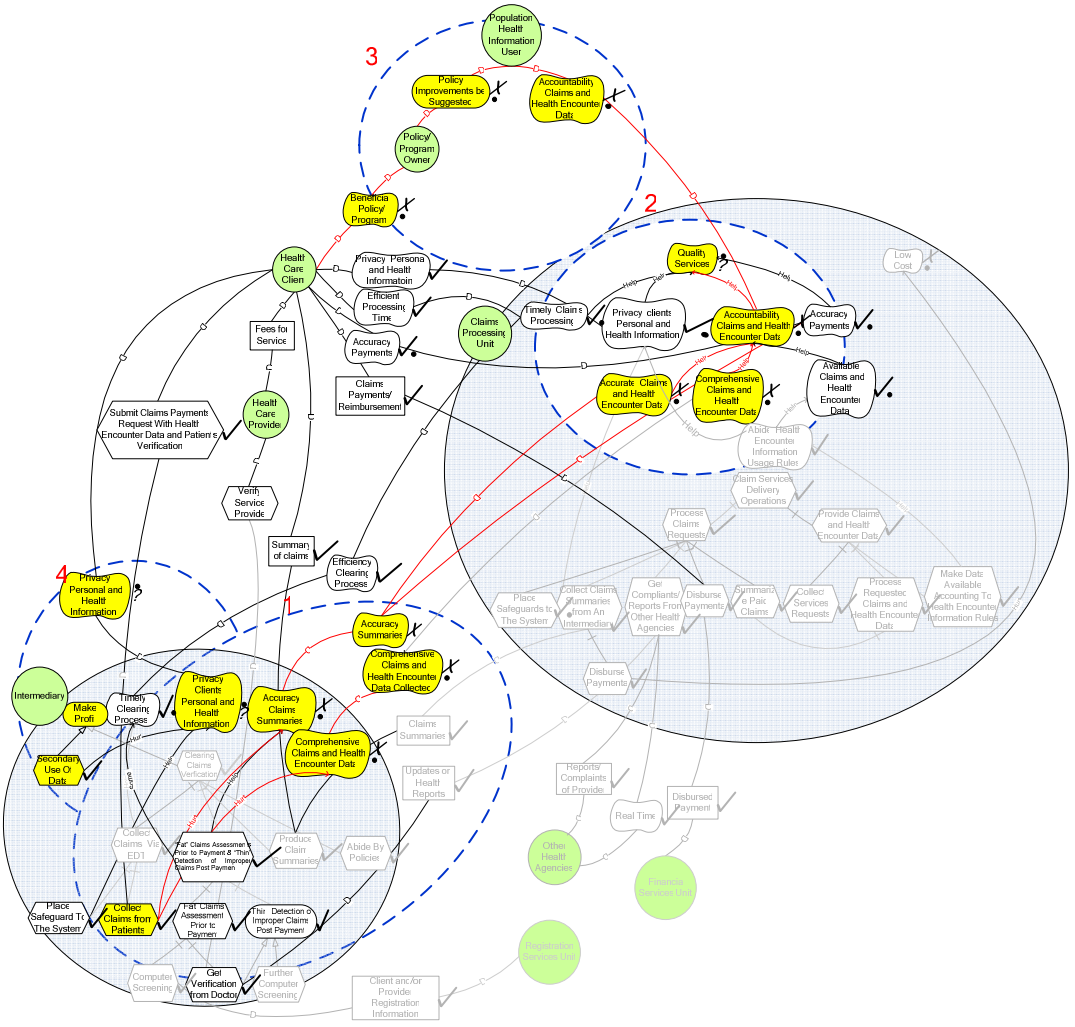


Figure 51: Strategic rationale diagram for Solution 6

Since claims will be collected from patients (Figure 52- Dashed Circle 1), the Accuracy and Comprehension of Health Encounter Data will be *weakly denied* (Figure 52- Dashed Circle 2). This causes *inadequate* Policy Improvements Be Suggested (Figure 52- Dashed Circle 3). Moreover, the patients' requirement on Privacy of Health and Personal Information is still *in question* due to Possible Secondary Use of Data (Figure 52- Dashed Circle 4).

The following table summarizes the results for the four solutions analyzed in terms of the achievement of quality criteria.

Table 5. Summary of alternatives evaluations

	Unit		Population Health Information User	Policy/ Program Owner	Health Care Provider		Health Care Client			
	Low Cost	Quality of Services	Accountability [Health Information]	Program Improvements be Suggested	Accuracy [Payment]	Efficiency [Processing Time]	Beneficial [Policy/ Program]	Privacy [Personal & Health Information] – the claims unit	Privacy - doctors	Privacy – clearing agency
S3	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A
S4	✓	?	✗	✗	✓	✓	✗	✓	N/A	N/A
S5	✗	✓	✓	✓	✓	✓	✓	✓	✓	?
S6	✗	?	✗	✗	✓	✓	✗	✓	N/A	?

Solutions 3: Get Patient's Verification before Summiting Claims will give the best performance in terms of quality requirements achievement. Then the claims unit could suggest the strategy to some authority unit and take corresponding actions if the strategy is approved. However, sometimes, the bests result from a systematic evaluation process may not be chosen because of political, cultural, or financial reasons. The solution may not be executed.

In the case study, we show the organizational change at a high level. It may be changes to multiple systems, such as the claims collecting system, the verification system as well as the health encounter data processing system. Moreover, depending on the scope of the enterprise, change may involve multiple processes, each of which may be similar to or more complex than the health claims payments process. For example, the Local Health Integration Networks initiative aims to ensure the coordination among multiple health care programs. The intentional modeling should be applicable to different levels of complexity and should bring the same benefits as revealed in this case study.

4.6 Broad Issues on the Knowing Cycle

4.6.1 Sense Making

In the above sections, detailed sense making using models has been presented. There are also some broader issues to be considered. In the Literature Review (Section 2.2.1), we have discussed that organizational sense making could be belief-driven or action-driven. For the EA case, the following considerations suggest that it is more of a belief-driven sense making process. As constructing EA is for change, it is not committing to certain behaviors. Moreover, EA is for guiding the organization to change.

No actions have been taken yet to make things happen. Thus, it is not manipulating. On the other hand, constructing as-is architecture is a process for organization members to create meaning about the organization's current situation through connecting the contradicting or similar interpretations. Thus, the sense making process during the EA construction is more belief-driven.

4.6.2 Decision Making

First, the decision making process is not linear, but iterative. As mentioned before, there could be many iterations involved in generating new solutions and evaluating them. In addition, the enterprise may need to go back to the diagnosis stage from the selection stage to reconsider the decision situation. Moreover, some new options may not be feasible due to external interruptions, and even at the late stage of design phase or selection phase, there are always new options that present themselves (Mintzberg, Raisinghani, & Theoret, 1976). In either case, this framework could be applied iteratively – to further refine the goals, task, and softgoals, find "hurt points", explore alternatives and select preferred strategy - until an adequate solution is found.

According to Mintzberg et al. (1976), the process of decision making is supported by decision routines (i.e., decision control, communication, and political routine) and affected by dynamic factors. The decision maker should have a decision control routine to plan the decision, decide which participants to consider, how much time they plan to use, and the resources available to them. The decision maker should also know when to switch to the next stage of the decision making process, such as when there are enough alternatives and when to stop an evaluation. The members in the enterprise need to

communicate with each other to gather information in order to understand the decision needs, the alternatives, and feasibility of solutions. Furthermore, multiple stakeholders have to be taken into consideration. Moreover, not all of them have the same political power as others. Some of them will have power on the selection of a solution over the other. The concepts of actors and their strategic dependencies provide a way to include political differences. As the process is used to deal with change, the dynamic factors in such an open system have to be taken into account. Interrupts, scheduling delays, feedback delays, timing delays and speedups, comprehension cycles, and failure cycles could "cause it [the decision making process] to speed up, to branch to a new phase, to cycle within one or between to phase, and to recycle back to an earlier point in the process" (Mintzberg et al., 1976, p. 263).

4.6.3 Knowledge Creation

The product of the architecture construction process consists of a set of texts, tables, lists, and models which are knowledge artifacts. The process of producing these artifacts is a knowledge creation process, which is the conversion between tacit knowledge and explicit knowledge.

During the EA construction process, the architect often needs to look up existing business documents or architectural documents to learn about the enterprise, not only how the enterprise is operated but also why it operates this way. This is especially important when the architect needs to create the baseline description of the enterprise. As some knowledge, especially most of motivation knowledge, is kept in tacit formats, an architect may need to communicate with domain business experts or other architects to

get an idea of what are the salient features of the as-is situation and the target situation, what are the gaps between them, and some potential migration strategies. In current practice, this is often done in workshops. People in the EA area also socialize through their participation at "community of practice", such as the EA open house attended by the researcher. Through socialization, members exchange their tacit knowledge and increase their own expertise through an internalization process. This internalization process could be helped if the knowledge is captured in explicit formats, such as intentional models. Then the architect needs to externalize his/her understanding about the business and the environment into paper using text or models. Constructing the intentional models could help with the externalization process by stimulating an explicit thinking process about motivation. However, it is impossible for an enterprise to have all the models. There are some models or portions of models that are vital for the success operation or survival of the enterprise. These are the ones the enterprise needs to concentrate on making explicit (Zachman, 1999). The result of the knowledge creation is a common understanding of the business among enterprise members. Especially, the "why" knowledge could be documented in the format of intentional models. The knowledge could be retained and retrieved for reuse and reference by business for further change.

4.7 Summary of How Intentional Modeling Addresses the Knowledge Needs

4.7.1 Sense Making

In the sense making stage, the knowledge needs identified in KM research are

knowledge about what is happening in the business and in the environment, why this is happening, and what it means to the enterprise. Without thinking about the process from a KM perspective, some important piece of information will be overlooked, for example, the "why" behind what is happening and the importance of understanding the dependencies between the organization and its environment.

Through the case study, we can see that the BMM is capable of laying out high-level business means and ends as well as influencers and their impacts on the business. The BMM provides forward and backward traceability which could help answer the questions like "what the organization is doing?" and "why it is operating the way it is doing?" On the other hand, the i* framework goes one step further to provide a comprehensive picture of the dependencies between the enterprise and its environment and help the organization understand its business operations at a process level. The i* framework further answers the questions of "what the organization is doing?", "what are the dependencies between the organization with its environment?", and "what are the impacts from the environment on the business?"

4.7.2 Decision Making

In current EA practice, decision making process is not structured and has no structure for information required for making decisions with rationales. With the clarification from KM research, an architect needs to construct information about the cause-effect relations about the business problems, the information about feasible solutions and the information about the organizational goals which help define preferences and selection rules and evaluate potential contribution of available solutions

to the organization. Only after obtaining this information, he/she could compare their relative contributions to the organizational goals to make a decision with well-supported rationales.

The i* framework is found to be useful in providing these kinds of information. The workability, viability and ability analysis associated with the framework allow the enterprise to identify the root causes not only to unachieved functional and non-functional goals but also to the insufficient achievement of stakeholders' dependencies. From the root causes, the organization can then follow the means-ends links to create a space of alternatives. Moreover, the explicit representation of softgoals allows the organization to define quality requirements as part of the decision preferences or rules. The contribution links with the goal evaluation algorithm allows the architect to systematically evaluate the contributions of each solution to the organizational goals which the enterprise prefers to achieve through this round of change. By comparing the extent of the goal achievement, the architect can then select one solution to do further quantitative analysis. Last but not least, in case that the enterprise does not find a solution which sufficiently meets the goals, the i* framework also allows the enterprise to formulate new solutions and reevaluate them until a satisfying solution is found.

4.7.3 Knowledge Creation

The knowledge needed for the knowledge creation is the explicit representation of the knowledge about "why". As discussed in section 4.6.3, building intentional models makes the architect's thinking process explicit as well as lays down the knowledge about "why" explicitly on paper. Once we have the knowledge explicit, the knowledge

conversion process will be easier, and the knowledge can be retained into the organization's memory for future sense making, knowledge creation and decision making processes.

5. Evaluation

As addressed in the Research Methods section, design science must include some forms of validation of the research outputs. In other words, constructs, models, methods and instantiation built or designed in the first step should be evaluated with an appropriate method according to the initial goals of the research. As March and Smith (1995) mention, design science evaluation “is complicated by the fact that performance is related to intended use, and the intended use of an artifact can cover a range of tasks" (p.254).

Two forms of evaluations were used: working out the intentional models for a case study, and interviewing potential users to obtain feedback based on the case study.

Based on the documents collected on the health claims payments case, this research applied intentional models and their associated analysis to the case following the framework presented in the thesis. Experiencing how business problems could be solved by using intentional modeling in enterprise architecture indicated intentional modeling’s applicability and appropriateness to manage the knowledge about “why” in enterprise architecture. Through working out the models for the case, the researcher explored both positive and negative findings about intentional modeling. Positively, the Business Motivation Model provided a tool for the researcher to lay out major business elements: means, ends, influencers and their impacts. The task and goal/softgoal decomposition structure in the i* framework forced the researcher to reveal processes, clarify goals, add missing details, and reduce redundancies. The means-ends links helped the researcher come up with the solutions which the researcher had not thought before. The goal

evaluation made it possible to describe goal conflicts and synergies so that the researcher was able to consider design tradeoffs in selecting among alternatives. In conclusion, the explicit expression of rationales including goals, softgoals and dependencies from stakeholders and the explicit traceability between the rationales and courses of action helped improve awareness of problems and commitment of solutions. Negatively, sometimes, it was hard to decide whether some requirement should be a hard goal or a softgoal, such as in the case of abiding by policies; at other times, it was not clear whether a process should be a goal or a task at initial rounds of analysis. The researcher also explored some further research topics during the instantiation process. For example, the subjective qualitative evaluation made the researcher have different values to one element at different rounds of analysis. This will cause more problems when the reasoning process is done by different people or people in different working groups. Therefore, there is a need for a more methodological or more quantitative reasoning algorithm. Moreover, the models in this thesis are to be used by business people since they will know how to evaluate the business elements. However, they are busy and not trained in creating and utilizing such models. Thus, there is a need for developing support tools which are capable to show relevant parts of a model in a format that business people can easily understand and make decisions.

A second form of evaluation is interviews with practitioners and consultants. Although this cannot evaluate the framework's performance, it can give an impression of the models' appropriateness as to perform the task of constructing to-be business architecture. Between December 2005 and February 2006, four interviews were conducted with experts in EA, KM, and IM fields to get valuable feedback on this

research. As these interviewees had been introduced to the notation of intentional modeling in summer 2005 and they were familiar with how health care systems work, they were able to give opinions of the applicability, appropriateness, and completeness of the presented framework at this stage (see Appendix C for interview questions). These interviews were a preliminary form of evaluation. The next stage of the evaluation will be for users to try out the models themselves.

The main strengths of the target architecture construction framework that resulted from the evaluation are threefold:

1). It provides a rational process for the target architecture construction process.

2). The BMM and i* offer various links and analysis techniques that provide traceability between high-level business objectives and low-level operations, between business problems and root causes, and between change initiatives and rationale for selecting them.

3). Following this framework, enterprises can stimulate an explicit thinking and approaching process for critical change.

The following sections present in-depth evaluation of the results in terms of the framework's applicability, appropriateness, and completeness.

Applicability

Motivation In terms of the capability of the proposed framework to represent motivation in EA, the interviewees showed general agreement that IM is helpful for architects to reveal the "why" element of business, the motivation for change as well as the rationales for a selected change initiative. One interviewee from a government organization mentioned that the framework provides a very rational process which is

useful for bringing logic to the construction process, but in reality, the process cannot always be rational. Even though architects can follow the process, and get a reasonable solution, the decision makers may choose other solutions due to political and cultural factors. The interviewee's comment about the insufficiency of intentional modeling to present political issues is due to the limitation of the case study where political factors were not deeply analyzed. The strategic actor construct of i*, indeed, is able to present political differences as well as power distribution.

Traceability The interviewees showed strong agreement that different links in i* are good at providing traceability. The task/goal/softgoal refinement through decomposition, means-ends, and contribution links makes the thinking logic explicit. Especially, the workability, viability and ability analysis make it easier to trace the root causes to business problems so that they know what to change. One interviewee found that this refinement format is similar to decision trees they use to make their decisions. At the same time, they also saw the advantage of i* over the decision trees: i* offers well-defined link types which could be used for different kinds of traceability; i* allows cross-referencing among sub-trees.

Dealing with Change The participants also showed a warm appreciation of the potential of the framework to facilitate enterprises to deal with change. One interviewee felt that the proposed framework was more suitable for critical change. For this kind of change, the decision makers may want to follow a rational process to support their decisions. In situations where time is critical, the framework may not be useful for quick decisions as it is time consuming and takes a lot of efforts to build the models. In the future, a more empirical study should be conducted to study how much time and efforts

are needed to construct the intentional models.

Appropriateness

The appropriateness of the way this research used KM concepts was raised. Some of the interviewees had different understanding of KM. It was hard for them to think of sense making and decision making as parts of KM. Instead, they think these components are what they called “problem solving”. The researcher thought this was perhaps why KM has limited usage in EA and this was caused by different perspectives. In this research, the researcher viewed the two concepts from an information needs perspective. That’s why the researcher followed the knowing cycle concept in order to clarify what kinds of “why” knowledge are needed for each activity of the framework.

The use of intentional modeling was perceived as appropriate in the scope of the research. Some interviewees were able to relate some of the concepts to the concepts they use, but they presented the concepts using different names and different formats.

Completeness

One interviewee mentioned that the “culture” component is an important factor to cope with change. This component was originally missing from the framework and was added as a control element in the SADT diagram (see Figure 14) for the whole architecture construction process.

Other findings

Some of the interviewees identified other areas of EA where the proposed framework could be applied. One interviewee mentioned that the capability of the framework was not limited to deal with change. Even for initial round of enterprise architecture construction where change has not occurred yet, the enterprise could use this

framework to facilitate the implementation of business driven information systems. In reality, most systems are implemented without clear understanding of the business objectives they are meant to implement. It would be helpful if there are some methodologies which could provide traceability from business requirements to system specifications, and vice versa.

Through evaluation based on the instantiation and the interviews, both the researcher and the interviewees felt the needs for tool supports. Functions like model drawing by filling in a predefined form, automatic goal reasoning, workability, viability, and ability analysis, and providing answers to "what if" questions when evaluating new solutions were considered useful. There is an existing tool called OpenOME[1] to support goal & agent-oriented modeling. It has the capability of model drawing, automatic goal reasoning, and limited ability of processing user queries and presenting portion of a model only relevant to current analysis. As the researcher knows, the tool development team is working to enhance the tool's functionalities. It should not be difficult to implement those desired functions. With the tool support, application of the framework will be much more efficient.

[1] www.cs.totonto.edu/km/openome

6. Contributions

As the business environment is becoming more and more complex and the rate of change is escalating, a blue print, such as enterprise architecture, could help enterprises plan for change. One step in using enterprise architecture to deal with change is the construction of to-be architecture, which shows what an enterprise targets to be in its future business and technology environment. Even though there is a large number of work that has been done on EAFs to guide the development of EA (Zachman, 1987, 1992; Schekkerman, 2005a; CIOO, 1999; The Open Group, 2002; Buchanan and Soley, 2002), little has been done on how the target architecture could be constructed in such a way that motivation is explicitly represented and utilized to guide change initiatives.

Most of the models in EA tend to focus on "what" and "how" rather than "why". On the other hand, intentional modeling is designed for presenting intentions, motivation, and reasons, but has not been applied to EA. This paper has proposed a methodological framework showing one way to incorporate intentional modeling into EA in order to assess the capability of intentional models and the potential benefits they can bring to EA, in terms of facilitating enterprises to manage the knowledge about "why" to support change.

Through the evaluations, this thesis has demonstrated that it is feasible to use intentional modeling in EA to present the "why" knowledge and therefore, facilitate the traceability between "why" and "how" knowledge. The research also has shown the benefits of using IM in EA to help an enterprise make sense, create knowledge, and make decisions to deal with change.

To assess whether IM could be used to represent the knowledge about "why", this framework first clarifies what kinds of "why" knowledge an enterprise needs in order to deal with change, i.e., what kinds of "why" knowledge need to be captured in EA. Instead of applying knowledge management concepts to EA artifacts like other studies do, this thesis applied the Knowing Cycle concept by Choo (1998) to the EA construction process to provide a structure of knowledge necessary to be captured in each architecture construction activity, especially the knowledge required by sense making and decision making. They include the knowledge for making sense of "what is going on in the business and in the environment?" and "why is this happening?" i.e., understanding the way the enterprise is doing its business and motivation behind its current behaviors. They also include the knowledge for diagnosing problems and root causes, the knowledge for designing and developing solutions, and the knowledge for selecting one solution, i.e., decision preferences and rules based on organizational goals and contributions of available solutions. The knowledge could enable the architect to make decisions with explicit rationales.

These kinds of knowledge were found to remain tacit and hard to present using traditional, non-intentional modeling techniques. This research has demonstrated how IM could fulfill the knowledge needs. To validate the feasibility of intentional models' capability of analyzing the "why" knowledge of the business, providing traceability between the "why" and "how", and helping an organization deal with change (i.e., to address the second research question), two IM techniques had been introduced, which are the Business Motivation Model (BRG, 2005) and i* framework (Yu, 1995).

The BMM is designated for the "motivation" concept of EA. However, at current stage, the Business Rule Group has not illustrated its application to EA. This thesis has shown one sample format for constructing a BMM and a possible way to apply it to EA. Through the case study, this study has explored the BMM's potentials to help depict how an organizational works through revealing both forward and backward traceability between the businesses means and ends and the traceability between them with the motivation originating from impact assessments about influencers.

The i* framework (Yu, 1995) was originally designed for Requirements Engineering and has been used for analyzing strategic intentions. It goes beyond the BMM in terms of better-defined goals and softgoals, more detailed description of how an enterprise is operated and why, more comprehensive interrelationships among stakeholders, fuller traceability analysis to help the enterprise discover the motivation for change and opportunities for business improvements' explicit rationales to support identification, selection and implementation of change initiatives that fulfill an enterprise's needs. However, there is no study being done to explore how i* could help with EA processes. The framework presented in this thesis has shown one way to utilize i* to manage the "why" knowledge in EA with the complementary BMM framework and has assessed its potential benefits using the health claims payments case.

The concepts of agent, well-defined goals, softgoals, tasks and resources give a clear picture of *strategic dependencies* among the enterprise and its stakeholders. The rationales behind the strategic dependencies are revealed in *strategic rationale* diagrams. Based on SR diagrams, an architect could do *workability, viability, and ability analysis*. In workability analysis, tasks are decomposed into subtasks through *decomposition* links,

and goals are achieved by tasks through *means-ends links*. Through these links, the architect could evaluate whether a process is workable or not by investigating whether there is workable routine for doing so. In viability analysis, softgoals are finely defined to make sure that they could be operationalized into some business processes. Through *contribution* links from processes to softgoals, the architect could see which business process has what kind of impacts on which softgoal. By tracing the contribution links from softgoals back to processes, the architect can identify where the problems are located if a softgoal is not satisficed. Furthermore, through *dependency* links, the architect can tell whether the enterprise is able to fulfill the dependencies from its stakeholders to a sufficient degree. If not, the architect can again use the links to trace down the root causes, i.e., the motivation for change or opportunities for business improvements. Moreover, after knowing the root causes, the architect could explore a space of potential change initiatives by following *mean-ends* links. Finally, the i* framework is flexible enough to allow the architect to assess different solutions by plugging them in current business processes and evaluating the impacts of the solutions on business functional and non-functional requirements. Finally, a suitable solution could be chosen with explicit rationales before the enterprise commits to one.

In summary, the proposed framework has addressed the researcher's questions defined at the beginning of the research and has shown that current EA practice could be enhanced by incorporating IM to manage the "why" knowledge. This research has integrated IM into the existing enterprise architecture development processes to provide explicit rationales for the target architecture. Enterprises now would know more about what it is doing and why it is doing this way, and it can better position itself in its

environment, understand where change come from, and how to deal with change and to what extent the problems can be solved. With the knowledge, enterprises could adapt to change in a more timely and efficient way.

7. Future Research

Intentional Modeling

The research also has opened other possible further research. First, a tighter integration of the Business Motivation Model and i* should be studied in the future. To integrate the modeling techniques, we need to ensure the concepts of the two modeling techniques could be cross referenced. The BMM's means-ends notations focus more on business strategy level and are classified as strategies, tactics, objectives, etc, whereas i*'s notations on goals, softgoals, and tasks are more general terms which can be used for different business levels. An external influencer in the BMM could be considered as an actor in i*, and an internal influencer could be a resource, task, goal, softgoal, or belief according to its characteristics. The business units' and processes' notations in the BMM could be related to i*'s actors and tasks. However, to determine whether they mean the same concepts will be understood when the OMG has further defined these concepts.

In addition, in order to be applicable in practical settings, intentional modelling concepts and analysis techniques would need to be integrated into established enterprise architecture models and practice. Intentional analysis techniques such as workability, viability, and ability, exemplified in i* need to be integrated with richer enterprise architecture ontology such as those in Jonkers and associates' (2004) study of concepts for Modelling Enterprise Architecture. Concepts of service and value (Gordijn, Yu, & van der Raadt, 2006) should also be included.

Moreover, the i* framework uses quality attributes as criteria to make decisions. Normally, an enterprise needs to combine quality evaluations with quantitative evaluation to get more solid results. The i* model could also be further developed to include a quantitative evaluation algorithm. For example, instead of assigning a

qualitative satisficed/denied label to each element, an enterprise could assign quantitative values to it, such as the benefits/costs of performing a task. According to a predefined quantitative evaluation algorithm, the quantitative values could be propagated to high-level elements, and the selection of a configuration will depend on the quantitative values, such as the overall benefits/costs of a new business configuration.

Application of intentional modeling to lower-level EA

Even though this research focuses on architecture at a business level, the contributions of intentional modeling are not limited to business architecture. The steps could also be used to construct target information and information technology architecture. The following diagram illustrates how this could be done.

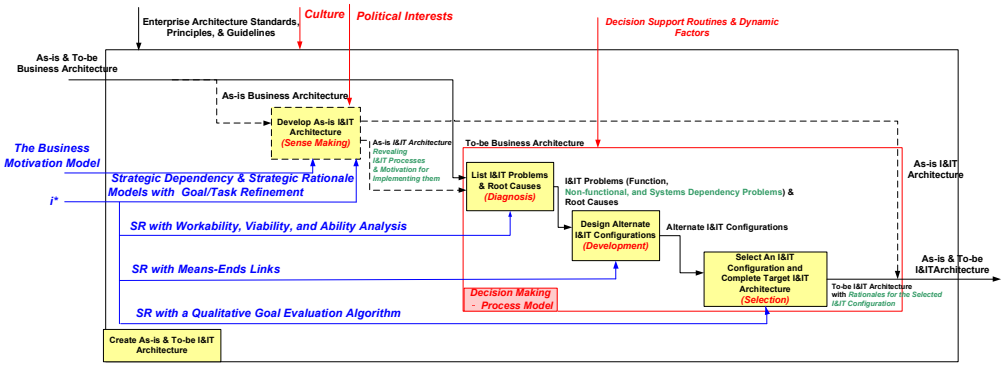


Figure 52: Construction of target information and information technology architecture

Once the enterprise has as-is and to-be business architecture, it can construct the as-is I&IT architecture. The current framework allows the enterprise to use workability, viability, and ability analysis to find the problems of existing I&IT strategies against target business and I&IT requirements and identify root causes. Following the means-ends links, the enterprise could explore a space of I&IT configurations, and using the goal evaluation algorithm, the enterprise could find a suitable I&IT configuration which fulfills not only the functional requirements but also the non-functional

requirements. This further helps the enterprise align its I&IT strategies and their implementations with business objectives.

Tool Support

As discussed in the Evaluation section, it is desirable to have tool supports. First, the tools should include an enterprise architecture repository which facilitates the store, search and reuse of architecture artifacts. Second, the tools should help construct the intentional models. This could be done through predefine a set of forms that users can fill in the forms about the elements and their relationships. Then the tool will generate the models automatically. In addition, it would be efficient if the tool could help architect conduct workability, viability, and ability analysis automatically, finding unsatisfied goals and their root causes. As there is a formal methodology about how the analysis should be carried out. It will not be very difficult to implement the analysis in the tool. Furthermore, the tools should be able to conduct "what if" analysis by analyzing data and relationships across individual or multiple designs/models and deriving logical steps based on "what if" scenarios. Moreover, it is desired for the tools to provide traceability not only from motivation to other elements at the same level in EA but also from high-level motivation to low-level artifacts. This requires artifacts for different rows and columns to have cross reference links among them. Different kinds of links in i* could serve this purpose. As we can see from the case study, often the models could become very complex. There are studies on managing the scalability of i* models, such as Yu's thesis (2004). Again, there is a group working on a goal/agent-oriented modeling tool called OpenOME, and these functions are not difficult to implement based on existing functions.

EA Governance

As building enterprise architecture is a large scale project, there is a need for an enterprise architecture governance body to provide policy guidance, advice and assistance in defining, designing and implementing EA discipline and practice, ensuring architecture quality, and validating the architecture against business priorities and directions. The governance body should also monitor ongoing business and technology changes, assess the changes, decide changes to architecture framework and principles, or even request for new round of architecture work (Schulman, 2002). As we incorporate IM into EA, EA governance will need additional functions to manage the knowledge and corresponding processes. The governance also needs to provide guidance on how to implement intentional models and how to incorporate intentional models with other models constructed by the enterprise. The additional governance functions and guidelines, such as set up additional checkpoint for the motivation component for EA, need to be further investigated.

Evaluation, Theorization and Justification

Due to time and resources limitation, a thorough evaluation was not conducted. Moreover, since EA and EAFs are still new phenomena, it is difficult to give an explanation of how and why the proposed framework works within its environments. Thus, it is difficult to theorize on the artifacts at current stage and justify the cost of following the proposed framework. Theorization and justification will be developed once EA and EAFs practice become more mature and the development becomes more feasible.

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Appendix A. Enterprise Architecture Principles and Standards

Architecture principles are divided into business, information, application and technology principles. The followings are a few examples for each category of the principles.

Business Principles

- Maximize Benefit to the Enterprise

Information management decisions are made to provide maximum benefit to the Enterprise as a whole.

- Information Management is Everybody's Business

All organizations in the Enterprise participate in information management decisions needed to accomplish business objectives.

Information Principles:

- Data is an Asset

Data is an asset that has value to the Enterprise and is managed accordingly.

- Data is Accessible

Data is accessible for users to perform their functions

Application Principles:

- Ease of Use

Statement: Applications are easy to use. The underlying technology is transparent to users, so they can concentrate on tasks at hand.

Technology Principles:

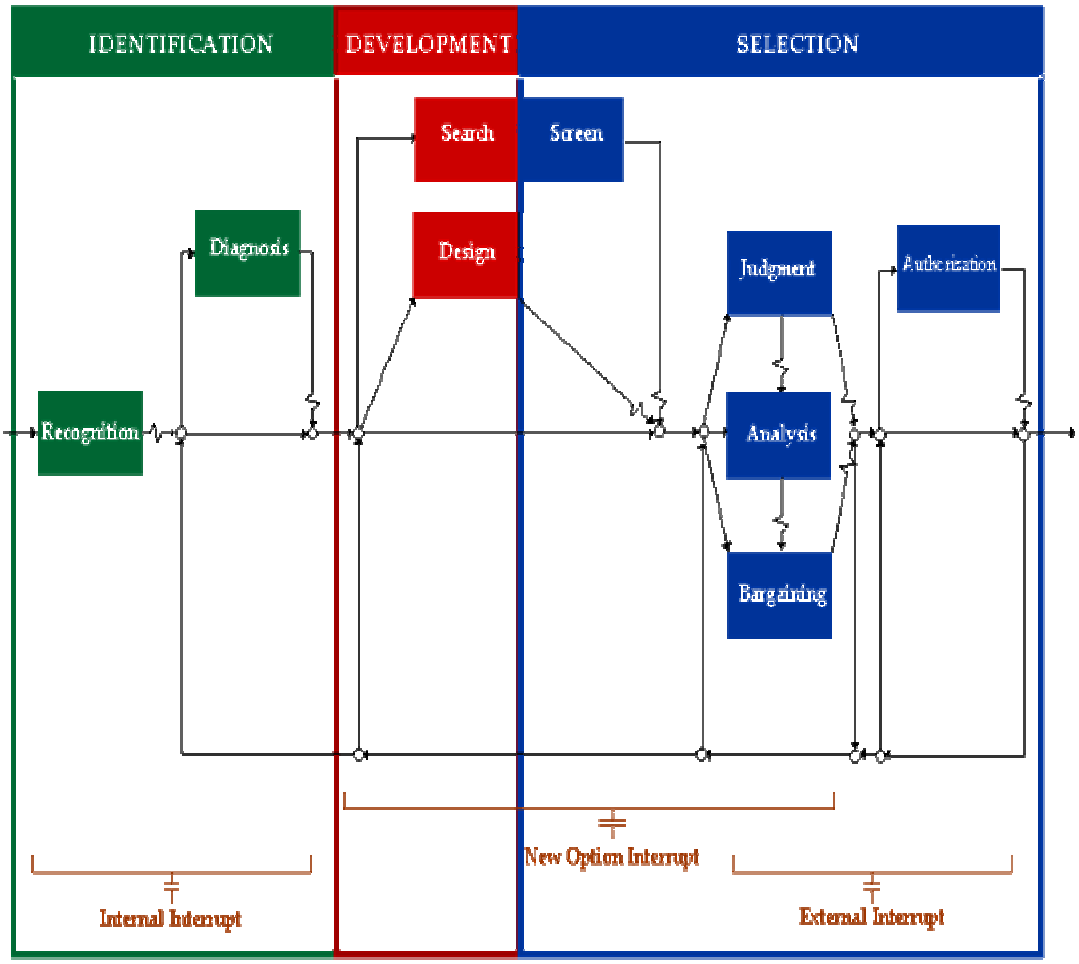
- Requirements-Based Change

Only in response to business needs are changes to applications and technology made

Enterprise Standards

- preEN/ISO 19439 : Enterprise Integration - Framework for Enterprise Modeling, ISO TC 184/SC5/WG1 - CEN TC 310/WG1, 2003
- preEN/ISO 19440: Enterprise Integration - Constructs for Enterprise Modeling, ISO TC 184/SC5/WG1 - CEN TC 310/WG1, 2003
- ISA 95.00.01: Enterprise-Control System Integration , IEC/ISO JWG15, 2002
- ENV 13550 : Advanced Manufacturing Technology - Systems Architecture - Enterprise Model Execution and Integration Services, , CEN/TC310, 1999
- IS 15704: Requirements for Enterprise Reference Architecture and Methodologies, ISO TC 184/SC5/WG1, 1998
- IS 14258 : Industrial Automation Systems - Concepts and Rules for Enterprise Models, ISO TC 184/SC5/WG1, 1998
- ENV 12204 : Advanced Manufacturing Technology - Systems Architecture - Constructs for Enterprise Modeling, CEN TC 310/WG1, 1996
- IEEE 1471-2000 Standard for Architectural Description

Appendix B. The Decision Making Process Model



Appendix C. Interview Questions

Applicability	How do you think such a framework could improve the representation of the "motivation" concept of enterprise architecture? • How do you think the concepts of means, ends, influencers, and their impacts of the Business Motivation Model could improve the representation of the motivation embed in the enterprise's business plan? • How do you think the strategic dependencies among stakeholders and the workability, viability, and ability analysis done in SR diagrams could further improve the representation of the motivation for change? • How do you think the well-defined goals/softgoals and it associated evaluation algorithm could improve the representation of the rationales for choosing one change initiative over the others?
	How do you think such a framework could make it easier to trace in both directions from business courses of action to business motivation, from business problems to root causes, from business configuration decisions to their rationales, and trace from to-be architecture to as-is architecture? • How do you think the mean-ends relationships in the BMM could make it easier to trace from business strategies to business goals? • How do you think the linkage between influencers, their assessments, and potential impacts on the enterprise could make it easier to trace from business goals, strategies, and rules to its original needs? • How do you think the decomposition links in i* could make it easier to reveal processes that are embedded in systems and human heads? • How do you think the means-end links in i* could make it easier to explore potential business models for alternate business service delivery? • How do you think the contribution links in i* could make it easier to reveal the impacts of operations on non-functional requirements of the enterprise? • How do you think the various links in i* could make it easier to trace from unsatisfied business goals or dependencies to the business processes which cause the dissatisfaction? • How do you think the evaluation process could make it easier to trace the rationales for business configuration decisions?

	How do you think the target architecture resulting from the framework could help an organization better deal with change? • How do you think the architecture could help enterprises better understand what kinds of motivation necessary to be captured in their EA? • How do you think the architecture could help enterprises better integrate sense making, knowledge creation, and decision making in order to be adaptive to change? • How do you think the target architecture could help enterprises clarify triggers of change, reasons for the change, where to make change, what alternatives available, and the rationales for choosing the change initiative the presented in the target architecture?
Appropriateness	In your opinion, does the knowledge management concepts used appropriately in the framework?
	In your opinion, do the intentional modeling techniques and their associated analysis used appropriately in the framework?
Completeness	In your opinion, what elements are missing from the framework?
	In your opinion, what elements should not belong to the framework?
Other issues	What challenges (i.e., cost, man-power, etc) of applying the framework would you foresee?
Further impression	Do you have any further comments?