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From Strategy to Information Systems: a Business Process Oriented Framework

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ABSTRACT

An organization requires understanding how business, strategy and the supporting information systems are aligned so that it can continuously improve its self-knowledge, identify problems and solutions. However, integrating, communicating and capturing business and system models proves to be a difficult task since these concepts are often seen as disparate issues. This paper focuses on combining organizational and system concepts using three separate areas of concern: goals, business processes and information systems. These concepts are presented as extensions to the Unified Modeling Language and illustrated by modeling the purchase and sales operations of a retail store.

1. INTRODUCTION

Aligning business and information technology is a fundamental issue in nowadays organizations. The use of information technology and global networks provides the methods for interconnecting organizations and customers, enabling transaction costs to be driven down and making the customary functional or hierarchical structure less attractive from a management point of view. Moreover, competitive pressure is forcing organizations to rethink how business is done and the type of business they do. In this setting, an organization needs to be flexible enough to cope with its complexity while not disregarding the opportunities created by business changes. This means that an organization requires to have knowledge of how it operates at both business and information system levels and to be able to assess the dependencies between these.

In this paper, we present a framework for describing and tracing organizational and system concepts using three areas of concern: strategy and goals, processes and information systems. This framework is expressed as an extension to the Unified Modeling Language (UML) using a Profile [1][16]. The framework is illustrated by modeling the operations of a retail store from the strategic, process and system viewpoints.

The remainder of this paper is structured as follows: next section contextualizes the approach; sections 3, 4, 5 and 6 discuss the framework's core concepts, namely goal, business and system modeling; section 7 examines a case study. Finally, in section 8 we set out our conclusions.

2. CONTEXT

This section puts in context goal, business and system modeling.

2.1 Goal Modeling

Strategy is an integrated set of actions aimed at increasing the long-term interests and strengths of an organization regarding its competitors [23]. Strategy can be realized by goals driving the operations of an organization, which must be accomplished by at least one business process. However, Kawalek points out two issues concerning goal capture [10]. First, the complete goal set cannot be captured since some goals are disregarded when interviewing the stakeholders. Second, goals are not shared by all the participants of business processes. Representing the strategic concept from where a goal was derived from, a goal model is able to deliver more knowledge about the business and to facilitate communication between participants.

Goals are classified as qualitative or quantitative and can be further specialized depending on the specific domain being modeled. Furthermore, viewing goal modeling from the Balanced Scorecard's standpoint, it is possible to increase the representational power of goal models, capturing more knowledge about the overall business and strategic and operational goals [9]. These issues will be addressed in more detail in section 3.

2.2 FROM BUSINESS TO INFORMATION SYSTEMS

The architecture of an information system (IS) describes the structure of a system's building blocks, their relationships and the guidelines governing their design and evolution [6]. However, the dependencies between business concepts and the supporting information systems are usually embedded in the development process, which makes difficult tracing which parts of business are realized by which blocks of the system [6][11].

One issue that organizations have to deal with is ensuring that the IS architecture is business-driven, enabling the architecture to support the business requirements and to be adjusted to changing needs. However, fine-tuning the business strategy leads to business process rethinking [14]. Thus, an organization must adjust the IS infrastructure to the way business processes are structured.

Current software component technologies are making easier for a business COTS component marketplace to emerge, facilitating reuse and lowering development and maintenance costs. Nevertheless, an organization requires a means to trace business specifications down to the information systems blocks.

We consider a system as an interface providing access to its services, whereas the system itself is a black-box building block. Composing and relating the blocks through the corresponding interfaces provides a simplified description of an information system yet detailed enough to trace its high-level dependencies to business processes.

2.3 REPRESENTING BUSINESS AND SYSTEM CONCEPTS

Representing business and system concepts in a common language facilitates the creation of solutions that can be more easily conveyed to business and software actors. Our approach makes use of the UML since it has broad support from the industry and academy and it can be adapted to different domains using its extension mechanisms [19].

UML 1.3 is focused on modeling object-oriented software and does not provide suitable extensions to model the business domain. However, the UML provides extension mechanisms to adapt or extend its semantics to specific domains. One of these mechanisms is the profile, which allows creating or customizing metamodel concepts for a particular

domain. A profile is a specification that specializes at least one standard reference metamodel [16]. It is a definition context for elements such as, well-formedness rules, tagged values, stereotypes, constraints, semantics expressed in natural language, extensions to the standard metamodel and transformation rules. The elements included in a profile are compliant with those of the MOF and its reference metamodel. The OMG is currently working on the standardization of several domain-specific metamodels using profiles, such as defining the real-time domain [18] or enterprise distributed computing concepts [17].

3. GOAL MODELING

Nilsson's goal patterns make use of three concepts [14]:

Goals control business behavior and assert the expected state of business resources.

Problems hinder goal achievement. They do not only express negative conditions to the accomplishment of goals but also enable identifying new goals that mitigate these problems.

Contradictions arise when two mutually exclusive goals exist.

Nilsson further classifies goals as quantitative or qualitative. A *quantitative goal* can be measured using a metric, while a *qualitative goal* requires human judgment to assess its status. Every goal must have a description. Quantitative goals also have a target and current value and a measurement unit. Goals can be hierarchically composed or simply related to each other (such as contradictions). Goal relationships satisfy the following rules:

Every sub-goal must be satisfied in order to satisfy the common parent goal.

A goal can have multiple alternative sub-goals.

Achieving a goal positively or negatively contributes to the achievement of another goal.

Problems can also be decomposed into sub-problems. Since a problem is always associated with a goal, the problem hierarchy can be mapped to the goal hierarchy (a sub-goal is always created in order to eliminate a problem associated with a parent goal).

3.1 EXTENDING GOAL MODELING

The Balanced Scorecard (BSC) is a tool for translating vision and strategy into action and measuring its effects [9]. The BSC makes distinction between operational and strategic goals and measures. While operational goals are usually associated with short-term returns, strategic goals concern long-term strategic purposes. The BSC also considers four different kinds of goals to express an organization's vision and strategy. These depend on each of the four different perspectives introduced by the BSC: financial, customer, internal processes, and learning and growth (v. Figure 1). Therefore, in order to capture strategy, goals as well as their origin must be considered.

In addition to the qualitative and quantitative goal classification, and taking the BSC concepts in consideration, we add two other classification schemes: operational and strategic. *Operational* goals identify the "business perspective" and can be classified either as *qualitative operational goal* or as *quantitative operational goal*. *Strategic* goals, just as operational goals, define the "business perspective" and a "time frame" representing the strategy's window of opportunity. Strategic goal can be specialized in *qualitative strategic goal* and *quantitative strategic goal*.

Figure 1. The Balanced Scorecard.

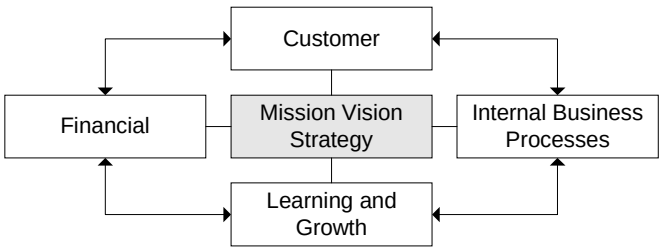


Table 1. Goal Profile.

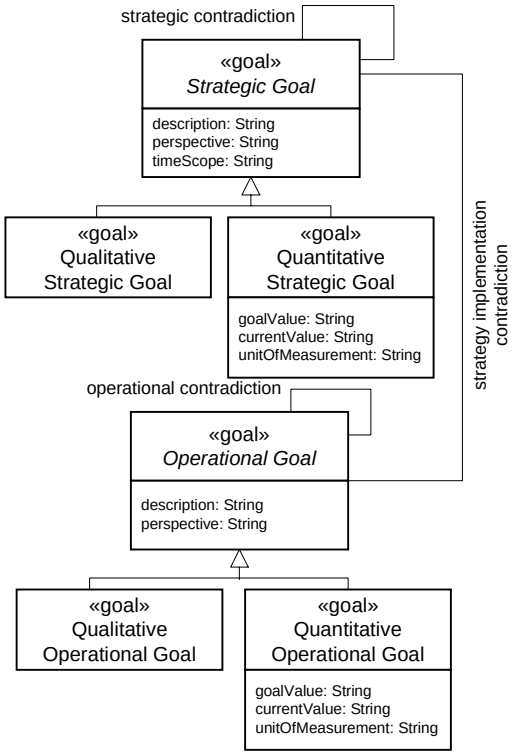
Stereotype	Goal
Extended meta-class	Core::Class
Semantics	Represents a goal that was originated by a specific business perspective of the organization's strategy. It can be further described in natural language.
Notation	UML Class icon with the «goal» stereotype.
Icon	«goal» **goalName** description: String perspective: String
Meta-model	Core::Class; achieved by; Goal; Process

There is no need for further classifying problems since they always depend on goals. However, since goals are specialized as strategic or operational, the goal contradiction classification scheme requires to be updated accordingly. The following scenarios are possible:

- A *strategic contradiction* arises from two inconsistent strategic goals. It implies that the involved strategic options must be assessed and properly weighted, possibly leading to further evaluation of future scenarios and strategic positioning.
- A *strategic implementation contradiction* arises from inconsistent strategic and operational goals. Since it causes short-term problems, measures enforcing the strategic path should be revised.
- An *operational contradiction* exists between operational goals, requiring the involved goals to be revised in the supporting processes.

The purpose of discriminating apparently similar conditions is not to automatically solve contradictions but to draw attention to the current strategic planning and to provide a basis for goal and strategic assessment.

Figure 2. Predefined Goal Classes.



3.2 Goal Modeling in UML

The profile for representing a goal is summarized on the following table. Problems are informally described in natural language using UML Notes.

4. BUSINESS PROCESS MODELING

A business process is a set of activities that bring value to a customer during which the state of the business resources change. Processes can be structured as a hierarchical decomposition of its activities. A process uses resources as input and produces resources as output.

Porter's value chain model is a common model for business analysis [20]. It highlights specific activities or processes that add value to the products or services of an organization, enabling competitive strategies to be applied. Primary or core processes are directly related to the production and distribution of products or services. Supporting processes sustain the organization's core activities. They include the organization's infrastructures, human resources, technology and procurement.

4.1 Process and Resource Modeling in UML

To model business processes and resources, we introduce the «process» and «resource» stereotypes as described in Table 2 and Table 3. Figure 3 and Figure 4 show the defined specializations of «resource» and «process».

5. INFORMATION SYSTEM MODELING

As discussed in section 2.2, we define a system as a block which encapsulates part of the functionality of an information system through a set of services.

5.1 Information System Modeling in UML

According to Herzum and Sims [6], a component may fit in three functional categories: utility, entity and process. A utility component comprises the supporting services required across different entity components. An entity component provides services supporting process components which directly relate to business processes. General components are those who fit in more than one category. Four «system» classes are defined according to these categories (v. Figure 5).

Table 2. Process Profile.

Stereotype	Process
Extended meta-class	Core::Class
Semantics	A «process» represents a unit of work. Its execution may be linked to the execution of one or more other «process» instances through «resource» flows.
Constraints	(1) A «process» must be associated with one or more instances of «goal». (2) A «process» has a one-to-one association with the UML ActivityGraph::ActivityState, representing the flow of its sub-processes.
Notation	UML Class icon with the «process» stereotype or the alternative icon.
Icon	«process» processName
Meta-model	Core::Class; part of; Process; Goal; Resource; achieves; produces, consumes, uses, refines; ActivityGraph:: ActionState

Table 3. Resource Profile.

Stereotype	Resource
Extended meta-class	Core::Class
Semantics	A «resource» is produced, consumed, used or refined by a «process».
Constraints	A «resource» must be associated to one or more instances of «process».
Notation	UML Class icon with the «resource» stereotype.
Icon	«resource» name; description: String; state: String
Meta-model	Core::Class; Process; Resource; produces,consumes,uses,refines

Figure 3. Predefined Resource Classes

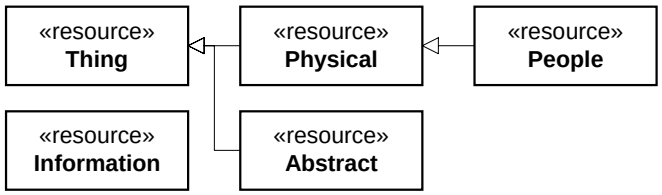
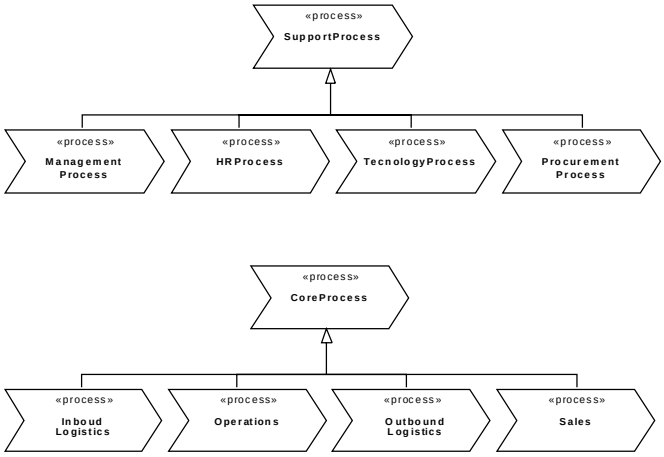


Figure 4. Predefined Process Classes.



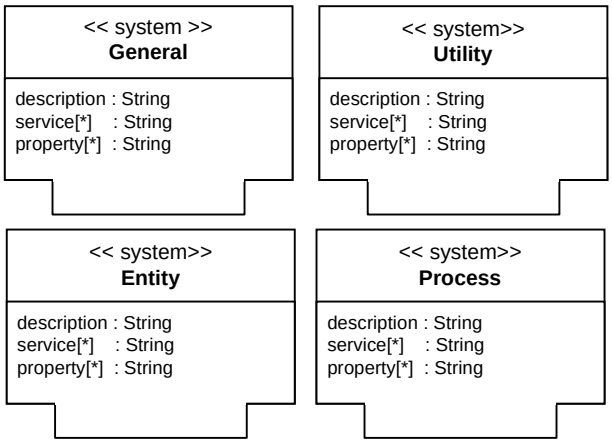
6. THE FRAMEWORK

The framework separates three types of concerns: goals, processes and information systems. Business strategy is represented by goals, which must be achieved by one or more business processes. Business processes interact with resources and perform work which may be supported by

Table 4. Predefined Process Classes.

Stereotype	System
Extended meta-class	Core::Class
Semantics	A «system» represents a building block of an information system.
Constraints	An System has a one-to-one association with the UML ActivityGraph::ActivityState, representing the flow graph of its sub-systems.
Notation	UML Class icon with the «system» stereotype.
Icon	<< system >> name; description: String; service[*]: String; property[*] : String
Meta-model	Activity Graph::ActionState; supported by; uses; system; process; part of; Core::Class
Predefined classes	General System, Utility System, Entity System, Process System (v. **Error! Reference source not found.**).

Figure 5. Predefined System Classes.



information systems. The information system layer represents how system services are related business processes. The dependencies between these concerns are depicted in Figure 6.

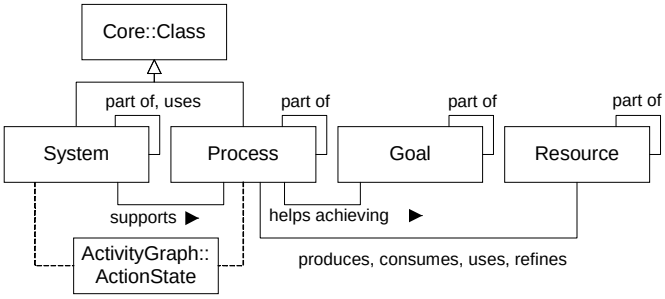
Instances of models created using this framework can be observed from different views, each revealing different details. Two of these views, the structure and the behavior view, justify being highlighted. The *structure view* describes how goals, processes, resources and systems are organized and depicts the dependencies between them. It comprises four UML object diagrams:

- *Goal vision diagram.* Describes the goal structure, problems and goal inconsistencies.
- *Process structure diagram.* Describes the business process structure and dependencies.
- *Goal, process and system diagram.* Describes the dependencies between goals, processes and systems.
- *System structure diagram.* Describes the IS as the breakdown of systems into sub-systems and their dependencies.

Goal, process and system models are inherently hierarchical and can be represented at various levels depending on the purpose and target audience. Therefore, a complete business and system description is accomplished by using multiple structure diagrams with different levels of detail.

The *behavior views* makes possible to represent organization dynamics at system and business levels. These views make use of UML's behavior diagrams in order to describe the behavior of processes and resources, and to describe the interactions between systems and between systems and processes.

Figure 6. The Framework Model.



7. CASE STUDY

To illustrate the framework, we model the purchase and sales operations of a retail store from its strategic, business process and information systems viewpoints.

7.1 Current Situation

XYZ is a midsize retail store. Its core processes are Buy Supplies, Setup Store and Sell Products. XYZ's strategy is centered on three goals: (1) providing customers a better shopping experience, (2) having 95% percent of its products ready for selling, and (3) reducing stock levels to increase cash flow.

Shopping experience depends on waiting time, service quality and by properly displaying available products. These goals trigger an inconsistency resulting from the need of lowering waiting time (e.g. larger number of counters) and better service quality (e.g. extra personnel available for assisting customers). Achieving both of these operational goals requires hiring extra personnel, which increases operational costs. Another problem arises from requiring high product availability and low stock levels. Before adjusting the product ordering frequency and quantity, stock run outs can happen. Figure 7 shows a goal vision diagram that depicts this scenario.

Operating a retail store consists of buying supplies, setting up the store and selling products to clients. Buy Supplies focuses on the supplier side of the retail value chain (buying, receiving and paying). Setup Store concerns the inside store operations, namely warehouse and shelf maintenance. Finally, Sell Products is responsible for attracting customers and selling and delivering products to them (v. Figure 8). The Buy Supplies and Sell Products processes are adapted from MIT's Process Handbook [14].

The XYZ store has three information systems services: procurement, back-office and front-office. These are general systems since they are assembled from other systems, as depicted in Figure 9. Using the goal, process and system diagram, we get a bird's eye view of the XYZ store structure (v. Figure 10). This diagram allows tracing system and business dependencies. For instance, if the Purchasing system does not provide its services, the execution of the Submit Order process is held back, which, in turn hinders the accomplishment of the Product Availability goal.

7.2 Supporting a Strategic Redefinition

Aiming for a larger market share, the XYZ managers decided selling their products through the Internet. Since this strategic change concerns both business processes and information systems, it is important to identify its impact in the organization.

The new strategy brings in a new set of goals: (1) consistent contact with the customer (store and Internet); (2) delivering 99% of the products on the advertised time; and (3) designing a virtual store that suits the customer's needs. The core processes remain unchanged since the core business is the same; only the way customers use the store has changed. However, the supporting processes have to be redesigned to achieve the new goals. The systems supporting the Sell Products process must also be updated, namely the POS and the Customer Relationship Management system. Additionally, a new system supporting product delivery ("last mile") must be introduced. Figure 11 depicts these changes.

8. CONCLUSIONS

This paper outlines an object-oriented framework that aims at answering some problems in integrating business and system modeling. It makes use of a set of common UML extensions to describe different aspects of strategy, business processes and the supporting information systems infrastructure. The emphasis of this framework is on providing the basis for creating such a common representation and simultaneously providing a way to trace concept realizations from different areas of concern.

Taking into account the Balanced Scorecard's concepts, goal modeling gains expressive power and gets closer to management concepts. Business processes emerge as a middle-tier between goals and systems, providing a means of representing how high-level task are accomplished.

Figure 7. Goal Vision Diagram

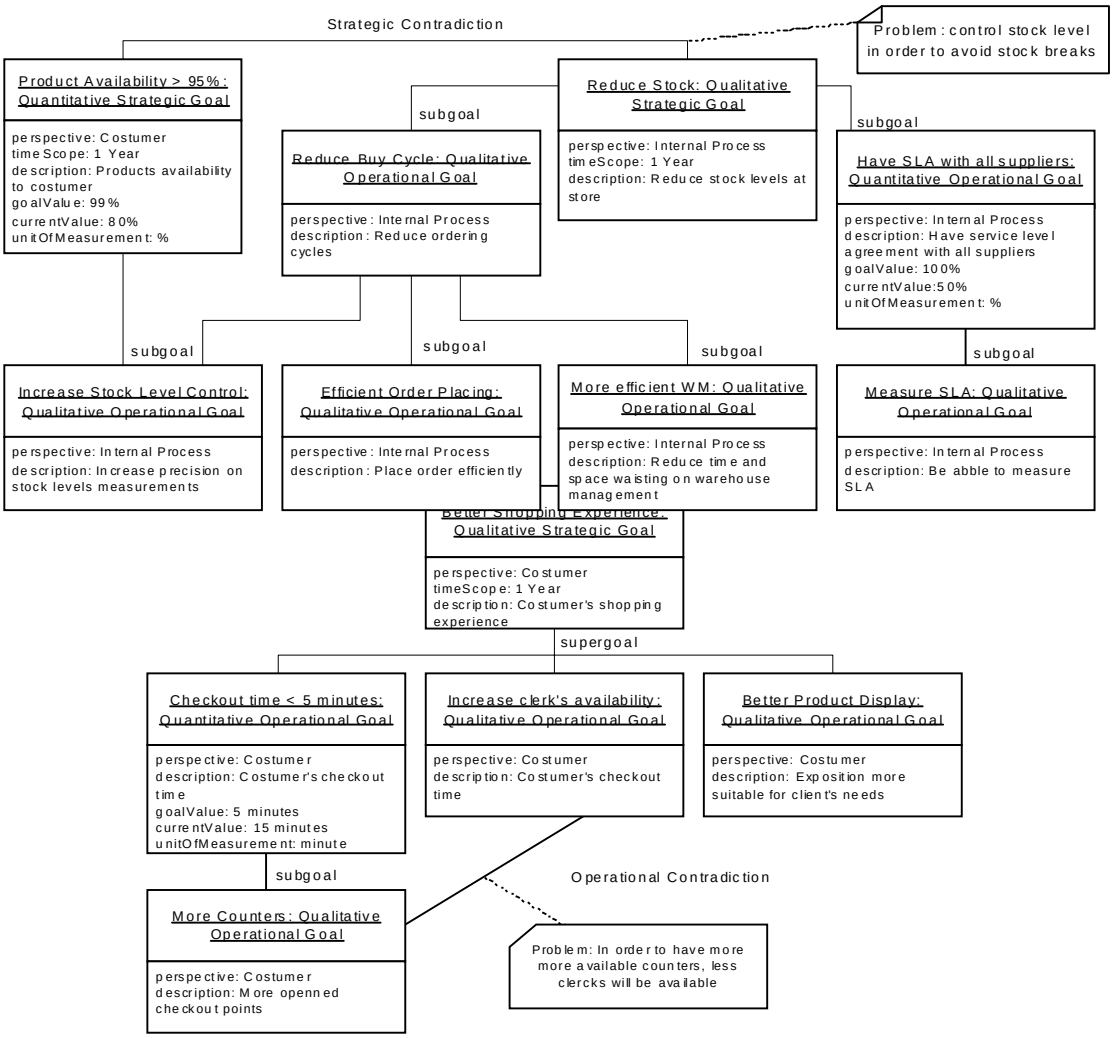
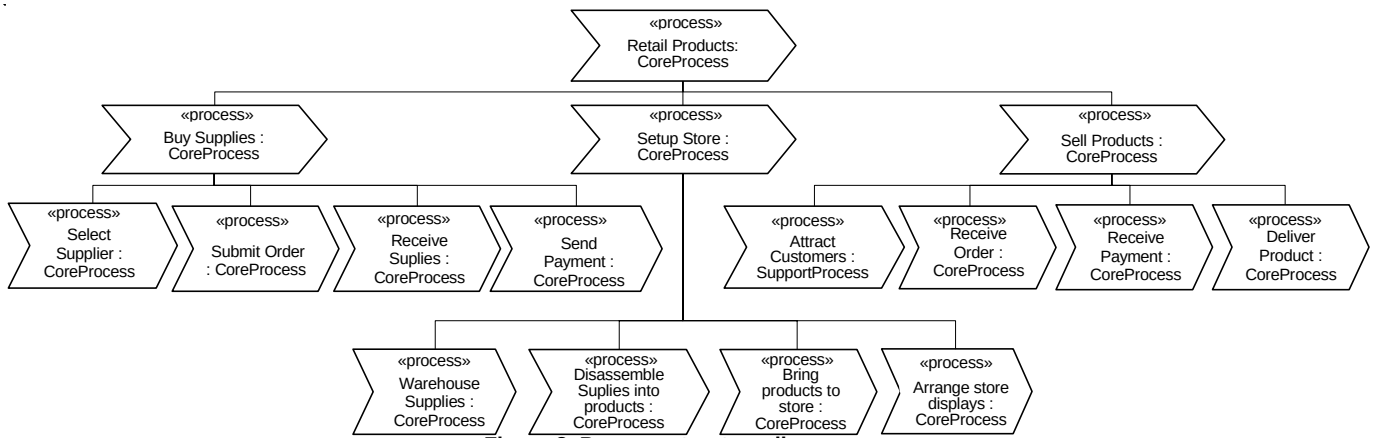


Figure 8. Process Structure Diagram.



The associations between the process and system layers allow representing how the latter are supporting the business activities.

Future work includes specifying a methodology for capturing requirement into business models and a development process for traceable system design using business and strategic requirements as a starting point. Our current research involves modeling strategy, process and systems patterns using case studies from real world organizations. In this setting, this framework sets a foundation for representing these patterns.

Figure 9. Information Systems Diagram

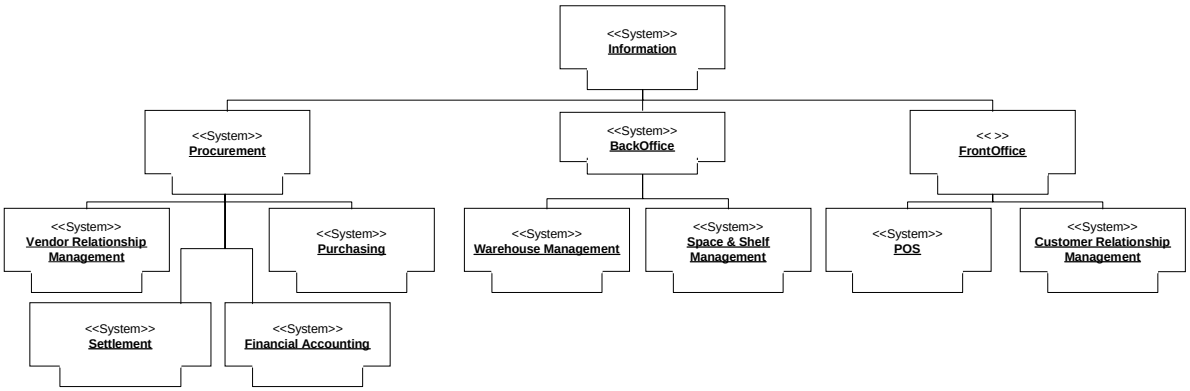


Figure 10. Goal, Process and Systems Diagram

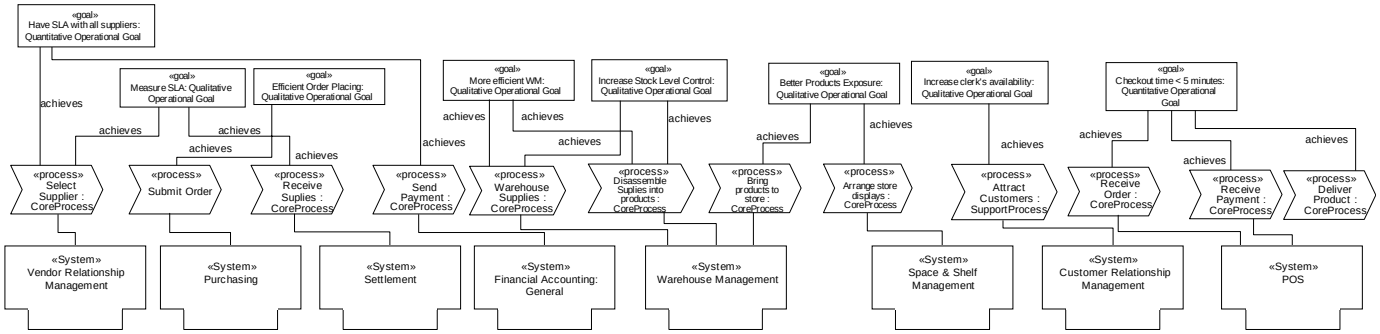
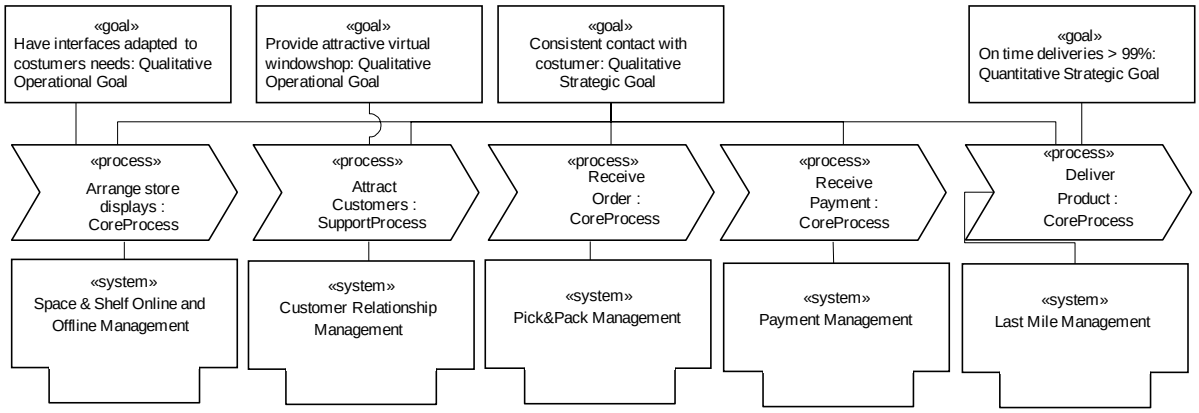


Figure 11. Goal, Process and System Diagram Illustrating the B2C Strategy



9. ACKNOWLEDGMENTS

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