From Business Models to Service-Oriented Design: A Reference Catalog Approach

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Abstract. Service-oriented architecture (SOA) is rapidly becoming the dominant paradigm for next generation information systems. It has been recognized, however, that the full benefits of SOA would not be realized unless its capabilities are exploited at the business level. In the business arena, innovations in e-business have led to the identification and classification of business models and analysis of their properties. To ease the transition from business design to service-oriented system design, we propose a reference catalog approach. Recurring business designs are collected, pre-analyzed, and documented as a set of reference business models, following a standardized template. Each reference business model is realized through a set of service-oriented design patterns. The *i** framework is the basis for modeling and analysis at both the business and service design level, taking advantage of its agent orientation for modeling service relationships, and its goal orientation to facilitate adaptation from generic patterns to specific needs.

Keywords: Service-oriented design; business models; business modeling techniques; agent and goal-oriented conceptual modeling.

1 Introduction

As the Internet gives rise to many new business opportunities and dramatically changes the traditional ways of conducting business, the concept of business models has become a tool of interest in the e-business world to capture new ways of doing business [2]. As we expect the concept of SOA will further revolutionize how enterprises use the Internet for business interaction and integration, new types of business models will emerge and have great impact on the underlying IT infrastructure. Consequently, design options will multiply rapidly, and technical system design will need to interact more closely with business design to explore and select among various alternatives, creating the need of conceptual modeling techniques to assist in capturing the design properties and bridging the gap between the two different levels of concepts.

In recent years, the Information Systems (IS) community recognized the demand for business models and started to develop modeling techniques for this purpose [7, 16, 17]. However, our research on existing literature indicates that the idea of business models has not yet had widespread impact on IS modeling, and the following question remains unclear: How can business model reasoning be used more effectively and efficiently in guiding the design process of an SOA implementation?

Although the value of business model design and analysis has been gradually realized, business design knowledge is often underused in existing modeling approaches. However, to improve the design and analysis process over time, it is important to capture repeatable solutions and be able to apply them to similar problems in the future. Our approach is to express and capture recurring business models and patterns in an expandable reference catalog, which consists of two parts: a set of reference business models and a set of business service patterns.

This paper first identifies the importance of business models and the use of business modeling techniques, and explains the relevance of the *i** modeling framework [25] in this context. Then, it proposes a business model driven SOA system design methodology, which is an application of the *i** framework to business modeling and SOA design. Its main idea is to maintain a set of reference business models in a reference catalog, so that common design knowledge in recurring business models can be reused to solve similar business problems and help define the technical specifications.

2 Business Models and Business Modeling

The concept of business models became popular in the late 1990's, and has been considered to be central in the discussion of e-business, as the success or failure of a firm is often attributed to the viability of its business model. Despite its popular usage, there is no agreement on what the term should precisely encompass [18]. In the business literature, business models refer to the actual design of business, such as a method of doing business [19] or a company's business architecture [22]. On the other hand, business models in the IS engineering literature are *representation* of business concepts in the real world, often with the aid of some graphical notation and business modeling techniques. The notion of business modeling, as discussed in this paper, refers to the analysis and design process of business level concepts using business models in the IS engineering sense.

So far, the study on business models in the business literature has focused on descriptive aspects, such as what concepts can be expressed in them and how business practices from the real world can be captured as types of business models with a name and textual descriptions. Thus, its focus is less on the design and analytical powers of business modeling. On the other hand, the notion of business models in the IS engineering community is a tool for representing the business concepts, such that they can be properly expressed, designed and analyzed using various conceptual modeling techniques. Thus, the soundness of a business model in this sense would relate to how accurately it reflects the reality; whereas the soundness of a business model in the

business community would be measured by how well it helps a company to successfully conduct its business.

3 *i** for Business Modeling

A number of existing business modeling techniques has been studied in [12], including an extended version of Unified Modeling Language (UML) [5], the Business Model Ontology (BMO) [16, 17], the Business Modeling Method (BMM) [14], the e^{3}value framework [7], and a value network approach [1]. The result of the study shows that business goals and strategic interactions between business actors are often missing or underused in the design and analysis process of business models. However, as discussed in the business model literature such as [2], [6] and [13], a sound business model should effectively express and deliver the vision and objectives of the business, as well as model actor relationships and interactivity, because in the real world, consumers and other partners are actively co-producing values with the organization through various interactions.

Therefore, we turn to the *i** modeling framework [25], because it offers a set of agent and goal-oriented notation and analysis techniques that are highly relevant for modeling and analyzing business concepts, which are not offered by the other approaches mentioned above. Its notation, as shown in Fig. 1, captures business objectives and goals in terms of softgoals and goals, and models strategic relationships among business actors as dependencies, which can be in terms of a goal, resource, task, or softgoal. Using this framework also adds value to the model design process because it provides techniques to explore unmet goals, establish alignment between objectives and activities, and perform alternative exploration and evaluation. These are advantages for designing and analyzing business models using the proposed reference catalog, because usually reference models do not fit exactly to specific cases and need adaptation. Therefore, the *i** goal models provide analysis and reasoning behind the model design, thus facilitating the adaptation from generic business models to specific business cases. In addition, the Tropos design process [3, 23], which extends the i* framework, offers an integrated set of technical system design models that can be systematically derived from *i** models, further aids the alignment of business level concepts and technical design models.

Furthermore, we adapted the notation of *i** to include the modeling of business services, as shown in the legend of Fig. 2, because both the business and IT communities have proposed to analyze and design business operations as a set of discrete processes and services, which leverages the principles of SOA to achieve flexibility, agility and responsiveness to changing business needs [4, 8].

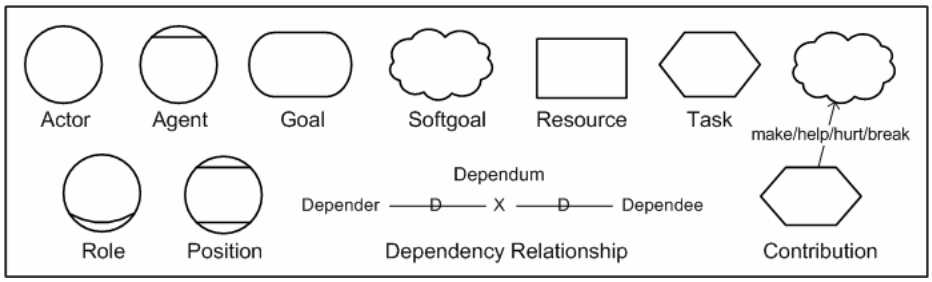

Fig. 1. Major modeling concepts in the *i** framework.

4 The Reference Catalog Approach

The proposed approach consists of a set of pre-analyzed, reusable, structured and connected model components that will be provided in a reference catalog, as described in the following sections.

4.1 Reference Business Models

A reference business model, as defined in [2], is a model that provides a generalized representation of a business model. It can be referenced or used as a basis for adaptation to the business of a specific company.

A sample set of reference business models for the reference catalog includes: *Direct-to-Consumer, Full-Service Provider, Intermediary, Shared Infrastructure* and *Value Chain Integrator*. Each of these represents a particular way of conducting business, thus companies wishing to implement a particular business model similar to one expressed in the catalog can retrieve the reusable model components from it to aid its business and technical system design process. These models are adapted from the set of e-business models proposed in [20] and [24]. A sample reference catalog containing details can be found in the appendix of [12]. The *Value Chain Integrator* business model is extracted from this catalog and used here as an example.

4.2 Reference Model Template

In the reference catalog, each reference business model is defined using a standardized template, which consists of the set of components listed in Table 1. The first 12 are general descriptions that help users to find a reference business model from the catalog that best fit their purpose, and the rest are pre-analyzed and generic models created using the *i** framework, which are effective tools for the representation and analysis of business concepts. In the following sections, we will describe in more detail each type of these model components.

Table 1. The set of components in a reference business model.

No.	Component Name	Component Description
1	Name	A unique name to identify the model in the reference catalog.
2	Summary	A brief description of the reference business model.
3	Key business drivers	The major issues that motivate the use of this model.
4	Solution	Description of how this model solves the issues listed as the key business drivers.
5	Potential advantages	A list of potential advantages that this model targets to deliver.
6	Challenges and limitations	A list of challenges and limitations that might be caused by the implementation of this model.
7	Key business actors	A list of key business actors that are involved in this model, and their roles.
8	Strategic dependencies	Strategic dependencies between the different business partners.
9	Revenue model	A description of how business participants can generate revenue by participating in this model.
10	Related models	Other reference business models that are similar to this model.
11	Sources	The source where this model is defined or proposed.
12	Examples	Examples of model usage in the real world.
13	*i** Strategic Dependency (SD) business model	A graphical representation of the reference business model, indicating the business actors, business goal dependencies, business collaborations and value exchanges.
14	*i** Strategic Rationale (SR) Business Model	A more comprehensive graphical representation of the reference business model, indicating the internal business objectives and activities of business actors.
15	Business Services	The business services that are identified from the *i** SR business model.
16	Extended Actor Diagram	A diagram that shows the architectural structure of the set of IT services and other subsystems.

The *i Strategic Dependency (SD) Business Model.** The *i** SD business model provides a graphical representation of the reference business model, indicating the business actors, business goal dependencies, business collaborations and value exchanges. The SD model provides a high level of abstraction showing only external relationships among actors, suitable for browsing and selecting from the catalog.

The *i Strategic Rationale (SR) Business Model.** The *i** SR business model provides a more comprehensive graphical representation of the reference business model, indicating the internal business objectives and activities of business actors. The SR model contains the details needed by business model designers to adapt the reference model to a particular business under question, by modifying goals, tasks and dependency relationships, and analyze it using *i** techniques to explore and evaluate various design options. For completeness, the SR model includes all relationships with external actors, which allows the SD model to be generated from the SR simply by hiding the internal elements of each business actor. An example SR model for the *Value Chain Integrator* reference business model is shown in Fig. 2.

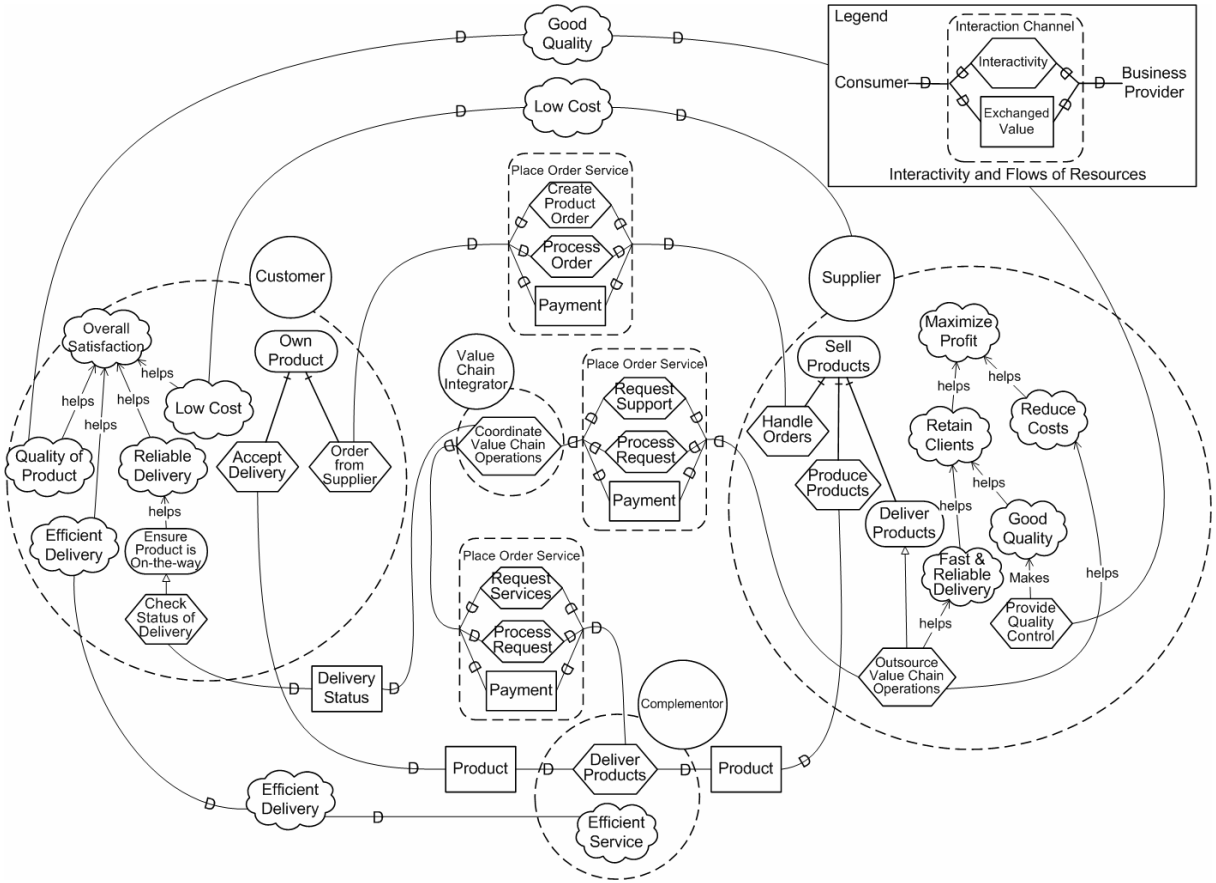

Fig. 2. An example *i** SR model for the *Value Chain Integrator* reference model.

Business Services. Each reference business model also comes with a set of business services, which are identified from the SR business model. They are organized in a table (exemplified in Table 2), in which each row links to a business service pattern in the second part of the catalog. The purpose of this separation between reference business models and business service patterns is that business service patterns often recur in business models, such as the *Place Order* service in the *Value Chain Integrator* example, hence referring to patterns in a separate section will avoid duplicate entries and increase reusability of model components.

Then, for each business service that is identified from the SR models, model designers may use the corresponding business service pattern and associated collaboration diagrams to further analyze and design how their specific service can be carried out, while guided by design options and rationales that are collected from previous experience or other experts.

Extended Actor Diagrams. We then use an extended actor diagram to illustrate the IT services or subsystems that each business actor needs for the business model to work. This diagram can be generated using the Tropos methodology as described in [11], where each of the actor's tasks is modeled in a task dependency, of which the fulfillment is dependent on a subsystem within the actor. As shown in Fig. 3 below, the actor diagram illustrates the architectural structure of the technical system that needs to be implemented by the business actor *Supplier*. It also guides the identification of IT services that the actor should provide, e.g., the *Place (Product) Order* service that will be used by its customers.

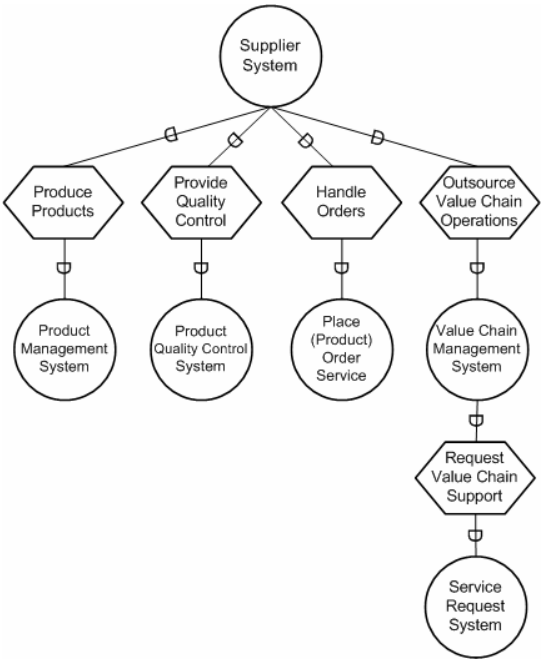

Fig. 3. An extended actor diagram for the *Supplier* actor.

Table 2. Business Services used in the *Value Chain Integrator* business model.

Service in SR model			Business Service Pattern
	Requester	Provider	
Place (Product) Order	Customer	Supplier	Place Order Service
Place (Service) Order	Supplier	Value Chain Integrator	Place Order Service
Place (Service) Order	Value Chain Integrator	Complementor	Place Order Service
Request Status	Customer	Value Chain Integrator	Obtain Data Service

4.3 Business Service Patterns

The second part of the reference catalog contains a set of business service patterns. Each business service pattern consists of the following components:

- A diagram illustrating the recurring business service
- Design rationales, if any
- One or more derived business collaboration diagrams
- Optional business process models corresponding to each business collaboration diagram.

These components capture common patterns of dependencies and collaborations between business partners, as well as provide design alternatives and reasoning to help analysts design strategic business services that will benefit them in their specific case. They are further explained in the following sections using the *Value Chain Integrator* example. Additional diagrams and details of the example may be found in [12], but are not included here due to space limitations.

Business Service Pattern Diagram. When a recurring business service is found in the *i** business models, it is captured and added to the reference catalog as a business service pattern in terms of generic business actors, such as service consumer and provider, and generic dependency relationships. For instance, the *Place Order* service occurred several times in the *Value Chain Integrator* model, and therefore is specified as a service pattern in the catalog with the diagram in the Fig. 4 below.

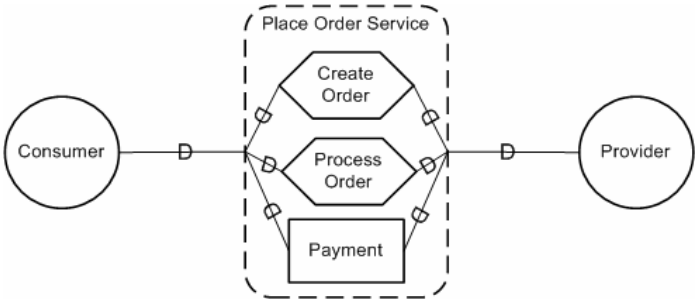

Fig. 4. The recurring *Place Order* service pattern.

Design Rationales. Design options and the reasoning behind each business service may also be recorded in the design rationale section under each service pattern, because they will be helpful when designing the same or a similar business service again in the future. For instance, the *Place Order* service pattern can support various payment options, and they are recorded in table 3.

Table 3. Payment options for the *Place Order* service.

No.	Design Options	Description, Intentions or Concerns
1	Pay-per-use (immediate payment)	Fees are incurred according to usage rates, and payment must be made at the time of usage.
2	Pay-per-use (periodic invoice)	Fees are incurred according to the usage rates, and fee statements are sent to the user periodically.
3	Subscription-based	Users of the service are charged periodically, such as daily, monthly or annually, and the subscription fees are incurred irrespective of actual usage rates.

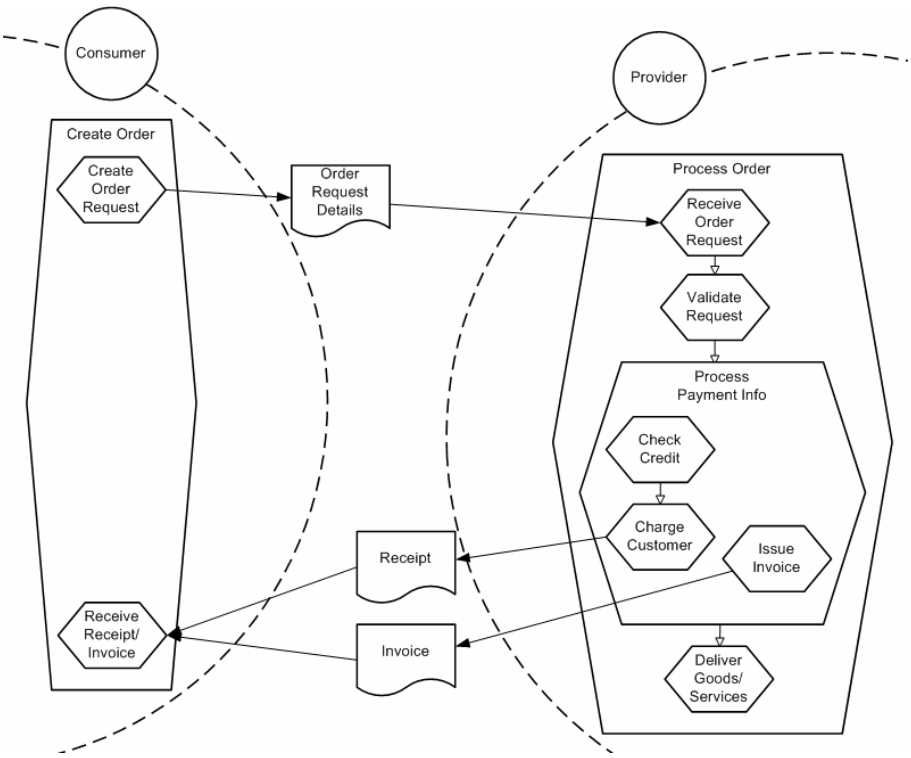

Fig. 5. The business collaboration diagram for the *Place Order* service pattern that supports both the *immediate online payment* and *periodic invoice* payment options.

Business Collaboration Diagrams. There is at least one business collaboration diagram for each business service pattern to illustrate the sequence of business activities and resource exchanges involved in the service. Each one of them can be

generated based on the method described in [10], where the task originating or receiving the service request is decomposed into more specific tasks performed in sequential order, and the interactions between business partners are shown as information or resources being transferred between them. An example is shown in Fig. 5.

Business Process Models. Business process models are optional, but in cases where a business service can be automated by IT services, a business process model can be used for generating process definitions that can be implemented and executed via IT service orchestration engines. For instance, some collaboration activities, such as the delivery of products, can only be done manually; whereas a *Place Order* service can be done electronically and be automated. There are various options for constructing a business process model, such as using the Unified Modeling Language (UML).

5 Guided Design via Reference Model

The agent- and goal-orientation of *i** modeling provides support during the adaptation of a reference business model (taken from the reference catalog) to a specific case. Fig. 6 outlines the procedure for this adaptation process. The process begins by selecting a reference business model from the reference catalog based on business drivers that relate to the company's specific needs. Then, to decide whether a reference business model is an appropriate one to start with, we assess the potential advantages of implementing the model as well as the challenges and limitations it may bring. Once a reference business model is selected, we instantiate *i** SD and SR models from the reference models, and refine them based on the company's characteristics and design decisions. The refinement process can be guided by design rationales recorded in the reference catalog from previous cases, as well as the *i** techniques that are described in the next section. Next, business service patterns are extracted from the *i** models, and are further analyzed and designed using business collaboration diagrams, either to be created or derived from the existing ones in the reference catalog. Then, potential IT services are identified from the set of business services, and for each of them, business process models are derived. The set of IT services, described in an extended actor diagram, along with the corresponding business process models will then be passed to the technical design and development process. Lastly, new model components and design rationales generated during the process will be added back to the catalog for future reference. In [12], the adaptation process is illustrated with a real world case study from the literature.

5.1 Business Model Instantiation

As explained earlier, the proposed approach begins with the selection of a reference business model that is similar to the business model to be implemented by the company under study. Then, the next step is to instantiate and refine the *i** SD and SR business models for this specific case by adding in the case's specific properties and by applying the *i** analysis and reasoning techniques. A refined *i** SR model is shown

in Fig. 7, which analyzes and designs a supplier's product shipping process using its specific organizational structure, such as its extra business roles as sales/shipping agent, warehouse and loading dock; while keeping the goals of improving efficiency and reliability in mind. The refinement process using the *i** analysis and reasoning techniques are described in the following sections.

Goal Analysis. This involves the addition of missing business goals that are relevant to the specific case, as well as the removal of goals that are irrelevant but given in the original model. Once the high-level goals are determined, they can be decomposed into more specific sub-goals as appropriate. The *supplier* in the example has the same high-level goals as in the reference business models, therefore no changes are needed.

Task Decomposition and Means-Ends Reasoning. Tasks in the original models are examined to see whether they are relevant to the business goals of our specific case. Irrelevant tasks are removed, and new tasks are added for goals that have not been addressed. Also, given more details in the company's scenario, some tasks can be decomposed into more specific subtasks. For instance, the *outsource shipping* task of the *supplier* in our example can be delegated to different roles in the company, i.e. the *shipping agent* is responsible for requesting shipping support from the *transport consolidator*, whereas the *loading dock* confirms the pickup of products. This helps the business analyst to analyze the business processes, as well as to check that all complicated tasks can be fulfilled.

Alternative Exploration and Evaluation. The *i** framework supports the exploration and evaluation of various design alternatives in achieving the same set of business goals by evaluating the contributions of business activities to goals. For example, *outsource shipping* is one of many options to fulfill the *ship product* task. Therefore, the business analyst can later replace this by another alternative, such as *handle shipping internally*, and see how this option contributes to the company's business objectives. The contribution links from options to goals will provide a qualitative evaluation for each alternative.

Feasibility Analysis. To verify that the instantiated business models are feasible, the refined SR model can be analyzed using the evaluation propagation rules defined in [9]. The evaluation labels, such as the ones shown in fig. 7, provide the results of the evaluation process and indicate any unachievable tasks or unfulfilled business goals. Initial label values are assigned to elements that involve design decisions, and then they are propagated to other elements via contribution or dependency links. For example, since it is the supplier's decision to outsource its shipping process, the *outsource shipping* task should have initial value 'satisfied'. To see the effect of this decision, the propagation rules are applied to label its neighboring elements, including the business goals that it affects. According to the resulting model, outsourcing should help the supplier to satisfy its need to *ship products*, as well as partially fulfilling its needs to *reduce shipping cost* and provide *fast and reliable delivery*.

This analysis process not only helps to check for capability issues, semantic errors or inconsistencies, but also allows the designer to discover any unintentional omissions or misrepresentations of important business concepts after refining the business models.

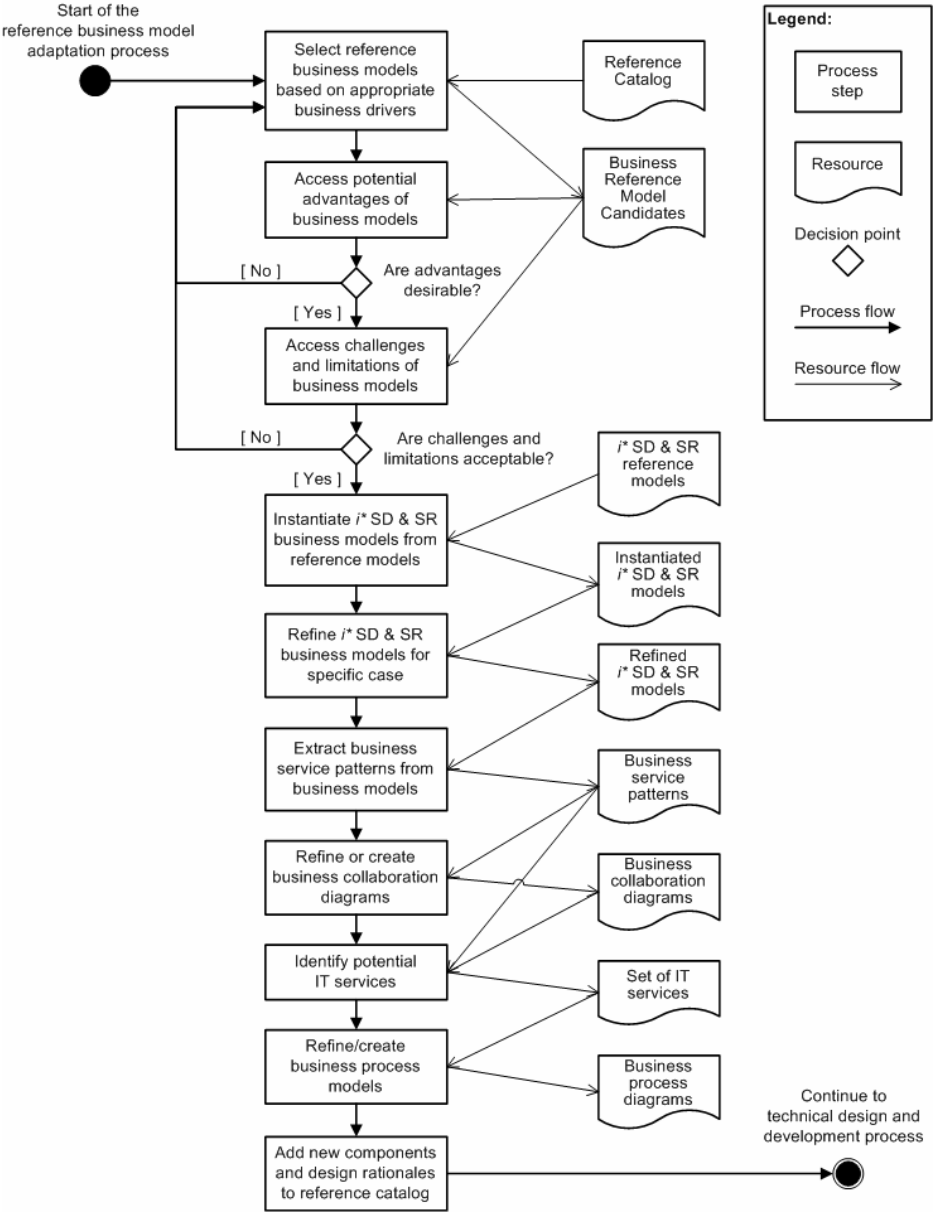

Fig. 6. A flowchart showing the procedure to adapt reference business model components to a specific case.

5.2 Service Identification and Design

After the business models are analyzed and refined, the next step is to use these models to guide service identification and design. Service patterns, design rationales, business collaboration diagrams and business process models are all captured in the reference catalog to aid the analysis. Although there are a number of business services identified in the business models, not all of them can be implemented by IT services. For instance, the delivery of products in the case study cannot be automated but must be done manually; whereas interaction between the supplier and transport consolidator can be automated, because shipping request can be stored and sent electronically, and its design and implementation can be guided by the *Place Order* service model components provided in the reference catalog.

6 Conclusions and Future Work

This paper discussed the importance of business modeling in the context of both business and service-oriented design, and adopted the agent and goal-oriented *i** framework as the conceptual modeling framework in this context. It also proposed a reference catalog approach that offers guidance and reusable knowledge to bridge the gap between the business and service design processes. This approach provides a set of pre-analyzed, reusable, structured and connected model components, and illustrated how the *i** modeling techniques are useful in the analysis and reasoning process for business modeling, helping business and system designers to adapt reference business models to specific cases. A number of other approaches, including an extended version of Unified Modeling Language (UML) [5], the Business Model Ontology (BMO) [16, 17], the Business Modeling Method (BMM) [14], and the *e*^{3}*value* framework [7] also intended to support the business modeling process. However, these existing approaches are not agent and goal-oriented, and lacks the modeling and analysis techniques that are needed for pre-analyzing reference business models and adapting them to specific business cases.

Future works for this research include a more in-depth evaluation of the *i** business modeling techniques and the proposed adaptation process, and to validate it in practice. Also, tool support will be needed to help constructing, analyzing and refining business and service model components, as well as storing and accessing reference business models in the proposed catalog. Possible tools that can be extended for these purposes include OpenOME [15] and TAOM4E [21], which are existing tools developed for constructing *i** models.

Lastly, the sample set of reference business models mentioned in this paper is expected to be preliminary and incomplete. To maintain an ongoing expansion of the reference catalog, experts can be invited to join the effort in refining and adding new models and components to the catalog as the business models and strategies evolve in the real world. Therefore, workable solutions to recurring business problems and best practices can be shared among members in the community.

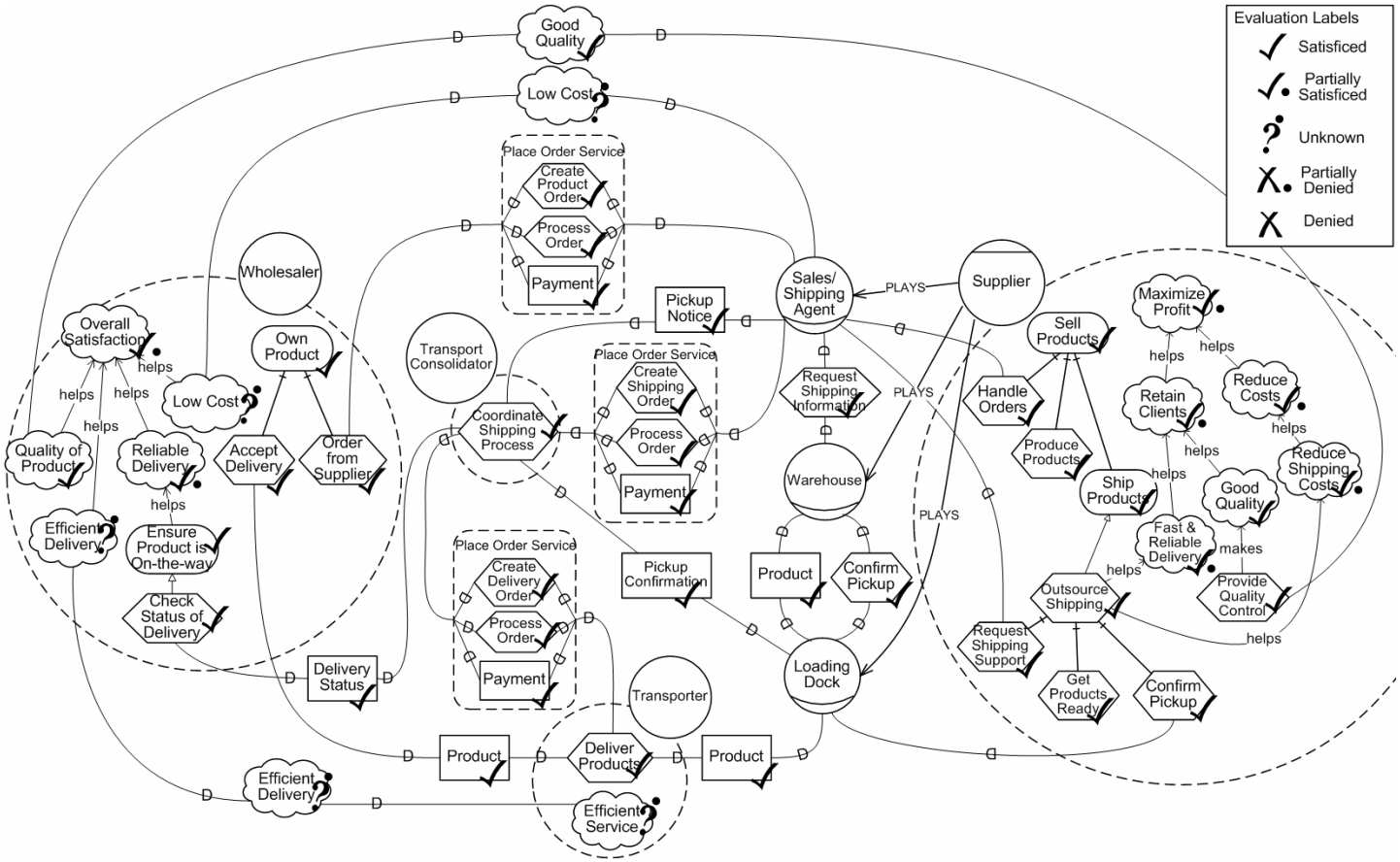

Fig. 7. A refined *i** SR model with qualitative evaluation labels for a specific business case.

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