Integrating Modeling At Several Design Abstraction Levels In Architecture And Process Design

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Motivation

This paper is motivated by the July Point of View column of Roger Burlton [11] in BPTrends. In that column he proposes, in summary, several perspectives in process modeling – context, process architecture, process analysis, and so on – and different modeling approaches and tools for each perspective. We agree that there should be such perspectives, which we call design levels, but propose an alternative integrated approach that uses the same modeling approach and tool. This avoids the serious problem of consistency and traceability that exists when designs at different perspectives or abstraction levels should be translated from one into another.

Our proposal is based on the experience and knowledge generated by hundreds of real life projects developed by graduates of the Master in Business Engineering (MBE) of the University of Chile. Such projects have been implemented and are required for the students to graduate at the MBE. Also, several consulting projects have successfully used the same approach – in particular, one in which we are designing the Enterprise Architecture and detailed processes for the Chilean public hospitals.

Design levels

Our experience in formal process modeling, tested on hundreds of projects, has led us to identify several levels of abstraction that represent different perspectives of processes in an enterprise, as follows:

- The first level represents the enterprise process architecture, which might contain all the processes of the firm – or a part of them – that are relevant to produce a certain service or product.

- The second level details the design of the processes that constitute the architecture and allow an adequate operation of the enterprise, emphasizing the specification of the subprocesses and the relationships among them by means of information flows. At this level, process modeling is non procedural.

- The third level gives, for the elementary activities of the second level subprocesses, the execution logic of their tasks, which includes the interaction with IT support that might contain complex business logics, such as an automatic credit scoring. This level is procedural in the sense that it defines strict processing sequences in the computing logic style.

Many enterprises that are world leaders on BPM model these three levels with diverse methodologies and techniques, as proposed by Burlton, without necessarily assuring consistency among them. At the MBE, we have developed a unified modeling approach of the above levels, based on IDEF0 and BPMN. This approach integrates both modeling notations as follows.

The fundamental idea is that different but complementary modeling approaches are required for process representation, depending on the level of detail that it is needed. Thus, to represent the process architecture and design of second level processes we propose a modeling approach that emphasizes the structure and flows, i.e., the components of the processes and their relationships through information flows, which is non procedural. However, to represent the technical nature of the third level models, including interaction with IT support, we propose an approach that is fully procedural and emphasizes activities sequence and control logic. We will show that these approaches are complementary in that the second one starts with the representations of the first one and adds details by decomposing processes into their component activities.

The first non procedural approach models the processes according to IDEF0 conventions, but using a BPMN software modeling tool. The BPMN notation includes a wide variety of representation elements. We use such notation, as explained before, to implement a modeling approach that emphasizes process structure and flow. Given that BPMN is clearly oriented to activity sequence and control logic, we have to use its elements creatively to represent information flows in the IDEF0 style. This is illustrated in the public hospital case as shown in Figures 1, 2, and 3. Figure 1 represents public hospital process architecture, using the idea of macroprocesses, which we explain below; Figure 2 details one macroprocess of the architecture, showing its processes and their relationships; Figure 3 details the subprocesses contained in such processes. The entire representation generates a tree, in the idea of IDEF0 hierarchical decomposition of processes, completely consistent among its different levels of abstraction. A particular characteristic of our approach is that, at every level of abstraction – including process architecture – the relationships among its components (intralevel) and with processes of other levels (interlevel) are explicitly specified, assuring the consistency of the model, as it was the original idea of IDEF0; this could be modeled in the past with softwares such as BPWin.
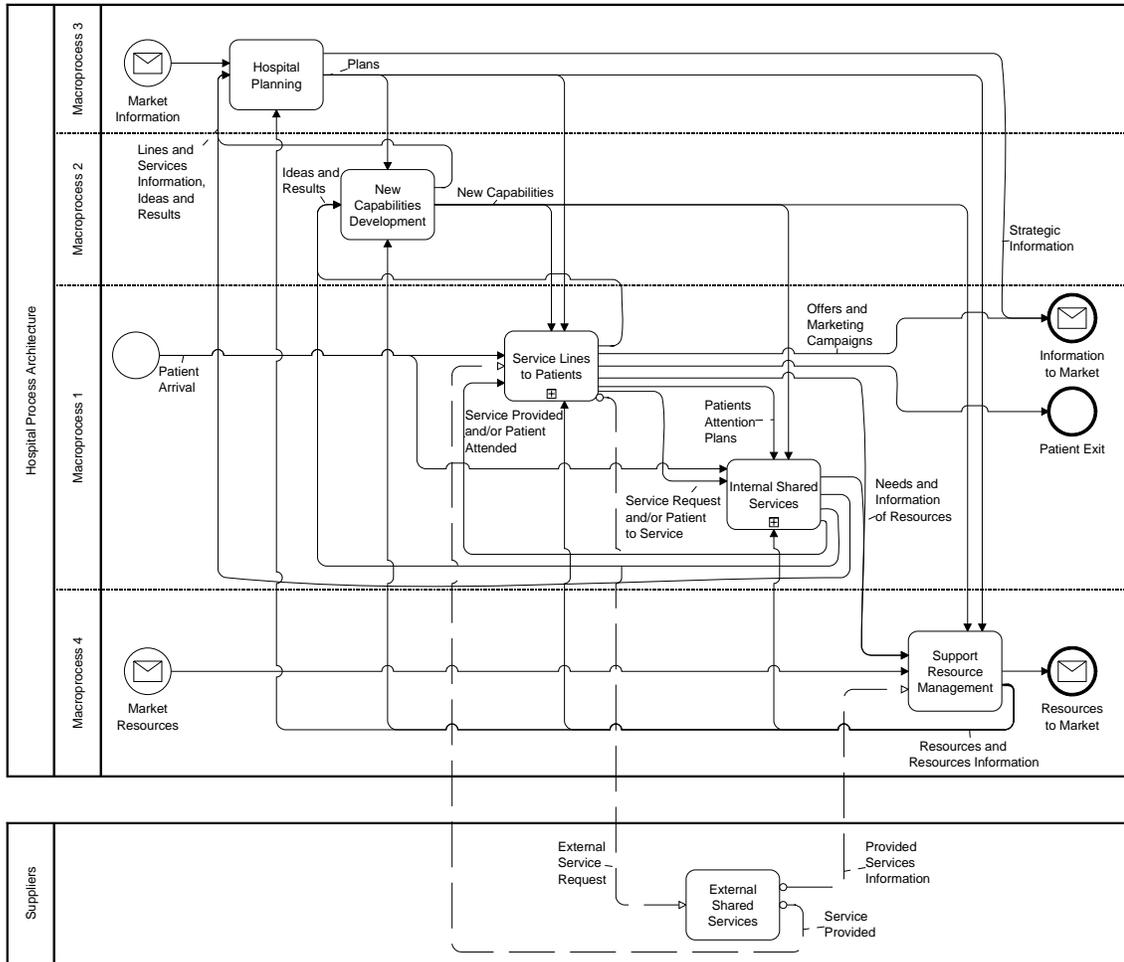
www.bptrends.com

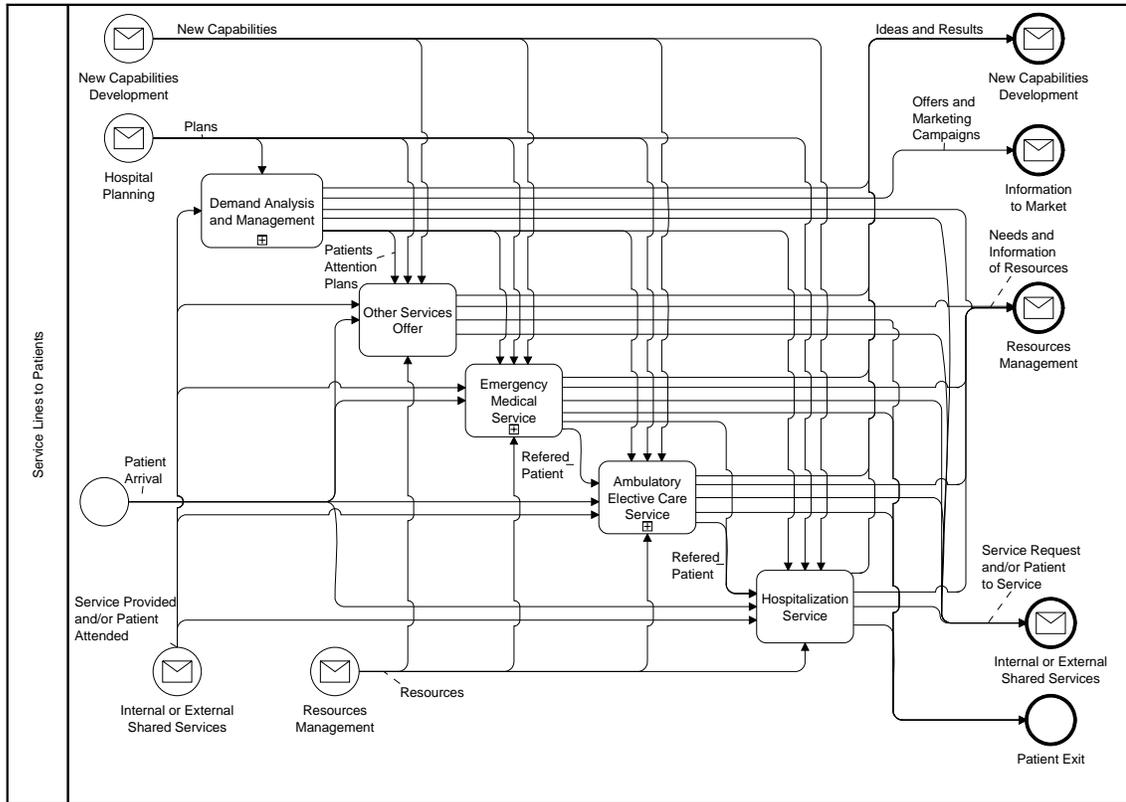**Figure 1. Hospital Process Architecture**

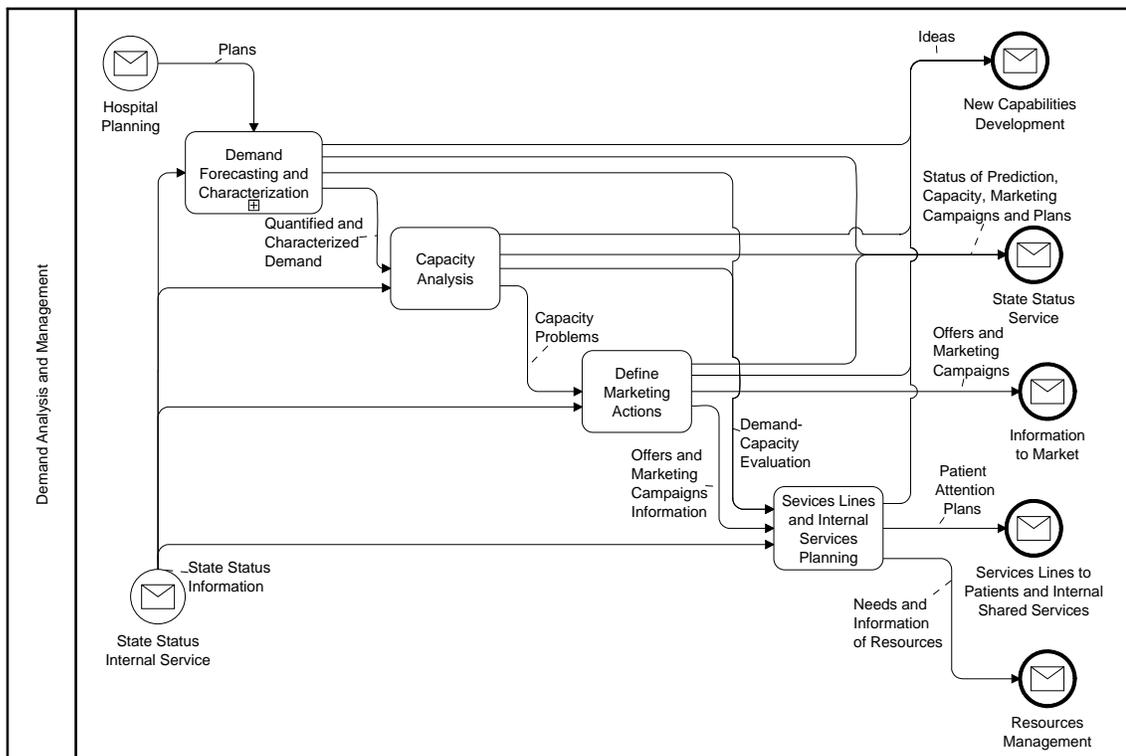**Figure 2. Macroprocess 1: Services Lines to Patients**

Figure 3. Demand Analysis and Management Process

The second procedural modeling approach details the lowest level of the diagrams of the processes modeled with the first one, including tasks sequencing and business logic executed in applications that support human-computer interaction tasks. We adopt BPMN conventions to represent sequence and control logic. Here, we define two sub-approaches: One that does not intend to simulate and execute the processes and one that does. The difference between them is the formality of the representation, because the second approach requires strict BPMN representation conventions to be followed in order to simulate and execute the modeled process. The advantage of this choice is that, under certain conditions, applications that support each process may be generated automatically, avoiding their designing and programming. This is feasible because BPMN can be mapped to BPEL (Business Process Execution Language), which can be run on suitable servers. In practice, it is hard to map the entire process to execution when detailed as described above. In many cases, it will just be feasible to select one part of the process, typically the one we would like to perform more automatically, to model it oriented to execution. We exemplify this modeling approach with the case of a public hospital, shown in Figure 4. It contains the procedural model of a process, shown in Figure 3, designed to forecast the demand of a particular service at the hospital, using a logic based on a neural network model. This model has been implemented and orchestrated with BPEL and other supporting software.
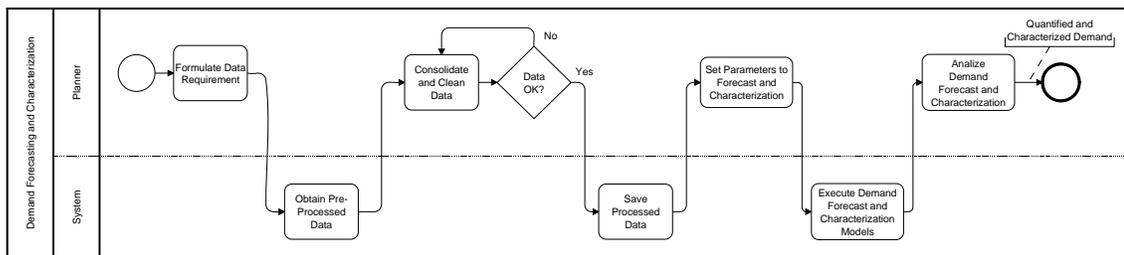

Figure 4.   Demand Forecasting and Characterization procedural model

In summary, depending on the level of detail and the objectives we pursue when modeling, we use different representation approaches that can be defined consistently and complementarily.

Architecture and process patterns

All the modeling and design of the previous section is based on general architecture and process patterns that are, in spirit but not in details, similar to reference models such as SCOR. Our patterns are based on the formalization of knowledge derived from many practical projects of business design, performed by graduate students of the Master in Business Engineering (MBE) at the University of Chile in collaboration with the most important Chilean firms. By 1998, we posited that all processed performed in an organization are part of one of the following types [2]:

* **Macroprocess 1 (Macro1):** Collection of processes for the production of goods and services that a firm offers to its customers, which starts with their requirements formulation, and finishes with the satisfaction of the requests. We call this macroprocess Value Chain, adopting a definition slightly different than Porters, which includes other processes inside it, such as the development of new products that we include as part of another macroprocess.

* **Macroprocess 2 (Macro2):** Collection of processes for the development of new capabilities that the firm requires to be competitive: new products and services, including business models; necessary infrastructure to produce and operate those products, including IT infrastructure; and new business processes to assure operational effectiveness and value creation for customers, establishing, as a consequence, IT based systems that support them.

     ✳   **Macroprocess 3 (Macro3):** Business planning, that contains the collection of processes that are necessary to define the direction of the organization, in the form of strategies, materialized in plans and programs.

     ✳   **Macroprocess 4 (Macro4):** Collection of support processes that manage the resources necessary for the proper operation of the other macroprocesses. Four versions of these processes can be defined a priori: financial resources, human resources, infrastructure and materials.

We call these macroprocesses because they contain many processes, subprocesses, and activities that are necessary to produce key products, such as the ones offered to clients, strategic plans, new products, and so on.

Recently and independently, several proposals of what we call macroprocesses have been made that are similar to ours. For example, the process structure of HP, shown in Figure 5 and based on SCOR, has the following macroprocesses: Products Design, similar to Macro 2; Business Development, to Macro 3; Enabling Processes, to Macro 4; and Supply Chain and Customer Chain, which together constitute Macro 1. Also, APQC has a similar proposal [1]. However, as mentioned before, the main difference with the former approaches lies in the explicit specification of all the relationships among the processes, at different levels of detail, which allows us to show with more realism how what the model represents is expected to work in practice. The relationships among the macroprocesses defined above are given in Figure 6.
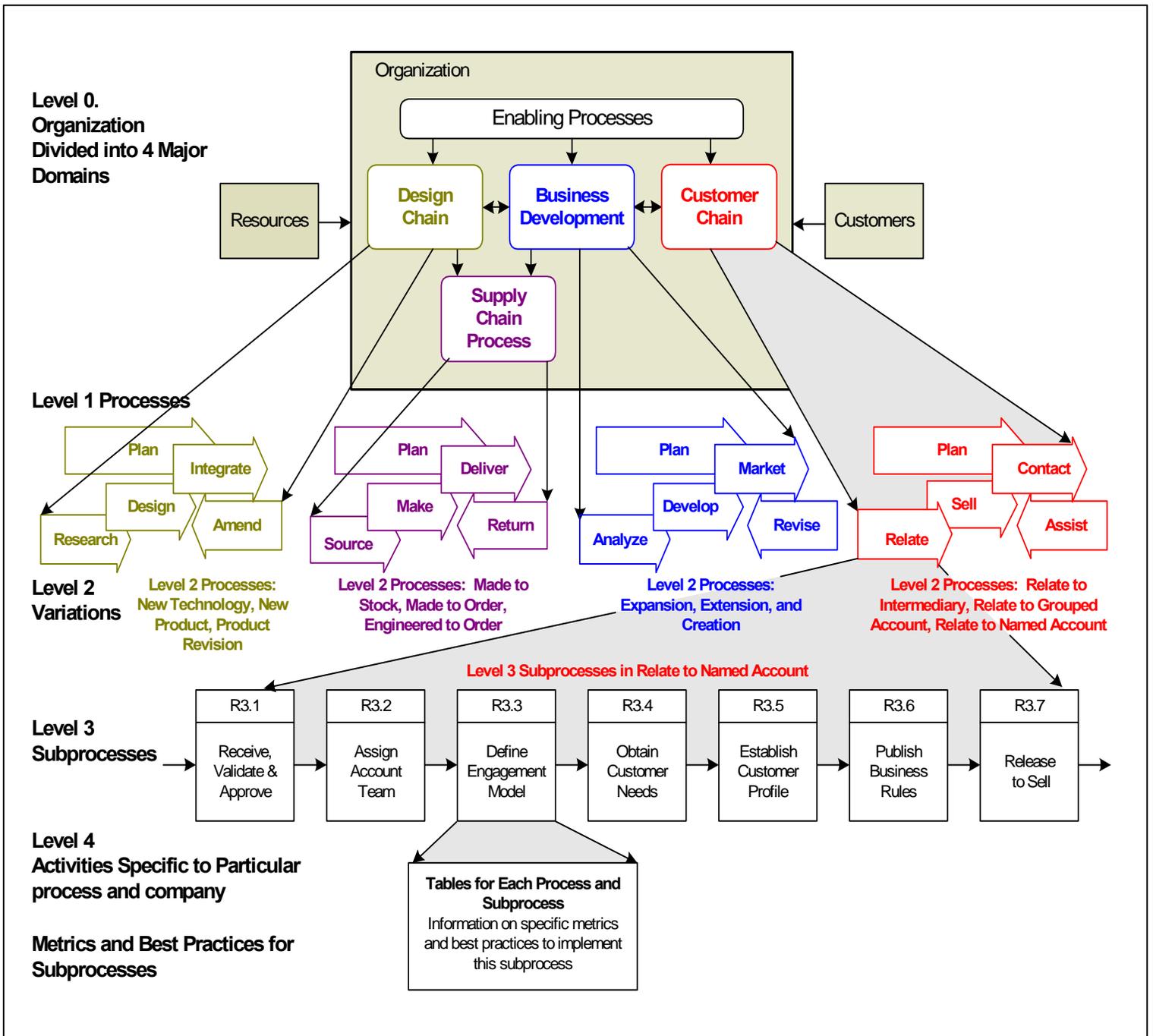
Figure 5. HP process structure[1]

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[1] Taken from a presentation by Paul Harmon

For each of these macroprocesses, we have developed detailed process patterns, which give, in several levels of detail, the processes, subprocesses, and activities they should execute in order to produce the required product. Patterns are normative in that they include what are recommended as best practices and what we have found that works in practice. They also include the relationships that should exist among processes, subprocesses, and activities. These patterns have been documented in several books in Spanish [2,3,4] and papers in English [5,6,7,8]. They have been validated in hundreds of practical projects, where they have been used as a starting point to perform process redesign [9,10]. This has allowed us to gradually improve these patterns with the experience of more than ten years of projects.

The four macroprocess patterns can be combined into different structures, depending on the business type. We call these structures Enterprise Process Patterns, and we will detail them in a forthcoming paper. In particular, the process architecture for hospitals, shown in Figure 1, was derived from one of these patterns.
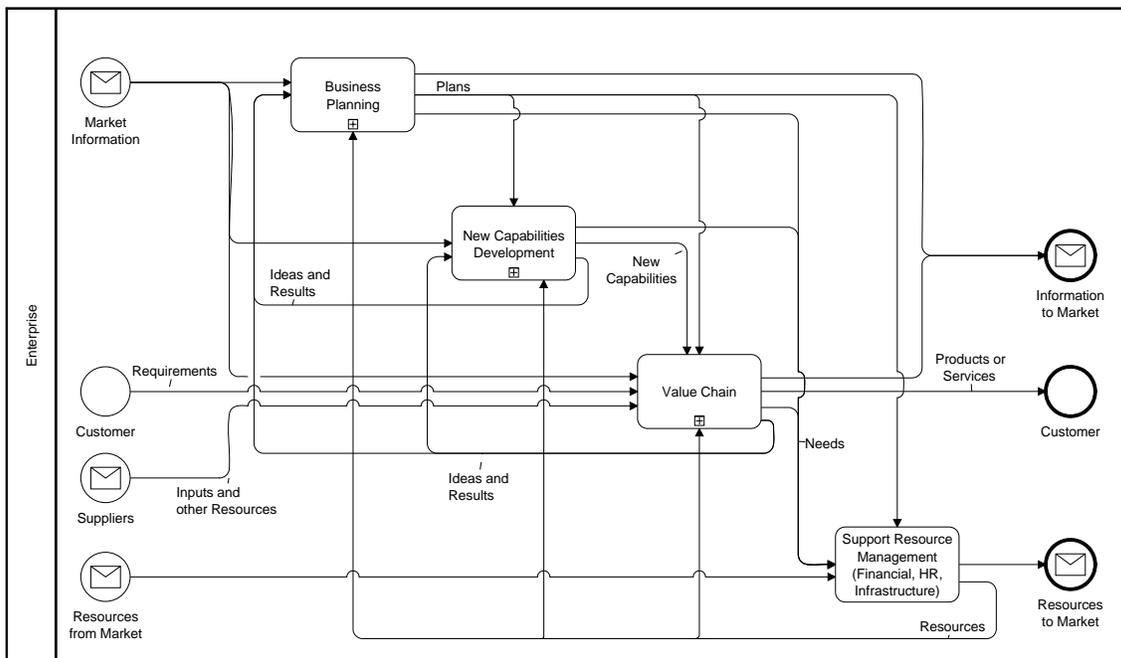

Figure 6. Macroprocesses and their relationships

Experience and conclusions

We have acquired considerable experience in the integrated modeling of the several levels of process design described above. We have done this with BPMN, using just one tool and the different approaches defined above. In particular, we have been able to model in the IDEF0 style with this tool. The main advantage we have experienced is the speed that is enhanced by the use of patterns, and that has allowed us to rapidly produce usable models with consistency up and down the levels of detail of these. For example, in the case of the public hospitals, which is a consulting project performed for the Health Authority, we were able to produce a general architecture for any hospital in one month and specializations for that architecture for particular hospitals in another month. Then we were able to design detail solutions for particular processes of the architecture in two months more and have processes running on a BPEL orchestration tool at about the six month of project initiation.

The key feature of all the approaches described above is the ability to go from strategy to architecture, to detail process design and implementation with just one set of consistent and unique models and tools. This has made possible for us, in other consulting projects we are developing, to show high level executives the full picture, from strategy to system implementation, avoiding fragmented views that are difficult to unify. We feel that this is a truly systemic approach.

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