A Value-Oriented Approach to E-business Process Design

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Abstract. Innovative e-commerce ideas have often floundered on an inadequate analysis of the expenses and benefits of the idea and an inadequate integration of the required e-business processes with other business processes. We present a requirements analysis and business process design approach that focuses on the analysis of the expenses and benefits of the e-commerce idea to all actors involved. We map this value viewpoint to the available business processes of the actors and show how to derive an economically feasible cross-organizational business process design.

1 Introduction

The implementation of an innovative e-commerce idea has to surmount several obstacles, each of which may cause an implementation failure. First, an innovative idea is, by definition, an idea that has not yet been implemented before. It is difficult to estimate the profitability of the idea before it is implemented. This indicates a need for techniques that allow us to estimate the profitability of an e-commerce implementation as early as possible. Second, e-commerce, again by definition, is the exchange of goods or services by means of computer software and networks. The profitability of an implementation of the idea must therefore discussed by business managers *and* software application architects. This requires specification and analysis techniques that can be understood by both groups of stakeholders. Third, any implementation of the idea must be integrated with the business processes and IT infrastructure available in the participating business actors. We define e-business as the implementation of business processes in computer networks. Implementation of an e-commerce idea requires the design of e-business processes that minimize the expenses for the business actors while at the same time maintaining the estimated profitability. This requires business process design techniques that incorporate techniques for the estimation of expenses and benefits.

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In this paper, we further develop an approach to explore an innovative e-commerce idea and to estimate its benefits, called e^3-*value* [5]. We use simple notations that require no more than a few minutes explanation in order to be understood. At the same time, these notations are sufficiently precise for application architects to make design decisions. We also introduce a method to map the e-commerce idea to a cross-organizational business process, maintaining the orientation on expenses and benefits. Finally, we briefly discuss the problem of mapping this cross-organizational process to the processes and information systems available in each business actor.

The ideas presented in this paper have been developed and tested in four consultancy projects (see [5]) in the field of advertizing, news and internet service provisioning, and music. Additionally, tool support is currently developed by the EC-IST project Obelix on ontologies for e-business. The contribution of this paper lies in the integration of the commercial and technical viewpoints in e-commerce implementation. We think that the neglect of the commercial viewpoint has been a frequent cause of failure in business process design and information system development. This paper argues that we should include this viewpoint in our scope.

In section 2, we introduce the viewpoints that we use in this paper. In section 3, we elaborate the commercial viewpoint, which focuses on value, and in section 4 we elaborate the business process viewpoint, which acts as an intermediary between the commercial and technical viewpoints. Section 5 summarizes the results and discusses topics for further research.

2 Viewpoints in E-business Process Design

The task of the e-business requirements engineer is to match business processes of a set of business actors to consumer needs in a market. (A consumer can be a business (i.e. a legal person) or it can be a natural person.) This problem can be structured by distinguishing four different viewpoints.

- Taking the **value viewpoint,** we produce three descriptions of the e-commerce idea.
  - The *value hierarchy* identifies the top-level consumer need and allocates this to objects of economic value to be produced by the business actors.
  - The *value exchange graph* refines this by identifying the activities in which these value objects are created or exchanged by the business actors. This graph can be seen as a shared discussion object, and can be used to generate profitability sheets.
  - *Profitability sheets* quantify the value exchanges for each business actor.
- Taking the **business process viewpoint**, we describe inter-organizational business processes and intra-business tasks.
  - A *process hierarchy* describes the transactions among businesses that realize the desired value objects.
  - A *task hierarchy* decomposes each process into tasks to be performed by business actors.

– Taking the **information systems viewpoint**, we describe an allocation of tasks to information systems and applications available in the business actors.

In this paper we focus on the first two viewpoints and briefly discuss the third.

We present no fixed sequence of writing the different descriptions listed above. However, there are two orientations associated with two viewpoints.

– *Divergence.* Taking the value viewpoint, we explore possible value activities and value exchanges that could realize the e-commerce idea. The focus is on creating new possibilities for value creation.
– *Convergence.* Taking the business process viewpoint, we identify the realistic means to realize the value proposition identified from the value viewpoint. The focus is on reducing expenses. Convergence, and expense reduction, is also the focus in the information system viewpoint.

In practice, these activities are intertwined.

We illustrate our approach using the case of the *Amsterdam Times*, which publishes a newspaper. The *Amsterdam Times* has a subscriber base. The initial e-commerce idea is to offer subscribers web services, such as accessing news articles on-line on a pay-per-view basis, surfing on the Internet and email. In this paper we focus on the idea to offer subscribers an on-line news article archive only.

During exploration of this idea, it became apparent that its commercial basis is the use of a *termination* fee to finance the on-line article service. In this context, *termination* is picking up the phone when someone calls. When a caller calls a callee, the telecommunication network sets up a connection path from caller to callee. When the callee picks up the phone, the termination point of this connection is realized. If an actor is willing to cause termination of a large quantity of telephone calls, most telecommunication operators are willing to pay the actor for that. This price paid by the telecommunication operator per realized termination is called the *termination fee*. Because the *Amsterdam Times* has a large subscriber base, it is capable of generating a large number of terminations. The stakeholders involved in exploring the e-commerce idea were not capable of articulating the idea this way initially. The elaboration process presented below helped them in doing this.

3 The Value Viewpoint

3.1 Value Hierarchy

One of the lessons learned from the *Amsterdam Times* project is that easily understandable description techniques are needed for the exploration of an e-commerce idea. Persons are involved with no background knowledge in conceptual modeling techniques at all and with no time nor inclination to learn these techniques. Hence, all our notations are simple.

We start elaborating an e-commerce idea with the elicitation of a **value hierarchy.** Figure 1 shows a value hierarchy for the on-line article idea. The numbers are used to be able to refer to parts of the hierarchy later on. They are not part of the notation. The value hierarchy says that to satisfy the need

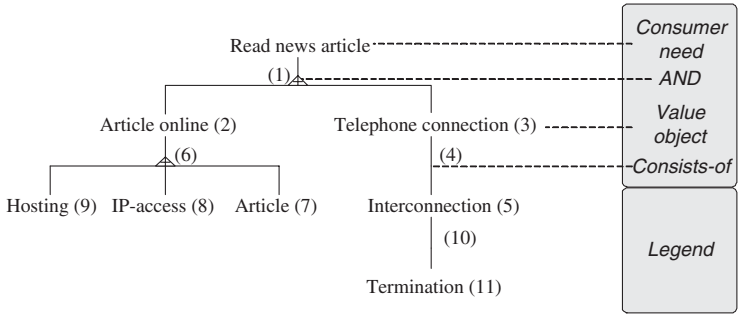

Fig. 1. Value hierarchy showing the objects satisfying a consumer need.

to read a news article, we need an online article and a telephone connection. The on-line article can be provided if there is an article, a hosting service that stores the article, and IP access to the stored article. A telephone connection can be provided if we have a number of interconnections and a termination at the consumer. Note that the further we elaborate the hierarchy, the more design choices we make. Such design choices occured during the execution of the online article project. For instance, the hierarchy proposed in this paper supposes that a *read news article* need can be decomposed into an *article online* object and a *telephone connection*, each to be delivered by a separate actor. Telecommunication companies refer to this as call termination. Another possible hierarchy supposes that the *telephone connection* is deeper into the hierarchy, as a sub-part of the *article online*. This is refered to as call origination (see [5]). Then delivery of an *article online* by a specific actor consists of the article itself, and the telephone connection needed to deliver the article.

In general, a value hierarchy is a rooted a-cyclic directed graph whose root represents a consumer need. Starting with a consumer need increases the chance that a product is really wanted by a consumer [12]. Children of a node represent value objects used to satisfy this need. A **value object** is a good or service of economic value to some actor.

The edges of a value hierarchy represent the *contributes-to* relationship. The reverse relationship is called *consists-of.* An AND-node represents the fact that all children are needed for the higher-level one and an OR-node represents that fact that only one of the children is needed.

The leafs of the value hierarchy are the boundary of our value descriptions. We know that one or more actors can produce these leaf objects against known expenses, so in order to elaborate the e-commerce idea, we do not need to de-

compose these leaf objects further. The value hierarchy is an important tool to relate the satisfaction of a consumer need (the intended benefit) to activities already performed by the business actors (expenses made to create the benefit).

Value hierarchies are similar to goal hierarchies known from requirements engineering (RE) [15,1,3]). Both are means-end hierarchies. The difference is that the nodes in a value hierarchy represent value objects to be produced or exchanged between business actors, whereas the nodes in a goal hierarchy represent goals to be achieved. Often, goal hierarchies are developed for single business actors, whereas value hierarchies are always developed for multiple business actors. Finally, a value hierarchy always starts with a consumer need, whereas a goal hierarchy typically starts with a business mission.

3.2 Value Exchange Graph

A value exchange graph shows which actors are involved in the creation and exchange of the value objects shown in the value hierarchy. The constructs which make up such a graph and their semantics have been defined extensively in [5].

Figure 2 shows a value exchange graph for our running example.

Like a value hierarchy, the value exchange graph represents a number of design decisions. The graph of figure 2 shows that there is a set of consumers called *Readers*, and that these exchange value objects with the *Amsterdam Times* and with an actor called the *Last Mile*. These in turn exchange value objects with a complex actor, a *Telecommunication consortium*, which consists of two actors, *Data Runner* and *Hoster*. Inside each actor node, one of more value activities are shown as rounded rectangles. Some of the exchanged value objects are numbered. This is not part of the notation. The numbers correspond with the numbers in the value hierarchy. We now explain the value exchange graph in more detail.

An **actor** is an entity perceived by itself and by its environment as an independent economic (and often also legal) entity. An actor makes a profit or increases its utility by performing activities. In a sound, sustainable, value exchange model *each* actor should be capable of making a profit. Actors are represented by rectangles with sharp corners. Sets of actors with similar properties, called markets, are represented by stacked rectangles.

To satisfy a consumer need, or to produce a value object for others, an actor should perform a value activity, for which it may be necessary to exchange value objects with other actors. A **value activity** is an operation that can be performed in an economically profitable way by at least one actor. It is depicted by a rounded rectangle. An important design decision represented by a value exchange graph is the decision whether a value object is to be obtained from other actors by means of a value exchange, or to be produced by means of a value activity by the actor itself. This e.g. reflects decisions on out-sourcing, and decisions about the optimal size of an enterprise [14].

A **value exchange**, depicted by an arrow, shows that actors are willing to exchange objects of value with each other. Value exchanges are between actors,

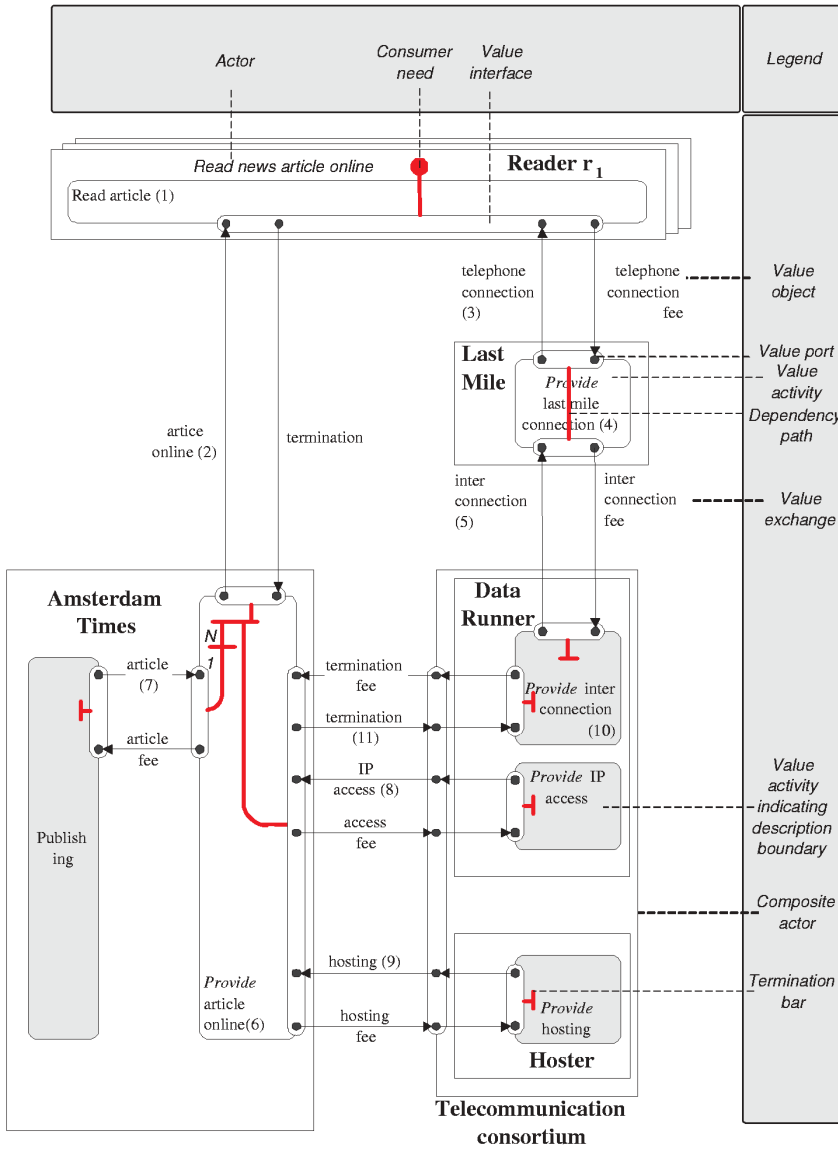

Fig. 2. The on-line article service offered by *Amsterdam Times* is funded by termination fees to be paid by the *Telecommunication consortium*.

or between value activities performed by actors. So in the example, a telephone connection is exchanged between the *Last Mile*, and a *reader*.

Each value exchange graph expresses economic reciprocity. We assume that our actors are rational economic entities that are only willing to offer a value

object if they acquire another value object in return that is of reciprocal value. Such a reciprocal value objects needs not necessarily to be obtained from the same actor who delivers/obtains the other object. Also note that reciprocal exhanges say nothing about the timeframe they should occur; all we say is that such exchanges must all happpen or none at all .

Reciprocity is shown by value interfaces and value ports. A **value port** is a willingness of an economically rational actor to acquire or provide a value object. A **value interface** is a collection of value ports of an actor that is atomic. By this we mean that an actor is willing to acquire or provide a value object through one port of a value interface if and only if it is willing to acquire or provide values through all ports of the interface. This models economic reciprocity. For example, Fig. 2 shows that a *reader* is willing to offer a telephone connection fee and a termination to its environment, but wants in return for that an on-line article and a telephone connection to deliver the article.

Note that the requirement of reciprocity causes us to introduce value objects not mentioned in the value hierarchy. The reason that these reciprocal objects are not mentioned in the value hierarchy is that their introduction is a design choice. Different elaborations of the value hierarchy contain different choices.

In most cases, value interfaces of actors are identical to value interfaces of activities performed by the actors: they exchange the same objects. For these cases, we only show the value interfaces of the activities and not of the actors. However, sometimes, we explicitly need to express an actor's value interface. For example, Fig. 2 shows that the *Telecommunication consortium* has a complex value interface, that iss built up from simpler value interfaces offered by activities in the *Data Runner* and *Hoster*. This is called **bundling.** The *Telecommunication consortium* offers IP access, hosting and termination to the *Amsterdam Times* as one bundle for specific pricing conditions. It is only possible to obtain these objects *in combination* in return for the fees mentioned in the diagram as part of the bundle. This is because *Data Runner* and *Hoster* co-locate equipment at the same physical site and therefore can offer hosting and IP-access for a lower tariff compared to the alternative that facilities to produce these objects are located at different sites.

A value hierarchy and one or more corresponding value exchange graphs are usually developed iteratively, starting with the value hierarchy. To get from a value hierarchy to a value exchange graph, note the following.

- The value objects in the hierarchy are the input or output of a value activity.
- The consists-of relationships between value objects in the hierarchy indicate a value activity in the graph. This activity produces a value object by using other value objects. An AND-node in the value hierarchy indicates that several value objects are needed to produce the output value object, and so the corresponding value activity at least aggregates and possibly transforms value objects into the desired output object.

For instance, the AND construct labeled (1) in Fig. 1 results in a value activity called Read article labeled (1) in Fig. 2, to be performed by a *reader*. The graph

shows that the *reader* needs to aggregate an article online and a telephone connection to be able to satisfy his need. The graph also shows that the *Amsterdam Times* produces the article itself by the value activity Publishing, and obtains IP access and Hosting from others.

We observed earlier that the leafs of a value hierarchy represent a system boundary. We know that other objects are needed to produce these leaf objects, but we do not describe these other objects because the business actors already know how to do this, and moreover, they already have activities in place by which they do it. The value exchange graph shows these activities as well as the value objects they produce. These activities are greyed in Fig. 2. We assume that these activities are profitable for the performing actor. This assumption must be validated by the business managers participating in the analysis.

Note that the development of a value hierarchy and a related value exchange graph is a process of step-wise refinement. It is common to start with a more course-grained hierarchy, which results in a value exchange graph with a few actors and value activities. To find more fine grained value hierarchies and value exchange graphs, we have proposed a deconstruction process which breaks down a hierarchy and graph into smaller parts [4].

3.3 Profitability Sheets

To estimate the profitability of the value activities and exchanges, we have to estimate the number of actual value exchanges in a time period (e.g. a month). For each actor, the results are summarized on a **profitability sheet**, which shows our best estimate whether the e-commerce idea could be profitable (see Table 1 for an example).

To create the profitability sheet, we first express the occurrence of a consumer need by a black dot in the consumer activity (Fig. 2). Each such occurrence will lead to an exchange across the consumer value interface, as indicated by the dependency path connecting the dot with the interface symbol.

A **dependency path**, depicted by grey lines, shows via which value interfaces an actor should exchange objects when triggered. Each dependency path connects two or more interfaces of a value activity by means of AND nodes (represented by a bar) and OR-nodes (represented by a split). It defines a Boolean combination of interfaces that must be valid for each activation of the activity. The dependency path defines the business logic of the activity, because it says that each conjunction of interface activivation compatible with it, is profitable. Dependency paths are used to assemble the data on profitability sheets.

When we do not care about the path of an activity (e.g. because the activity is already performed by the actor according to a known and profitable business model), we indicate this with a termination bar. In our example, the activities that produce leaf value objects of the value hierarchy are greyed.

The value exchange graph in Fig. 2 shows that each activation of the consumer value interface leads to an exchange with the *Amsterdam Times* and of the *Data Runner*, and this in turn leads to the activation of the value interface of these actors. The paths show the following information.

- The *Last Mile* exchanges a telephone connection for a telephone connection fee if and only if it exchanges an interconnection for an interconnection fee.
- The *Amsterdam Times* needs to obtains a termination fee, IP access and hosting service from the *Telecommunication consortium* to offer an article online. Also, it shows that a number (N) of *online* articles can be produced by using only *one* article *written by a journalist*. This shows that the marginal expense of generating a copy of a same article is zero.

Dependency paths have been inspired by Buhr's use case maps [2] but differ from them because they do not carry any scenario information. They do not represent business processes but are instructions to assemble the profitability sheets.

To construct the profitability sheet, we start at the consumer need and follow the paths and value exchanges, until we have reached all termination bars. Each time value objects are exchanged between actors, we update the profitability sheets for these actors.

A next step is to calculate the economic value of objects in terms of a monetary unit (e.g. Euros). How to do so depends on the kind of actor. *End consumer* actors want to maximize their consumer value, defined by [16] as the receipts experienced by consuming the object divided by the sacrifices to obtain the object. Holbrook's consumer value framework can be used to elicit factors which determine the valuation by consumers [6]. Table 1 presents a profitability sheet for an *enterprise actor*. Such an actor wants to maximize its profit and net cash flow, or at least wants to play break even. According to enterprise investment theory [7], cash flows are considered only for an investment evaluation. Consequently, Table 1 shows objects representing goods, services or intangibles (in short, objects other than fees) in parentheses, because we do not consider these objects for profitability analysis. Then for fees, the sheet shows how these fees are calculated, and a best estimate on the profitability for actors (not given here due to confidential project data). The profitability sheet for each actor gives the information for business managers to decide whether it makes business sense to go ahead to the next stage of elaborating this e-commerce idea, which is the definition of business processes required to produce the desired value objects.

4 Inter-organizational Business Process Viewpoint

The value exchange viewpoint elaborates the e-commerce idea for the strategic manager. It does not represent processes but the *willingness* of an economically rational actor to create and exchange value. It represents a steady state that exists when as yet to be identified technology and people do their work. Taking the process viewpoint, we describe

- which inter-organizational processes must exist to be able to satisfy the consumer need, and
- which tasks each actor must perform to realize within these processes.

This elaborates the value viewpoint for the operational manager. It shows which activities have to performed by whom or what, and in which order, to produce which result. We discuss each of these hierarchies in turn.

Table 1. Profitability sheet for the *Amsterdam Times*

Actor	Amsterdam Times	
Consumer need	Read news article online	
	Value Object In	*Value Object Out*
Exchanges with readers:	(*termination*)	(*online article*)
Exchanges with telco:	*termination fee* = *telephone connection fee* × *revenue sharing factor*	(*termination*)
	IP (*access*)	*IP access* fee = *fee per second* × *duration*
	(*hosting*)	*hosting* fee = *fee per pageview* × *page views*

4.1 Business Process Hierarchy

To find the required inter-organizational business process, we ask which processes must be performed to create the steady-state situation as represented by the value exchange graph.

Inter-organizational business processes are on-going activities that involve at least two actors. To identify the required processes, we use the following three types of processes, which are well known from both business science [9] and business process / requirements engineering [10,13] literature:

- *Primary processes,* which directly contribute to the satisfaction of consumer needs. This includes processes performed in the steady state, as well as ex-ante processes such as supplier selection and service subscription, and ex-post processes such as dispute resolution or service unsubscription.
- *Support processes,* which enable execution of primary processes and provide a suitable working environment.
- *Management process,* which organize, staff, direct, and monitor primary and support processes.

Fig. 3 shows inter-organizational processes needed for satisfying the consumer need to read an online article. The leafs represent processes; the other nodes classify the processes according to the taxonomy above.

Primary processes contribute directly to consumer satisfaction. The primary process consists of article delivery, which is the steady state of value activities and exchanges represented by the value exchange graph, and the subscription

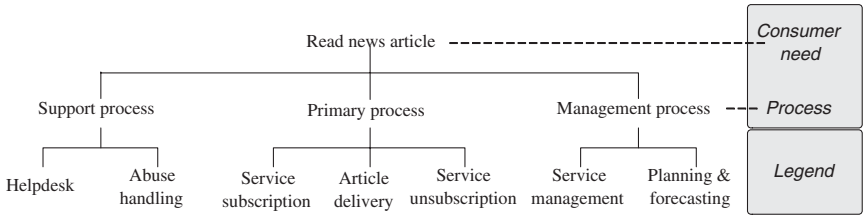

Fig. 3. Process hierarchy for on-line news article delivery.

and unsubscription processes, which represent the entry and exit of a consumer to and from this steady state. Each of these processes involves several actors and is therefore cross-organizational. This requires careful integration of the information systems and business processes of the participating actors.

Support processes contribute indirectly to consumer need satisfaction. Here we identify two of such processes. The helpdesk process handles complaints and solves problems of end-customers. Because in this specific case service provisioning is partitioned over a number of actors, it is an inter-organizational process too. The same holds for abuse management: *Readers* can for instance use the offered IP-access for unintended and sometimes illegal purposes. This may result in blocking reader's access to the service.

Cross-organizational management processes organize, staff, direct and monitor the other processes. An important management process in this case is planning and forecasting. To make the article online business case successful it is important that precisely sufficient resources (e.g. modem ports to dial in, webserver capacity) are available to serve the *Readers*. A shortage in resources (e.g. modem ports) immediately results in a decrease in revenues because revenues are based on the total duration of telephone connections. On the other hand, unused resources, representing a substantial investment, result in a loss, especially for *Data Runner* and *Hoster* since these parties have invested in theses resources. Another process is service management itself. Service management consists of managing the quality of service (e.g. measuring the percentage of *Readers* who get a service denial, for instance caused by shortage in modem resources), developing the service from a content point of view (broader selection of articles, search for related articles, etc), and negotiating between parties about service delivery (e.g. between *Amsterdam Times* and the *Telecommunication consortium*).

4.2 Task Hierarchy

Whereas business processes are on-going inter-organizational activities, task are terminating activities with input and output, assigned to a specific actor and therefore intra-organizational. For each process identified, we decompose the process into tasks which can be assigned to value activities of an actor. We try to reuse as much as possible of existing processes and information technology.

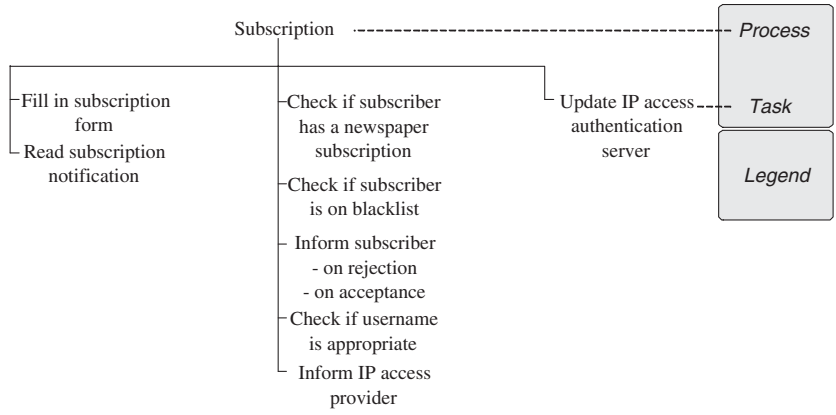

Fig. 4. Tasks for the subscription process

Fig. 4 shows the tasks for the subscription process as a task hierarchy. To identify the tasks, we constructed a UML activity diagram of the service subscription process, with a swimlane for each actor, identifying the tasks of each actor that are already in place and those that must be invented. This is however not a deliverable to be shown to management. The task hierarchy provides sufficient detail for a description of an e-commerce idea and does not require stakeholders more than two minutes to understand. A task hierarchy is used for the following purposes.

- To understand the tasks needed to fulfill consumer need;
- To understand which tasks must be performed by an actor to realize a value activity;
- To identify whether tasks are new for an actor, or whether tasks performed anyway can be used or changed;
- To gain insight in operational expenses of processes and tasks, which can then be compared to the estimations expressed in the profitability sheets;
- To identify information systems that can support the tasks. Linking tasks to information systems is part of the information system viewpoint, not discussed here.

To this end, we annotate the task hierarchy with a **task expenses estimation table** (see table 2). To assess the profitability of an e-commerce idea, it is important to discover substantial labor resulting in high expenses which may inhibit the business idea. Additionally, it is important to recognize whether tasks should be newly developed or existing tasks can be used for building the process.

5 Discussion and Conclusions

To sum up, the value viewpoint identifies actors, value activities and exchanges needed to satisfy the top-level consumer need. The process viewpoint identifies

Table 2. Task expenses estimation table.

Task name	*Estimated labor*	*Existing/new*	*Implements value activity*
Fill in subscription form	10 minutes / form	New	Read article
Check if a subscriber has a newspaper subscription	1 minute /subscription	New	Provide article online
Update IP access authentication server	0 (automated)	Existing	Provide IP access
...	...	...	...

all the tasks needed to perform these activities and exchanges. The value viewpoint indicates revenues and expenses, whereas the process viewpoint indicates expenses only.

What we have achieved so far is a conceptual framework of three viewpoints that integrates the commercial and technical views, and we introduced a number of simple description techniques that can be understood by all stakeholders and are yet precise enough to analyze commercial and technical feasibility of the idea. The proposed process can be viewed as a kind of commercial-technical co-design of e-business systems. The approach has been validated in a number of consultancy projects in the field of internet service provisioning, news, ads, energy, music and banking.

Guidelines for the transition from the value viewpoint to the process viewpoint are currently lacking. Guidelines for business process modeling [10] concentrate on the single-actor case and do not relate business process design decisions to a commercial value viewpoint. For the allocation of tasks to information systems (part of the information system viewpoint) there are some practical guidelines [11], some of which date back to Information Engineering [8], but again the integration with the process and commercial viewpoints is weak or non-existing. Our future research will focus on providing guidelines for these transitions, and validating these in additional consultancy projects.

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