PESOA

Process Family Engineering in Service-Oriented Applications

BMBF-Project

Modeling Workflows in the E-Business Domain

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Abstract

This report summarizes typical business process models from the business to customer (B2C) market that have been developed during a bachelor seminar at the Hasso-Plattner-Institute. Based on the investigated models, typical modelling issues of e-commerce workflows are exposed, analyzed and discussed.

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1   Introduction

One of the tasks of the PESOA project was the modelling and analysis of processes in the e-business domain [PES03].This includes the selection of appropriate and typical business process from the area of e-commerce. The main research was planned for the project partner Intershop with academically support by the Hasso-Plattner-Institute (HPI) regarding workflow technology. As an university institution, the HPI planned a bachelor seminar where students should model processes under the supervision of the PESOA research assistants. The processes regarding e-business should have been supplied by the partner Intershop. However, the partner Intershop decided to leave the project. Due to the leave of Intershop, the HPI decided to let the students analyze and model common e-commerce websites by observation only. The students have been requested to reason about the business processes that might be behind those websites and use the Business Process Modelling Notation (BPMN) [BPMN04] to model them. The BPMN has already been introduced in an earlier PESOA report [SPW04]. The seminar had the goals to collect different approaches and models of e-commerce business processes as well as to analyze the usability and applicability of the BPMN. The author of this report supervised the students during the course.

As it has to be expected from an undergraduate course, the results are differing in quality and quantity. Each student had the task to present and discuss his work during the seminar and describe the model and the results of the discussion in an article. All articles have been collected in a seminar reader [WSP04]. The topics for the e-business domain included the analyzing and modelling of Amazon.de, Otto.de, Dell.de, Ebay.de, Deutsche-Bahn.de and Ehotel.de. The students were requested to develop and document an approach for their work and give reasons for their design decisions.

The reminder of this report is structured as follows. First, a short introduction the considered domain is given. Thereafter a simple e-business sample shop that contains typical features of the domain is explained and discussed. This section also includes short abstracts of the student's models for Otto.de, Dell.de and Ehotel.de. The paper continues with a discussion of the models and closes with a summary that states the experiences for the PESOA project.

2   The E-Business Domain

This section focuses on the specific requirements for e-business websites that have been considered during the seminar. An extended introduction to the e-business domain in a broader scope can be found in another technical report of the PESOA project [Bay+04]. Usually, e-business can be seen as *"any process that a business organization conducts over a computer-mediated network"* [Ber01]. E-business can be divided into different areas like e-commerce, e-procurement, e-government and so on. E-business uses different techniques like the world-wide-web, workflow, groupware, e-mail, or web-services to achieve its tasks. Our main focus lies on e-commerce, which can be defined as *"any transaction completed over a computer-mediated network that involves the transfer of ownership or right to use goods or services"* [Ber01]. [1] Other sources state that there exists no commonly agreed definition yet [Sch03].

E-commerce can be seen as a new or additional sales channel for virtual and physical goods or services. Virtual goods are for instance MP3-music files, e-books, or software, whereas physical goods include for instance books, cd's and other items from traditional mail order businesses. Services are for instance video-on-demand, train and airplane tickets, lottery, gambling or auctions. E-commerce uses computer-mediated networks in combination with classical logistics, where virtual goods and services are traded directly inside the networks. The classical mail-order businesses use electronic networks as an extended catalogue. Today there exist many channels for e-commerce. Examples include websites, web-services, mobile-devices or e-mail.

In the scope of the seminar, the students had to give an overview of the business processes behind the websites that are required to conduct e-commerce. This includes the identification of the participating actors and their dependencies. The students should focus on the key business processes and keep a clear division between the navigational structure of a website and the business processes behind. The BPMN should be analyzed on their applicability to model e-commerce business processes. However, the students should not model an executable workflow definition. Regarding to the Model Driven Architecture (MDA) of the OMG [BHK04, MDA03], the diagrams should describe a computational independent model (CIM). This

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[1] An extended discussion of the terms e-business and e-commerce as used here can be found on the websites of the US Census Bureau: http://www.census.gov/epcd/www/ebusines.htm (October, 15th 2004). This definition relates to the glossary of the Accrediting organization of the American Business Schools (AACSB).

includes the observable *behaviour* as a main topic. The models should describe the usage of the websites, the requirements to its environment as well as the benefits for the users. They should not describe internal structures of the websites nor internal behaviour which does not directly affect the observable behaviour.

3 Exemplary Business Process Diagrams

This section introduces three different e-commerce shops that have been modelled by students during the course of the seminar as well as a sample shop created by the author of this report. The considered shops derive from the areas of traditional mail order business represented by Otto.de, new-economy e-commerce shops represented by Dell.de, and service-oriented shops without physical delivery represented by ehotel.de. The sample shop abstracts from modelling the delivery and payment of the goods. It focuses on modelling commonly used features. All models are incomplete in the sense that they only cover partial views of the companies and have been investigated only by observation.

Almost all students of the seminar utilized UML Use-Cases [OMG03] as a starting point for business process modelling. As an UML Use-Case Diagram contains all actors of the model, they simply map to different BPMN Pools. The basic communication lines between these Pools can be derived from the linkage of the actors and their use-cases. The business process diagram that contains the Pools gives a good frame for the business processes that must be modelled inside. Thereby the actor-specific processes represent the different use-cases. The business processes themselves have been identified by the use of observation and thoughts about possible background work that has to be done. The students also evaluated the applicability of the BPMN for the given tasks.

This chapter only resumes the key diagrams of the students work; the complete articles can be found in the report on the seminar *Prozessmodellierung* from the Hasso-Plattner-Institute [WSP04]. In addition, this report contains more articles about e-commerce topics as well as different models of a motor-control unit and organizational processes that utilize other notations like UML Activity Diagrams or YAWL. This section continues with the introduction of the sample shop, followed by Otto.de, Dell.de, and ehotel.de.

3.1 Sample Shop

The Use-Cases of the sample shop are shown in figure A1 (see appendix A). The number of actors and Use-Cases has been reduced to a minimum to introduce the key concepts of e-commerce web-shops. There is an actor Customer that interacts with the Shop by two Use-Cases. The first Use-Case informs the customer about particular products the shop has to offer and allows the configuration of a shopping cart. The second Use-Case

resembles the actual buy activity of a pre-assembled product-list. This includes checkout and delivery. The actors required for handling credit cards, invoice or shipping are out of scope for this example.

As the sample shop was modelled from scratch, several features have been gathered that should be supported. The shop should at least have several products, a shopping cart, a checkout and a shipping service. The products should have at least a textual description; optional elements that the shop could support are pictures and reviews. The standard shopping cart should be made persistent optionally. As an extra feature, the shop could also support personalized shopping carts, in this case ten percent rebate are given on everything the customer buys. Alternatively to the personalized shopping cart, an anonymous shopping cart could be offered, where the identity of the customer is hidden by a proxy. As a restriction, the shop should either supports personalized or anonymous shopping carts, but not both. The checkout should at least support the payment by credit card. If a personalized shopping cart is chosen, invoice payment is offered optionally. For shipping, only a standard service is offered as a must have feature. The described features are gathered into a feature diagram shown in figure A2. The feature diagram allows the derivation of several variants of the sample shop. This section continues with a look at how those variants change the business processes for the shop. What is not considered is how the features are actually mapped to parts of the process; this choice was made by the business process designer.

The business processes are modelled as business process diagrams in the BPMN (as all other business processes in this report). The diagram that contains the processes for a basic sample shop that only includes all must have features is shown in figure A3. The two actors Customer and Shop directly map to two BPMN Pools. The collapsed sub-processes are shown expanded below the Pools. A new instance of the customer process is created each time the Customer points his web-browser to the shop. This also triggers a new instance of the Shops processes, represented by a <<new>> annotation at the message flow between Customer and Shop. The Customer explores and chooses products, which results in messages send to the Shop. As those activities are usually non-linear, the Ad-Hoc modelling element of the BPMN has been used, which allows the arbitrary execution of the tasks included. Furthermore, the modelling of the web-browser navigation at the Customers side is bypassed. If the Customer finishes the shopping, he leaves the Ad-Hoc sub-process and moves on to the buy task which sends a message with the required information like address, name and credit-card number. Afterward he waits for the delivery of the order. Note that the whole Customers process is given implicit to the actual customer, but it has to be made explicit for synchronization reasons. The Shops process starts with the reception of a message from the Customer that is

sent when he points his web-browser to the shop. The Shop has a counterpart to the Customers Ad-Hoc process, which delivers product information and allows the composition of the shopping cart. Each of those sub-processes is triggered by a message from the customer and executes the requested tasks. The Shops Ad-Hoc process can be interrupted by an idle-timeout event which ends the Shops process immediately. This confirms to the timeout of a web/application-server which terminates the current session. Alternatively the Ad-Hoc process could be leaved by the reception of an order-message sent by the Customers Buy task. This leads to the Checkout sub-process which acquires the products from the storehouse and manages the bookkeeping in parallel. Afterward the delivery is send to the Customer and the Shops process is successful completed.

Figure A4 shows the enhanced processes that support all features except the anonymous shopping cart. The Deliver Product Information sub-process has been extended to retrieve pictures and reviews as additional tasks. All queries are made in parallel to optimize the speed. The personalized shopping cart feature results in an additional process part in the Checkout sub-process, where the Shop must decide if the current Customer has a personalized shopping cart, and if yes, calculate the discount. The persistence of the shopping cart requires changes at two abstraction levels of the Shops process. Initially after a new instance of the Shop is created and the process is started, the shopping cart for the specific customer is loaded. If the customer is unknown, a new shopping cart is created. Technically, this could be implemented by the use of cookies for instance. Also, after each reconfiguration activity in the sub-process Reconfigure Shopping Cart, the updated shopping cart must be saved. The most complex change was made for the support of the feature invoice. As could be seen from the actual process diagrams, the dependency between invoice and a personalized shopping cart is a pure marketing requirement in this case. However, we disallow invoice in combination with an anonymous shopping cart, which would make no sense.

The business process diagram for a shop with an anonymous shopping cart is shown in figure A5. This process contains all optional features except personalized shopping cart and invoice. To achieve the feature of an anonymous shopping cart, an additional actor A, who acts as a proxy between Customer and Shop, is added. The proxy makes the Customer anonymous by interrupting and changing the communication with the Shop. The actual details are left out in the model as the proxy is shown as a black-box Pool. It can be assumed that the proxy orders the products on behalf of the Customer at the Shop, where the proxy is a trusted, unrelated service. Interestingly, the proxy pattern [GHJV94] is independent of the actual processes; the main reason why it is used here is to showcase the use of an exclusive feature selection.

3.2 Otto.de

Thomas Hille started his analysis of the e-commerce web-shop Otto.de [Hil04] by creating a navigation model that resembles the navigational structure of the shop. This model is based on a notation by [SR04] and reprinted in figure B1. The navigation model is easy to understand but has several disadvantages. First, only linear or two-dimensional navigation is contained. Otto.de uses the concepts of pop-up windows heavily, and this parallel navigation structures can't be placed into one straightforward model. Secondly, the navigation model is quite unrelated to the business processes as most of the model covers only one or two tasks (e.g. browse products). In contrast, complex processes are represented as a single node. The original article of the student contains an extended navigation model which tries to bridge the gap between navigation and processes [Hil04].

The next diagram introduces five main actors of Otto.de, shown in a Use-Case diagram in figure B2. They include the Customer, the Otto Employee, the Otto Storehouse, the Supply Service as well as Financial Institutions. The student decided to represent Otto.de by two different actors, and merged them later into one BPMN Pool.

A top-down approach for modelling the business process diagrams was chosen. Figure B3 gives an overview of the Pools used for Otto.de. The figure also contains the processes at the Customers side. As they contain no complex structures, the modelling is extended in figure B4, which contains the high-level processes at Otto.de. This figure includes several collapsed sub-processes which handle the configuration of the shopping cart, collect the order information, ship the items and handle the accounting. As Otto.de supports different payment methods like credit card or invoice, a money reminder accounting is also modelled. A special case is the return of items which leads to money refund. All those tasks use messages for communication and synchronization with external actors like the Supply Service or the Financial Institute. A closer look at the composed task Collect Items in the Cart sub-process of Otto.de is shown in figure B5. The diagram also contains the expanded Select Item sub-process of the Customer. The process at Otto.de is started by a message that contains the first item a Customer puts into his shopping cart. This item is initialized with default properties like quantity or delivery options. Thereafter, a BPMN Event-based Gateway is used to handle further messages from the Customer. This includes adding additional item, removing items or changing the properties of an item that are already in the shopping cart. Note that the student only modelled a one-way communication from the Customer to Otto.de. This is the only direction that influences the business process. What Otto.de as a web-server might return (e.g. web-pages containing the shopping cart, etc)

is not interesting at this level of modelling. An in detail discussion and more diagrams can be found in the original article by Thomas Hille [Hil04].

3.3   Dell.de

Christian Liesegang modelled the business processes for the e-commerce websites at Dell.de [Lie04]. He started with a Use-Case diagram shown in figure C1. Included are a Customer and a special kind thereof, an Enterprise as well as a Service and Warehouse actor at Dell.de. The diagram contains several important tasks that are required like Shopping and Delivery.

Figure C2 shows the high-level processes at Dell.de. The diagram contains four Pools, the Customer, the Dell Store, the Dell Distribution Center and a Financial Institution which was not contained as an actor in the Use-Case diagram. As can be seen, there are many message flows from the Customer to the Dell Store, with the exception of an invoice message and the order which where received by the Customer. The Customer also interacts with the Financial Institution in the case of a bank transfer. As the website of Dell contains very complex navigation with a lot of configuration tasks, it was important to keep a clear distinction between the navigation and the business processes. The student placed all the navigation action of the Customer into the Do Shopping sub-process which allows the modification of the shopping cart. This happens in cooperation with the Order Transaction sub-process at Dells Pool. He also used an Event-based Gateway to handle the different incoming messages. Another sub-process of Order Transaction handles the confirmation of the order. The sub-process Order Transaction itself is modelled as a BPMN Transaction, which allows the compensation of all activities in the case of cancellation or exception. This is modelled by the compensation tasks Clear Shopping Cart and Clear Personal data and Credit Account if Paid.

The student also modelled a possible variation of the shop-system, which replaces the direct communication through a web-browser by a proxy that represents a telephone hotline. This variant is shown in figure C4. Interestingly, all internal processes of the Dell Store, the Distribution Center and the Financial Institution remain unchanged and can therewith easily be reused. The Dell hotline replaces the incoming messages from the Customers Pool by new messages to the Dell Store. The messages from the Customer thereby represent voice conversation which is initiated with the task Call Hotline and closed by the Hang Up task. The diagram does not contain error handling like for instance that the Customer could hang up all the time. An extended discussion concerning Dell.de can be found in the complete article from Christian Liesegang [Lie04].

3.4   Ehotel.de

Ehotel, a service-oriented e-commerce website that sells hotel reservations was modelled by Torsten Hahmann [Hah04]. He utilized a Use-Case diagram as a starting point, shown in figure D1. The diagram contains four actors, the Customer, the Hotel Clerk, the Pegasus System and the Ehotel Clerk. The Pegasus System is a backbone system for hotel-reservations. The typical tasks a Customer does are getting information on available hotels, book and cancel. The Use-Case diagram does not contain tasks like payment. The actors map directly to the Pools of the business process diagrams.

The high-level business processes for the Customer are shown in figure D2. They abstract from the concrete control flow by modelling just the typical control flow between the four tasks Information, Booking, Cancel, and Pay, where Cancel is optional. The concrete control flows are shown in figure D3, where the Pools for the Customer, Ehotel and the Hotel are shown. The student used the notation of BPMN Events to model incoming messages, timers and to handle exceptions. He abstracted from the navigation for example by defining a collapsed sub-process Inform Online at the Customers Pool which interacts with a sub-process Present Hotel Information at Ehotels Pool. An interesting point is the support for three different communication methods which include booking by fax/email, online, and phone. The concrete path is chosen at runtime, but the availability of a method must be decided at design-time. The model could be extended to support booking by wireless applications or remove the classical telephone support for instance. The Ehotel business process also uses the concept of Event-based gateways for modelling communication. The cancel period for the Customer is implemented by the use of timer events.

A refinement of the collapsed sub-process Present Hotel Information from the Customers Pool is shown in figure D4. In addition to the other diagrams, that have been considered in this report, this diagram explicitly contains data-flow by the use of Data-Object annotations. The data flow is different from message flow as it occurs between different tasks inside a Pool. The complete processes as well as an extended discussion regarding business processes in the hotel-reservation domain are considered in the article from Torsten Hahmann [Hah04].

4   Discussion

After introducing several e-commerce shops, the key issues of the models are discussed shortly. One of the most remarkable points is that not all activities that have been modelled in the business process diagrams can be mapped to a workflow. Take for example Send Delivery from the Sample Shop, which requires a physical transportation of the goods ordered. This could only be supported by a workflow that triggers the start and notes the arrival of the goods. The complete computerization of an e-commerce business process is only possible for special cases, where the goods or services could be shipped by the use of electronic networks. Examples are online music-stores or online lottery/gambling. After stating those general limits, more specific topics are considered.

Most of the students started modelling with Use-Cases. This is a quite common approach and can be adapted seemingly for the PESOA project. The Use-Cases can be extended with additional information, like variants, in a tabular form [Lar02]. Based on the actors of a Use-Case, the required Pools of a BPMN diagram can be directly derived, either by a one-to-one mapping or by merging several actors into a Pool with different lanes. The Pool structure gives the raw-layout for the business processes which implement the Use-Cases themselves. Message Flow between different Pools occurs if two or more actors, which resist in different Pools, are connected to the same Use-Case. As message flow inside Pools is prohibited, the interaction between different actors inside the same Pool on different Lanes has to be modelled by the use of sequence flow.

The next task is to fill the Pools with business processes that implement the Use-Cases. Two different approaches are bottom-up vs. top-down modelling. Bottom-up modelling starts with modelling the first low-level task, the second one and so on until the whole process is modelled. This seems to be a natural way to model systems by observation, where every step that could be done on an e-commerce website is mapped to a corresponding activity. But as most of the students learned very fast, they observe the navigational structure of the websites, not their business processes. A better approach is the top-down modelling, where the top-level processes could be derived from the Use-Cases. Those top-level processes must than be brought into an ordering and can be refined as needed. Use-Cases and the contained top-level processes can also be used for communication and discussion with the different stakeholders, which are usually not interested in specific details.

The modelling moves on with the question where to place different parts of the business process. Take for example an imaginary Use-Case Composition of the Shopping Cart, which involves at least two actors, the Customer and the Shop. It seems obvious that each Pool contains at least a part of this specific business process. The sample shop, as well as the models of Otto.de and Dell.de, place the actual composition at the Pools of the Shops. The process part inside the Customers Pool is only used for triggering the process part at the Shop's Pools. But one could also argue that the actual composition should be completely placed inside the Customers Pool and the Shop only awaits the result. This argumentation is based on the traditional mail order business, where the Customer has a printed catalogue and composes his shopping cart – that is the ordering letter – completely by himself. So the question is: Does this make sense in order to reuse the processes, for example at Otto.de, for businesses that support both traditional and e-commerce business? In most cases it remains a security hole to store and manage the shopping cart at the Customers side (e.g. in a web-browser, a cookie could be used), but a Shop that handles a kind of external shopping cart for decades should have processes that fix those holes. So there should always be a documented argumentation, why specific process parts of a Use-Case have been placed inside a specific Pool.

After the decision which business processes have to be modelled and where they are placed, it has to be decided of how to model them. The typical elements of the BPMN that have been used by the students are Pools, Sub-Processes, and Tasks that are connected by Sequence Flows. Many diagrams rely more or less on the notation of an Event. Events start, hold or end Sequence Flows. A typical Event is the Message Event, which triggers or continues a process after the receipt of a message from another Pool. This Event type allows the synchronization of concurrent processes in different Pools. For the decision of a Sequence Flow between different types of Events, the Event-based Gateway was often used. Another use of Events is at the edge of tasks or sub-processes. Especially the sample shop and Ehotel.de model make extended use of this notation. An Event placed on the edge of a Task or Sub-Process redirects the Sequence Flow in the case that the event occurs. Typical examples are timeouts, compensations, errors or incoming messages. An element for reducing the complexity of concepts like navigation is the Ad-hoc Sub-Process, where the Tasks inside are executable in an arbitrary order which can be narrowed by the use of rules. Advanced concepts like Transactions have been used in some cases.

The modelling of variants by the students has been reduced to the replacement of complete Pools or Sub-Processes. The Dell.de example introduced an additional Pool that acts as a proxy; the same does the sample process to realize the anonymous shopping cart feature. Start and

End Events of the BPMN specification could be placed on the edges of sub-processes to model a kind of interface for Sub-Processes.

5   Summary

This report summarizes the efforts of the Hasso-Plattner-Institute in the e-business domain. It contains the results of a bachelor project that was held in the summer term 2004 as well as an additional model. The report shortly classified the part of e-business that the seminar covered – that is e-commerce. Thereafter a sample e-business shop was introduced, which highlights some of the common features in the domain. It was shown how those features influenced the resulting process models. The generic model was followed by an abridgement of three e-commerce shops from different areas that have been modelled by students of the seminar. The first one, Otto.de, is a classical mail order business which had extended its offerings by an e-commerce portal. The second one, Dell.de, allows complex configurations of the products and can be seen as some kind of new economy business, even if it is not this young. The field was completed by ehotel.de, a company that sells services for hotel-reservations on the internet.

The articles and presentations of the students are of different topic areas as can be seen in the corresponding seminar reader [WSP04]. Some students focused on dividing navigation and business processes, whereas other focused on variability of the models or the comparison and analysis of the BPMN. The author of this report extracted an approach of deriving BPMN business processes from UML Use-Cases which will be picked up in the following research parts. The core approach has been stated throughout the discussion chapter and will be extended and refined. Beside of generating ideas for further research, the seminar gave a collection of business processes which could be used for the current PESOA tasks at the HPI and other partners.

The main goal of the seminar was the analysis of the Business Process Modeling Notation and the applicability to the e-business domain of the PESOA project. Almost all students mentioned the expressiveness of the BPMN for their modelling purposes. However, the expressive and well structured notation requires some practice before everything confirms to the syntax. There are also a few things like inter-pool transactions that could not be modelled with the standard modelling elements of the BPMN but those are out of scope for the PESOA project. A discussion of using BPMN as a modelling notation for the PESOA project can be found in [Bay+04].

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7 Appendix A: Diagrams for the Sample Shop

Figure A1   **Use-Cases for the Sample Shop**
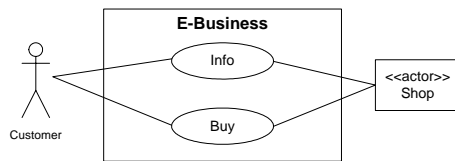
Figure A2   **Feature Diagram for the Sample Shop**
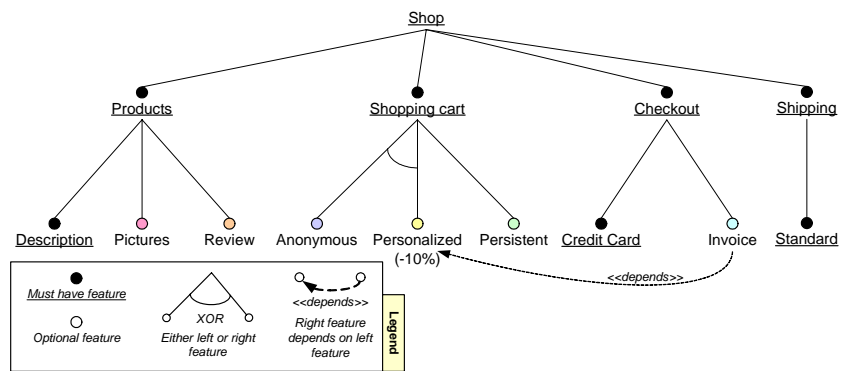
Figure A3   **Basic Processes for the Sample Shop (include all must-have features)**
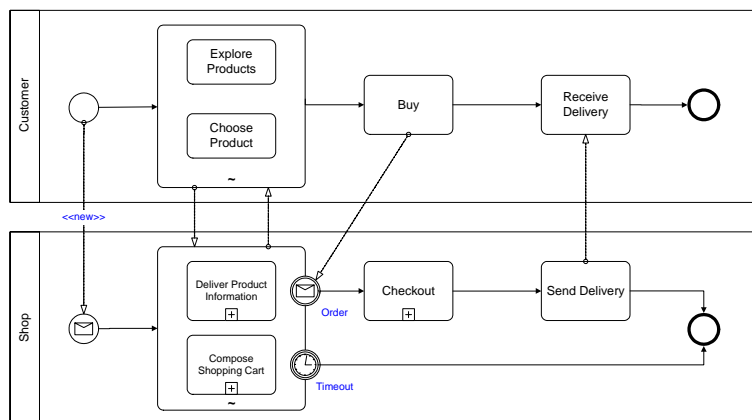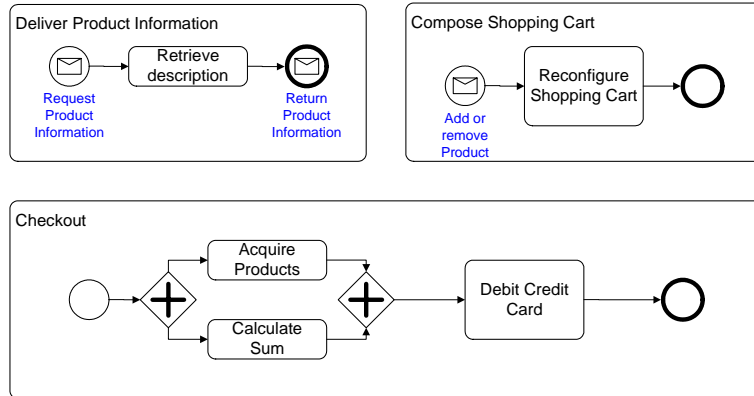
Figure A4   **Fully featured Processes for the Sample Shop (without anonymous shopping cart)**

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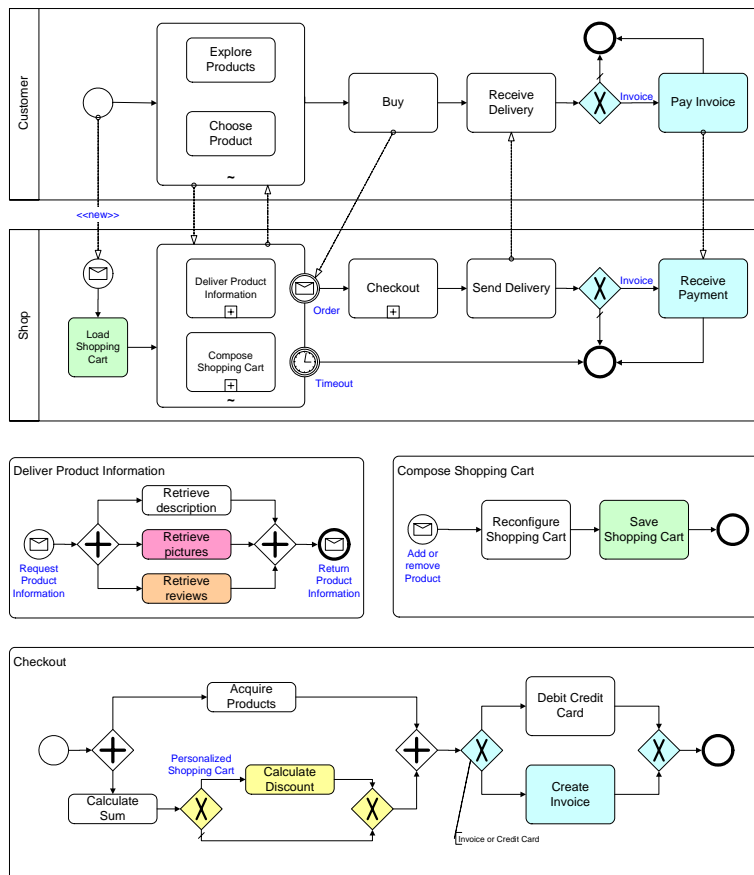
Figure A5   **Fully featured Processes for the Sample Shop (with anonymous shopping cart)**
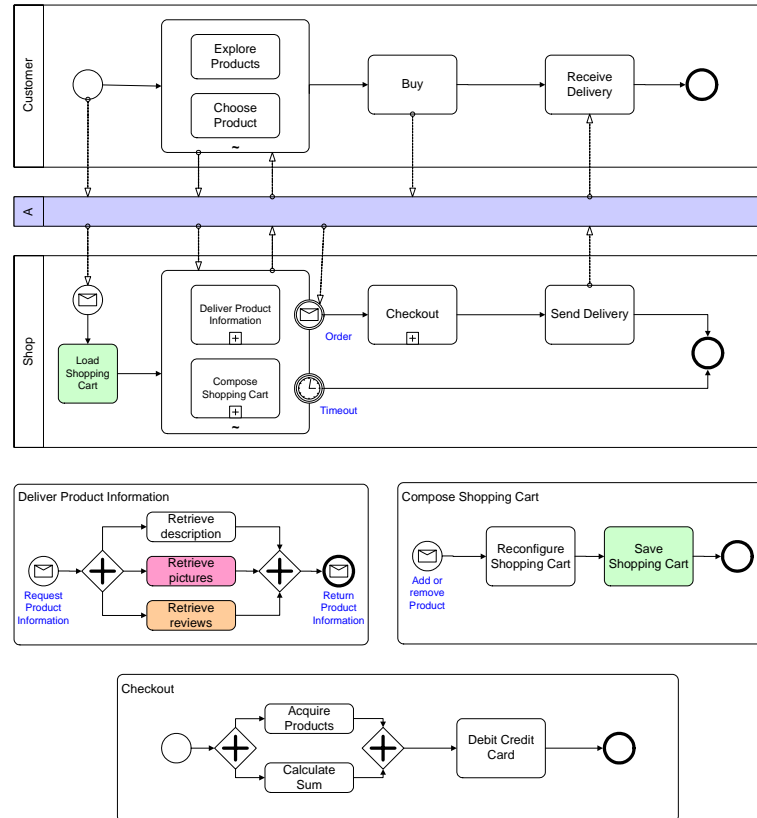
8   Appendix B: Diagrams for Otto.de

Figure B1   Navigation Model Otto.de [Hil04]
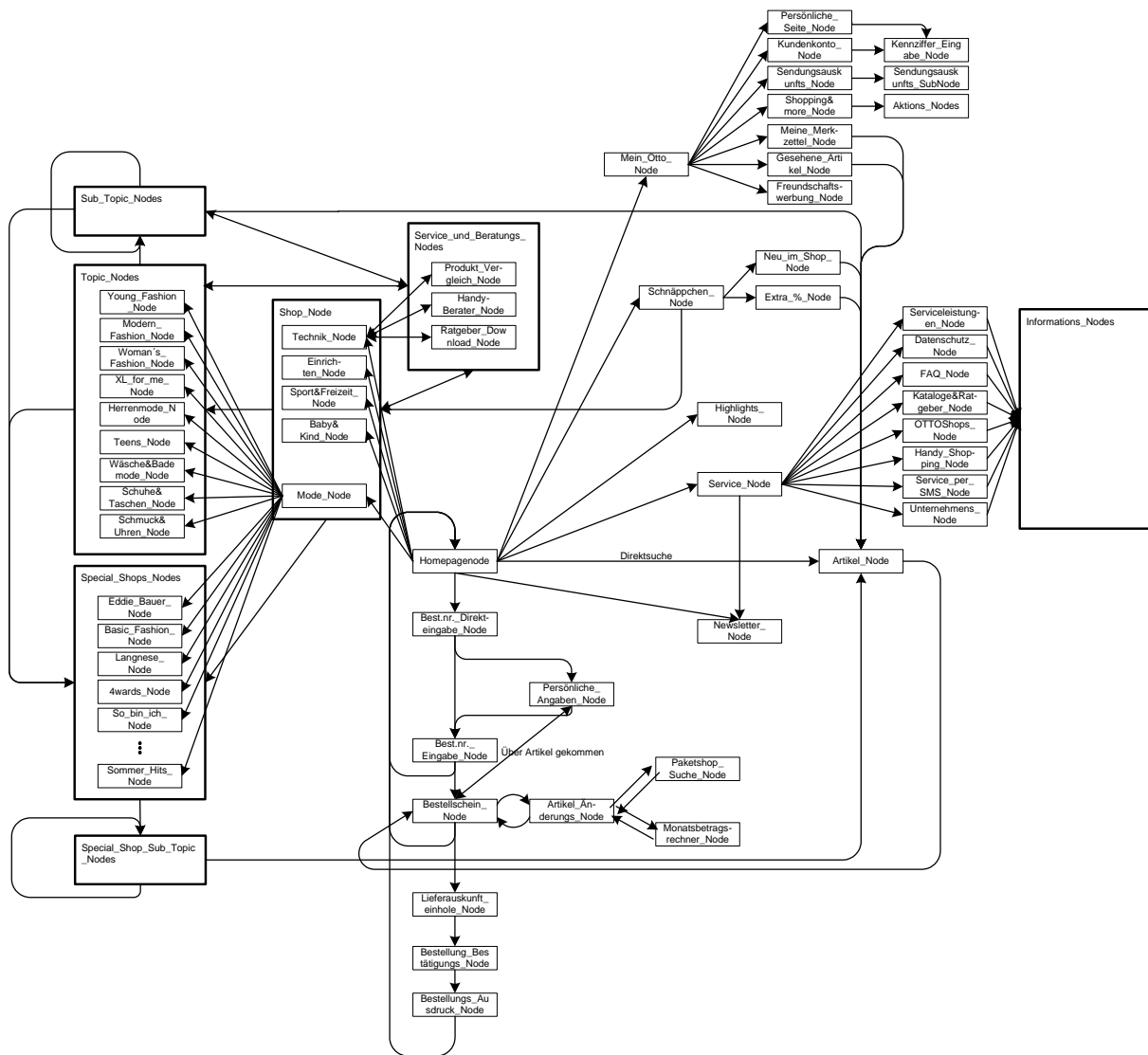
Figure B2   **Use-Cases Otto.de [Hil04]**
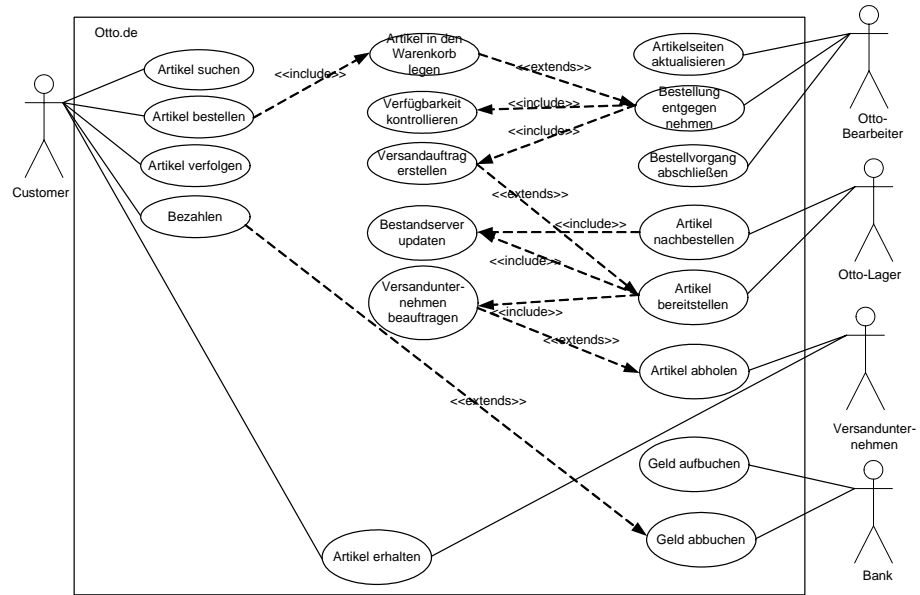
Figure B3   **Customer Process at Otto.de [Hil04]**
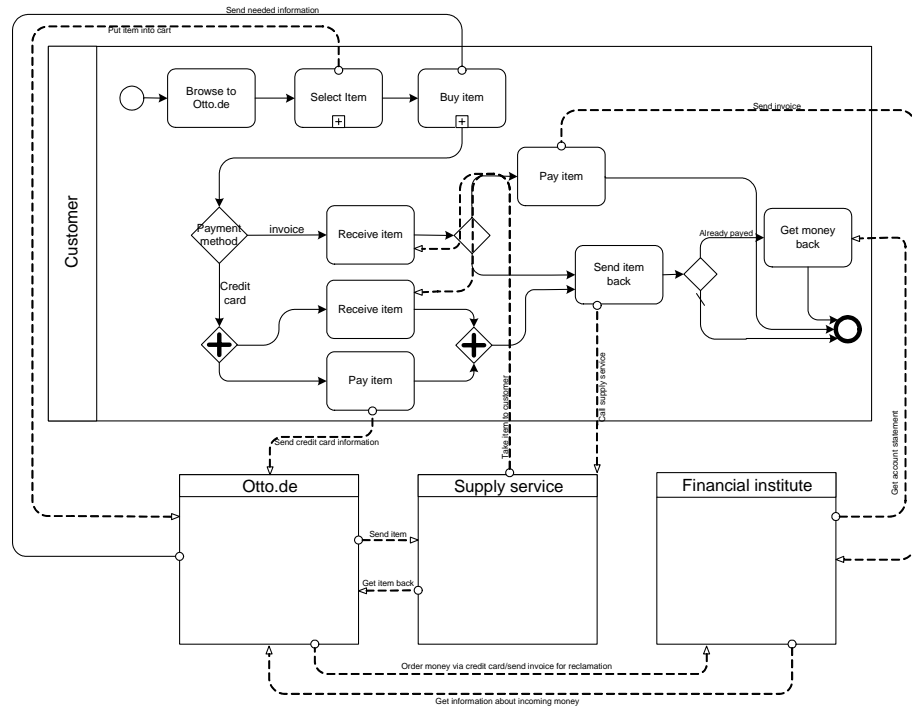
Figure B4   Customer & High-level processes at Otto.de [Hil04]

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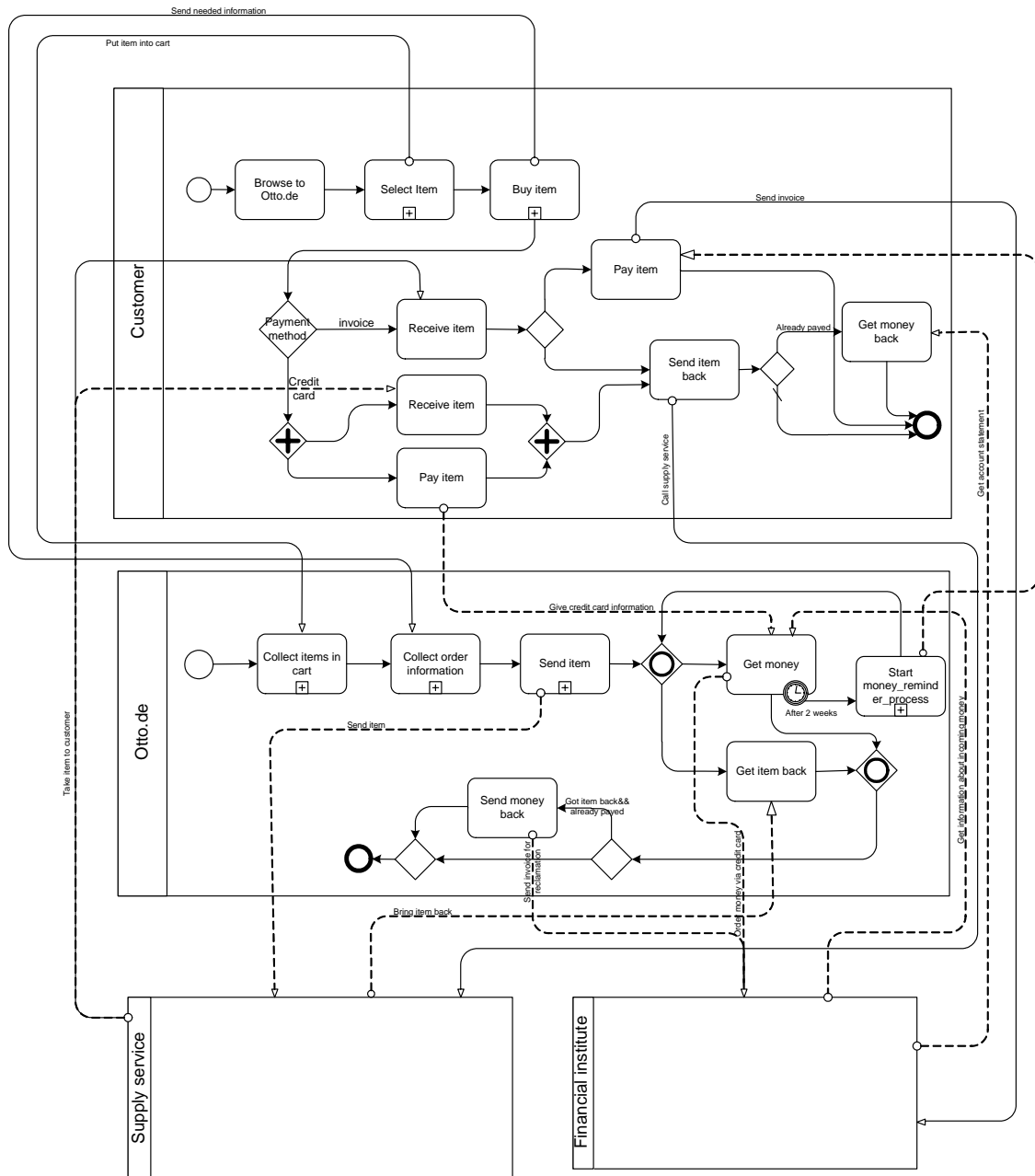
Figure B5: Collect item in Shopping Cart at Otto.de [Hil04]
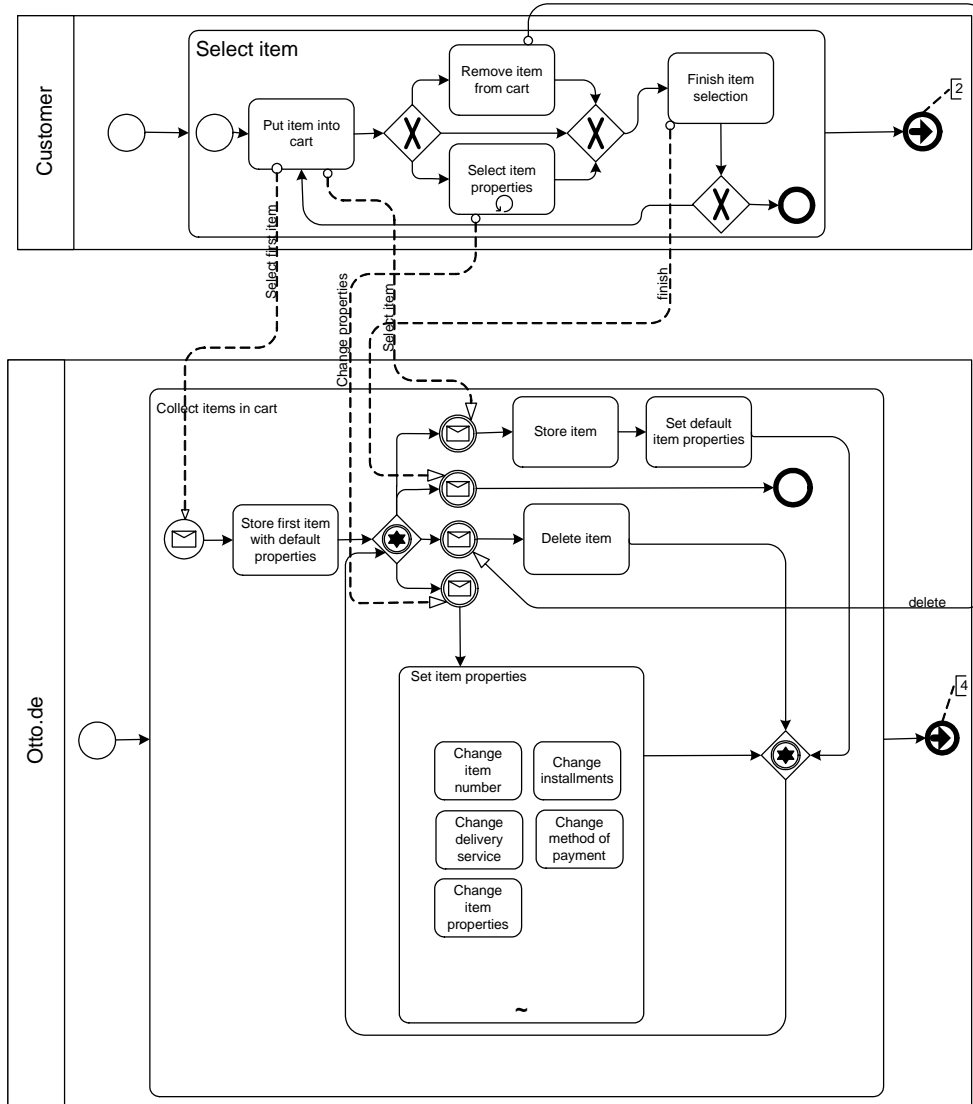
9   Appendix C: Diagrams for Dell.de

Figure C1   **Use-Cases Dell.de [Lie04]**
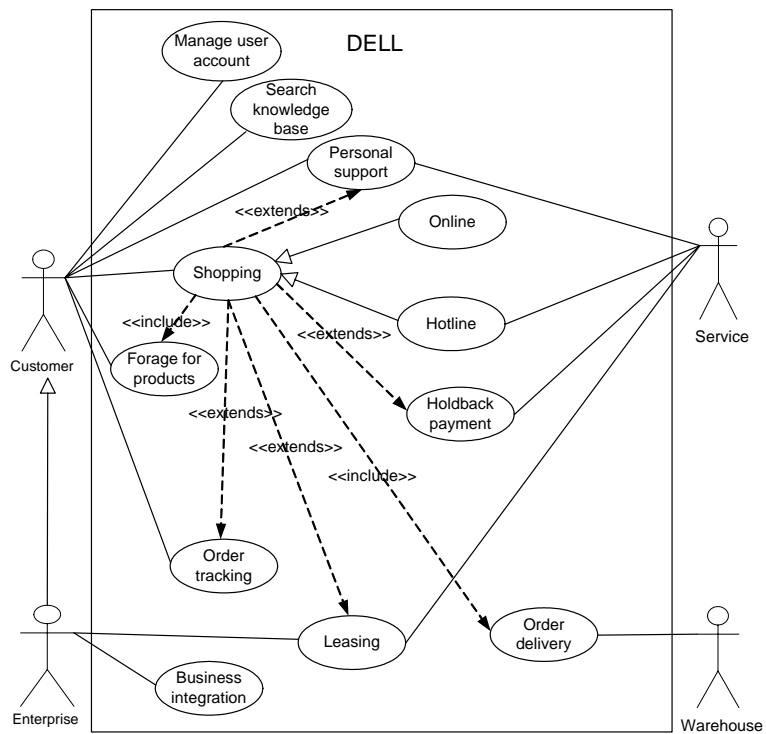
Figure C2   **High-Level Processes at Dell.de [Lie04]**
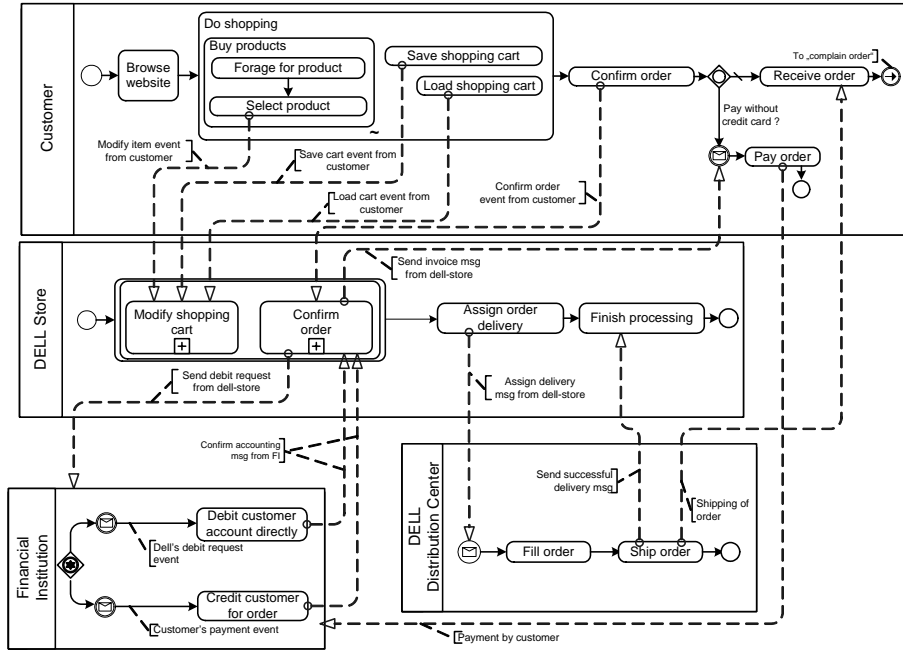
Figure C3   **Modify Shopping Cart and Confirm Order at Dell.de [Lie04]**
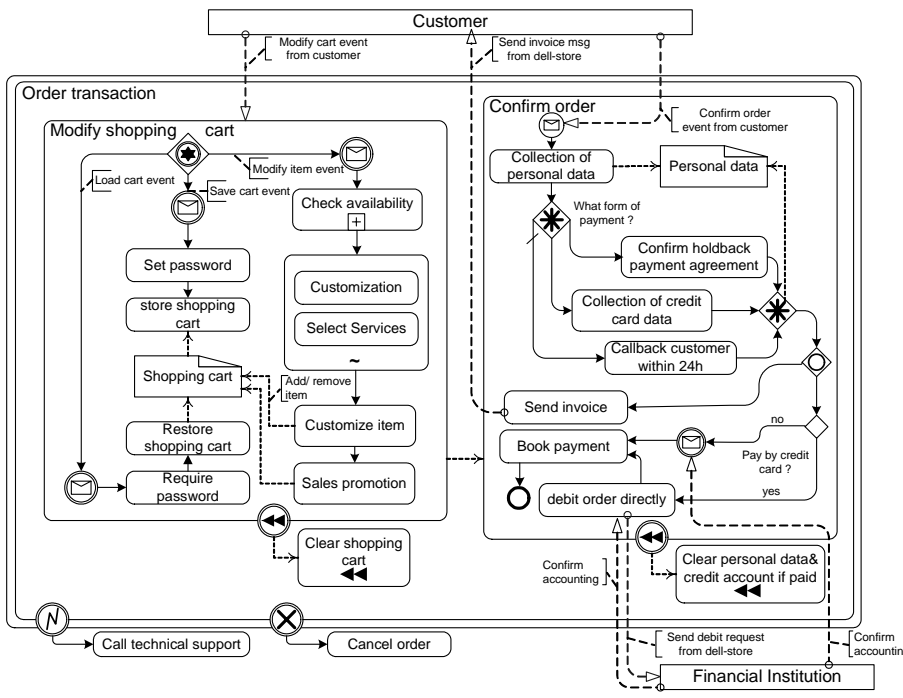
Figure C4   **Process Reuse at Dell.de [Lie04]**
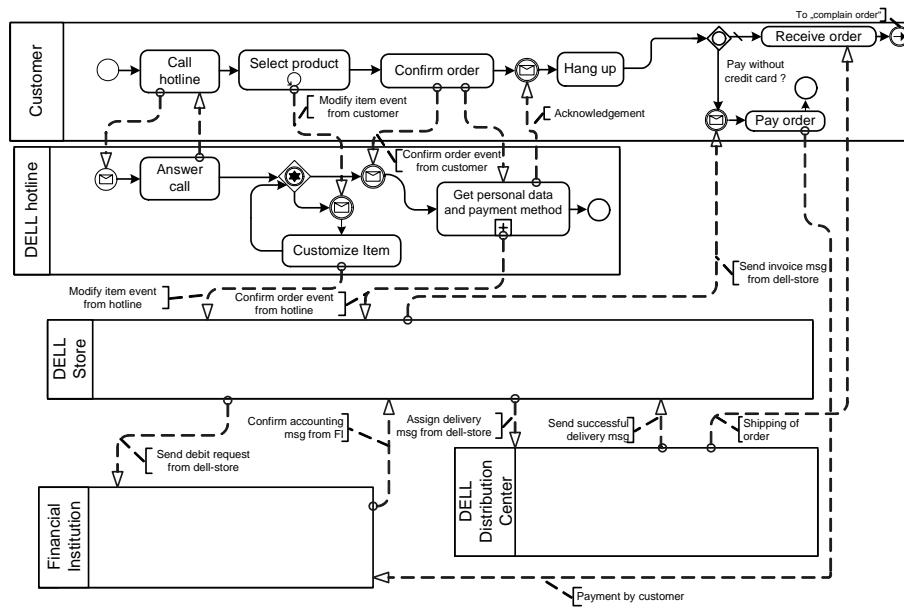
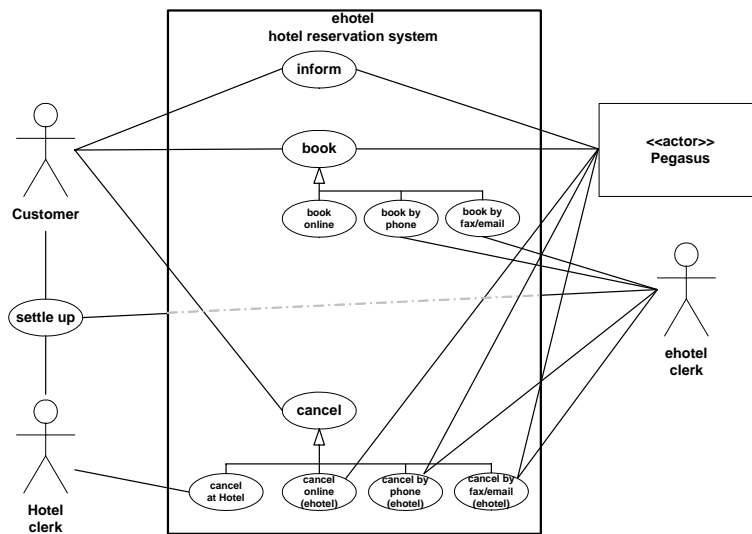# 10   Appendix D: Diagrams for ehotel

Figure D1   Use-Cases ehotel [Hah04]

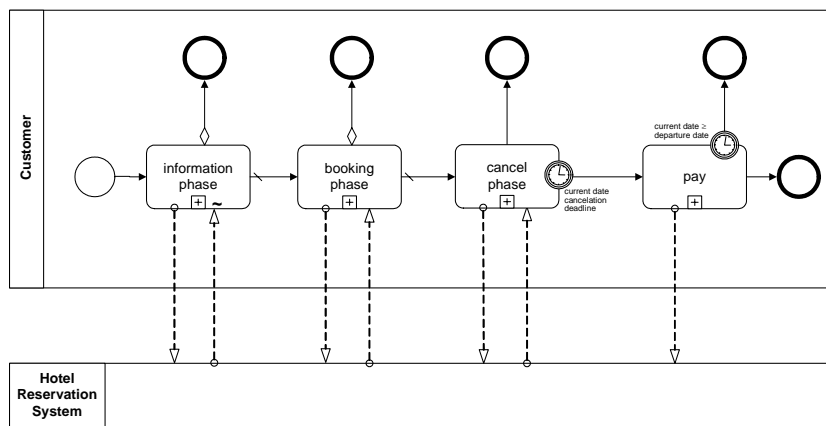**Figure D2   High-Level Customer Processes at ehotel [Hah04]**
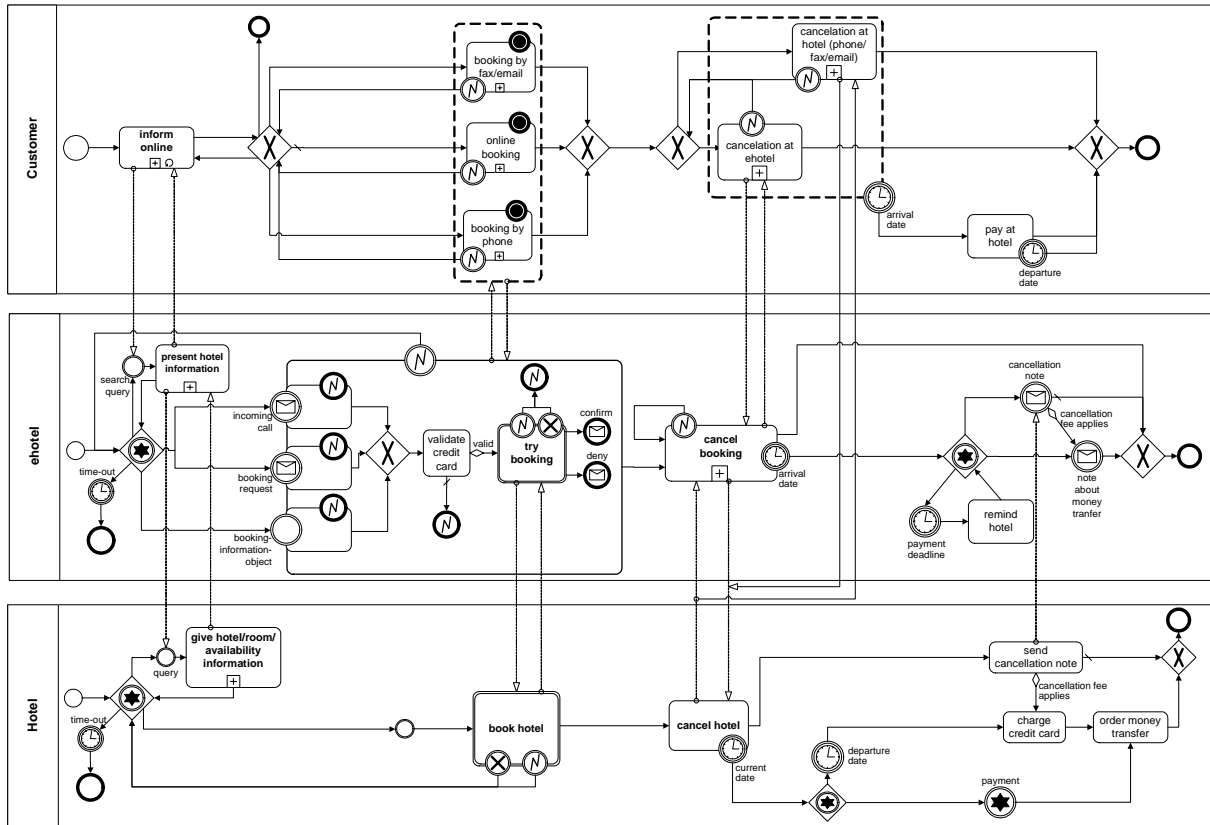
Figure D3   **Processes at ehotel [Hah04]**

Figure D4   **Present Hotel Information at ehotel [Hah04]**