A Method for the Multi-Perspective Design of Versatile E-Business Systems

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Abstract

Exploiting the potential of the internet economy demands innovative business models and versatile information systems. This requires a painstaking process of designing the future shape of a company and its information system. The realisation of cross-enterprise business processes requires the coordination of corresponding activities with customers and suppliers. An ever increasing number of new technologies and prospective standards makes the implementation or configuration of supporting software more and more difficult. To make things worse, most projects that are aimed at developing e-commerce systems are suffering from serious time pressure. This is too much of a challenge for many companies. This paper presents a method, called E-MEMO, that facilitates the design and implementation of e-commerce systems. It extends an existing method for multi-perspective enterprise modelling. The method includes a set of special purpose modelling language and a process model. E-MEMO also provides a set of re-usable generic conceptual models for more efficient support. With respect to new business models and the design of new information systems, models of business processes are pivotal. However, their customisation is hampered by serious obstacles. E-MEMO includes an approach to customize generic models of business processes for e-commerce systems that is based on template-based refinement.

Introduction

A couple of years ago, a few fancy web pages and impressive sales forecasts were sufficient to qualify as a serious electronic commerce contender. Times have changed. Often, exploiting the potential of the internet requires companies to refocus their business strategy, reorganize their business processes, and invest into additional software. Companies have to design a complex system with respect to business issues and technological aspects. In this paper, we call such a system an e-commerce system. Furthermore, there is need to coordinate these efforts with customers and suppliers in order to take advantage of cross enterprise process integration. On the technology frontier there is a plethora of systems and standards that are aimed at supporting efficient ways to initiate and process business transactions through the internet. While an evaluation of the merits of particular solutions is a complex task on its own, it is not sufficient. In order to protect their investments, companies also have to find out (or more likely: to bet on) which solution will survive in the long run. Coping with all these issues in addition to every day's business is too challenging for many firms – especially for small and medium sized enterprises. While a growing number of consulting firms offer relief, it is not a good idea to depend entirely on external help, since an electronic commerce system will often be at the core of a company's business. Making an e-commerce system a sustainable asset requires building up specialist knowledge in the company itself. Hence, there is urgent need for supporting business firms and consultants with developing competitive E-business solutions. Since there is hardly one best solution – in terms of corporate strategy, business processes and technology, the most promising approach to provide support is a method that guides its users with developing solutions that fit their needs.

Organizations that promote infrastructures for electronic commerce, e.g. Ariba, CommerceOne or RosettaNet, have recognized this demand. While they focus on the specification of interfaces to support electronic business transactions, they also offer 'business models' to illustrate the use of new technology. However, these models (RosettaNet 1999, p. 18; OBI 1999, p. 15; Ariba 2000, p. 11, 67) remain on a high level of abstraction. They do not guide the development of a long term strategy, nor do they provide support for designing detailed business processes. 'Collaborative Planning, Forecasting and Replenishment' (CPFR, VICS 1999, White 1999), an initiative promoted by the 'Voluntary Interindustry Commerce Standards (VICS) Association', on the other

hand, stresses a vision of closely cooperating business partners that may inspire the creation of long term strategies. However, with respect to the realization of this vision, the approach remains vague and superficial.

Different from those approaches, ECOMOD ('Electronic Commerce MODeling'), a project funded by the German National Science Foundation, is aimed at a method that supports the integrated design of business plans and associated business processes as well as the realization of the required information technology infrastructure. It is based on the assumption that electronic commerce requires to take into account multiple perspectives, such as managerial and technological as well as process views and static views on the enterprise. The method extends an existing method for multi-perspective enterprise modelling. This paper gives an overview of the method and describes in more detail the conceptualisation of generic models of cross-enterprise business processes as well as approaches to adapt them to individual needs.

Requirements

Designing and implementing a competitive e-commerce system is a complex task that requires taking into account numerous aspects. Therefore, it is important to help with the *identification of relevant aspects and critical success factors*. The diversity of the task implies the involvement of many people with varying professional background. To support all these participants with their specific tasks, a method should provide concepts that allow describing and analysing the problem domain *from various perspectives*, e.g. with focus on business strategy, business processes, resources or software architecture. On the other hand there is need for overcoming the language barriers between those different communities. That recommends to provide concepts together with proper illustrations that foster an *intuitive understanding* on a higher level of detail. Electronic commerce usually requires the specification of supporting software. Therefore the concepts provided by a method should be *sufficiently formalized*. A solution that is in line with a long term business strategy recommends a top down approach, deriving goals from the strategy, business processes from the goals, and software systems from the business processes. However, with respect to the implementation or configuration of software, it is usually necessary to take into account the peculiarities of existing technology. Therefore the concepts featured by a method should correspond to concepts used to describe the implementation level technology.

While these are requirements that should be fulfilled by methods that support analysis and design of information systems in general, there are three more requirements to be met by a specialised method for e-commerce systems. Firstly, re-designing a company to cope with the internet economy requires the ability to precind from traditional ways to do business. Hence, it demands a high amount of creativity and long term vision. This is a problem especially for seasoned domain experts who are limited by the world views they are used to. Therefore a method should provide support for designing innovative ways to do business. Secondly, establishing business processes for e-commerce requires taking into account aspects, most companies have little or no experience with, such as specific success factors, problems or exceptions that may occur during the execution of an e-commerce process. This implies the demand for *specialised concepts* that help with identifying and describing these specific features. Thirdly, e-commerce projects often suffer from a tremendous time pressure. One elegant way to satisfy these three requirements would be to develop generic patterns of reusable business plans, business processes etc.

Core Concepts of E-MEMO

The method developed within ECOMOD, called E-MEMO, is based on an already existing method for multi-perspective enterprise modelling, MEMO (Frank 1999, Frank 2002a). MEMO serves to analyse and design corporate information systems that are balanced with a company's strategy and its organization. MEMO consists of three main components: a high level framework that gives a "ballpark" view of the enterprise and allows to locate problem areas, special purpose modelling languages that allow to describe certain views in detail, and a process model serving as a guideline for project management.

The structure of the framework corresponds to common abstractions of business firms. It differentiates three so called perspectives - *strategy*, *organization* and *information system* - each of which is structured by four aspects: *structure*, *process*, *resources*, *goals*. A participant in a discussion can literally point to the focus of his concern by selecting a particular aspect within a perspective. Since e-commerce systems usually require to cooperate with external partners, the original framework was supplemented by a fifth aspect, *environment* (see www.uni-koblenz.de/~iw/EM/MEMO).
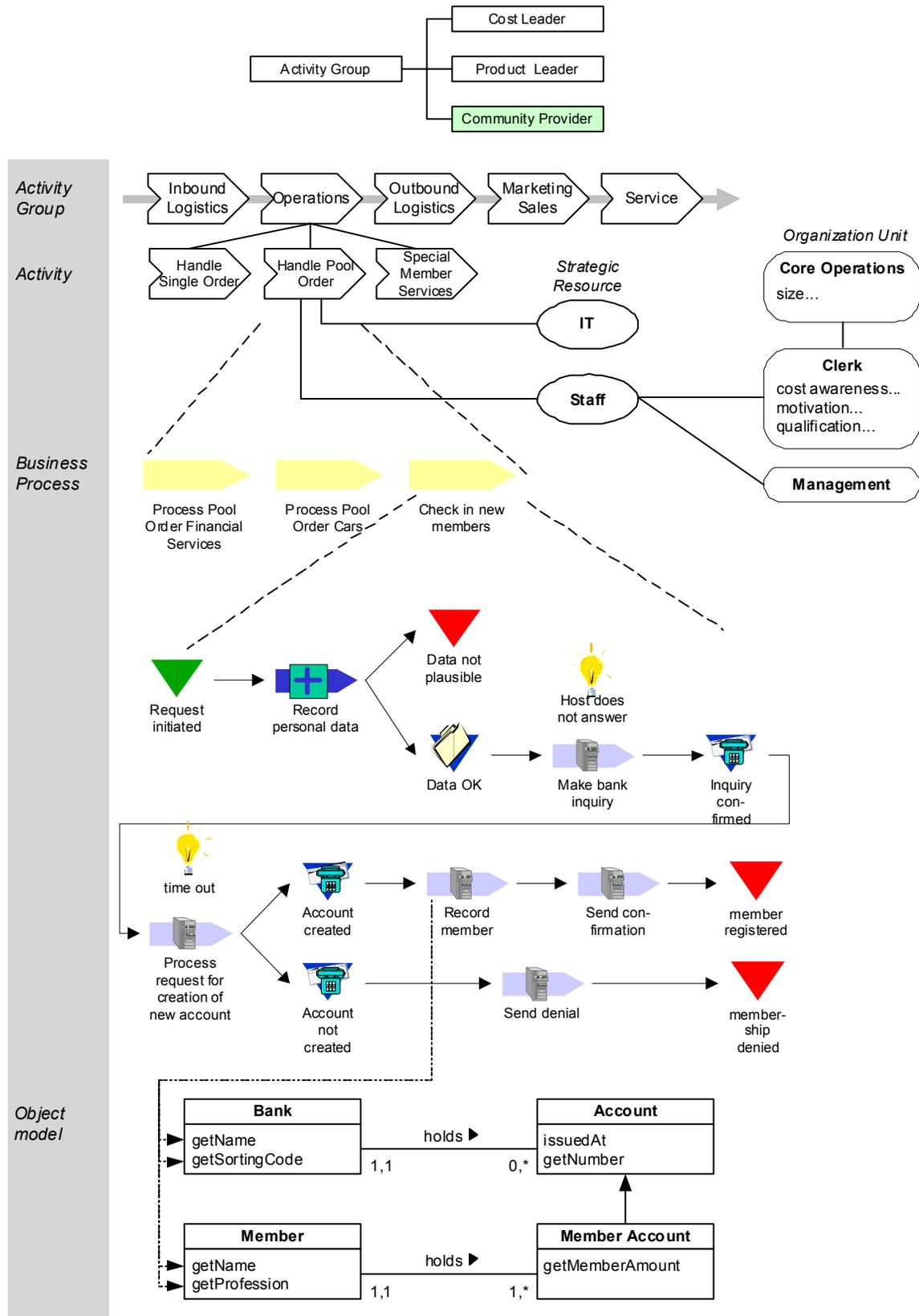
Figure 1. Usage of the MEMO Modeling Languages

MEMO provides three different graphical modelling languages (Frank 1999): The MEMO Strategy Modelling Language (SML) serves to express corporate strategies, e.g. by representing value chains or by decomposing generic strategies. The MEMO Organisation Modelling Language (OrgML) includes concepts to describe business processes, organisational structure and resources. Finally, the MEMO Object Modelling Language (OML) allows to develop static, object-oriented models of information in order to provide for a seamless implementation in software systems. All languages are specified through metamodels, which are described by concepts defined in a common meta-metamodel (Frank 1999). The languages are integrated by a common meta-language and by common concepts. For instance: the concept 'business process' is part of MEMO-SML and MEMO-OrgML. The process model recommends to start with analysing and, if necessary, (re-) designing the business strategy. The design of business process models that implement the strategy is the second major step. Further refinement of these models, including the design of corresponding object models, supports the partial generation of software.

However, the MEMO modelling languages lack characteristic concepts for doing business over the internet. For instance, on the strategic level, one may want to take advantage of concepts like virtual organizations. On the operational level, e-commerce allows new pricing mechanisms or new ways of payment. In addition to that, there is a plethora of technologies and standards that have to be taken into account on the IS level. For these reasons, the MEMO languages are being extended to cope with these new requirements. Fig. 1 gives an impression of how to use these specialized modelling languages. Notice that although our emphasis is clearly on the conceptual level, E-MEMO also takes into account the underlying technology.

Adaptable Generic Models

While a special purpose modelling language helps with structuring a problem domain according to analysis and design requirements, it still leaves a lot of work to those who apply it. With respect to the time pressure in e-commerce projects and the limited creativity of many users, re-usable generic models would contribute to a much higher level of productivity and innovation. Hence, E-MEMO puts emphasis on generic models of business processes. They are inspired by the vision that a company that seeks to introduce a powerful e-commerce system picks generic processes that are compliant with its strategy from a corresponding library. In case a selected process does not entirely satisfy the individual needs, it should be possible to adapt it to specific requirements in a safe and convenient way. This vision seems very similar to the "process handbook" proposed by Malone et al. (Malone et al. 2002). There is, however, one essential difference between the process handbook and our approach: While the process handbook uses decomposition hierarchies and natural language only to describe processes, E-MEMO features a (semi-) formal modelling language for representing reusable business processes and offers specialized processes to aid reaching the specific goals of a company. In addition to the approach of Malone, there exist more approaches working on the generic business processes or the reuse of existing business processes. SETCOM (Hagemeyer and Rolles, 1997) is an open repository of information models (product models, process models), that uses a thesaurus to make models more intuitively understandable from different points of view. While such a thesaurus is certainly helpful for using and resusing information models, SETCOM does not give hints how to choose models that fit a particular company: It does not include corresponding goals or specific restrictions of products/markets to be taken into account. WEGA, a tool developed by Ferstl et al. (1998) allows to decompose a set of generic processes into subprocesses. A subprocess may exist in different variants. Hence, a hierarchical structure is build up and one can choose, combine and configure processes. Again, this tool does not support strategy-oriented process modelling. Other approaches, like IBM (2002) or IPPM, a model of reference processes for production, developed by Warnecke et al. (1996) also lack a strategic perspective Brown et al. (1998) take an entirely different approach by introducing 'anti-patterns' of process design. Thereby they reader is to be supported to avoid mistakes. This is certainly helpful, but knowing how to do it wrong does not mean knowing how to do it right.

E-MEMO concentrates on a library of generic, adaptable e-commerce processes (e.g. different ways of procurement via marketplaces, via e-shops, with sell-side or buy-side catalogues, for different kinds of products etc.). To demonstrate its potential benefit, every process is evaluated against a set of strategic goals. Against this background, prospective users can choose generic business processes from the E-MEMO process library by focusing on *what* should be accomplished. A generic E-MEMO process describes *how* it should be done. It serves as a template that can be further refined by users. For this purpose, E-MEMO guides the user with a set of questions and corresponding suggestions. Every suggested alternative is supplemented with a specific explanation (see figure 2). Although the E-MEMO process library offers descriptions of generic business processes that are more comprehensive and precise than those to be found in the MIT process handbook (Malone et. al. 2002), it will not satisfy every company's specific needs. In these cases, generic processes can be customized using the E-MEMO modelling languages.

Customization through Specialisation?

Adapting generic artefacts to specific needs has long been a topic in software engineering. While there is a plethora of approaches that vary in detail, specialisation is of outstanding importance. In object models, specialisation provides a seemingly intuitive concept to re-use existing classes and enhance them with special features. There is no doubt that specialisation and generalisation are powerful concepts to deal with complexity and to adapt generic concepts to individual requirements. Applying specialisation to static object models can be very helpful with respect to productivity and system maintenance – although there is a number of problems that originate in the intensional notion of a class, which is used in most programming languages (Frank 2000). Other problems occur when inherited features within a specialised class are redefined, e.g. the notorious covariance problem (Meyer 1997, pp. 621). Nevertheless, applying specialisation to process models seems to be an appealing idea. A user would select a generic process model that fulfils his needs on a high level of abstraction. Then he could – without messing up the generic process model – add further refinements. This is, however, not a trivial task. It is extremely difficult to define the semantics of specialisation in a satisfactory way. At first sight, it may seem reasonable to apply a concept of specialisation that is used in static object models to process models, too. That would result in specialised processes, which enhance their super process with additional features, such as further subprocesses or additional resources. However, the intuitive notion of specialisation implies that an instance of a specialised concept can be used wherever an instance of its super concept is required. With this constraint in mind, defining the semantics of specialisation becomes a tremendous challenge. There are only few attempts to meet this challenge. Van der Aalst and Basten (1997) specify the semantics of the dynamic behaviour of a class (in object-oriented systems) by applying a special class of Petri nets. This is not sufficient for our purpose, since the concepts used to specify a class are not appropriate for modelling a business process. There is, e.g., no notion of required resources, of roles or of parallel execution. Wyner and Lee (2002) define specialisation for state charts and data flow diagrams. Again, these abstractions are not well suited for the representation of business processes. Furthermore, specialisation of a process is defined by deleting the parts that are not needed (or in other words, the generalisation is a combination of all specialisations). From our point of view, this is not acceptable, because it is not consistent with the demand that an instance of a specialised process type can be used wherever an instance of the super process type is required. Malone et. al. (1999) apply the notion of specialisation to business processes. However, they do not define its meaning. Hence, it is not clear whether a specialisation does not hurt the integrity of the resulting process type.

Customization through Template-Based Refinement

With respect to the difficulties related to the specialisation of process types, we decided not to pursue this strategy any further. The main goal of ECOMOD and E-MEMO is to support the introduction of e-commerce infrastructures in companies. The introduction of e-commerce infrastructures is a difficult and time consuming task, because knowledge about e-commerce and its implications on the company is mostly inexistent. This knowledge has to be bought or build up. This again makes the introduction of e-commerce infrastructures and processes very expensive. The needed time for implementing e-commerce processes and systems, and so the costs, can be reduced and the positive impacts on the company be optimized by offering a set of proven "ready-to-go"-processes, that correspond to the enterprise strategy.

So we propose an approach based on template-based stepwise refinement of generic process models. Note that generic process models are similar to so called "process patterns" (e.g. in Ambler 1998). For this purpose, E-MEMO offers a set of generic models of business processes for e-commerce, such as procurement, order processing, handling of customer complaints, or the exchange of goods. They are represented in MEMO-OrgML on a high level of abstraction. Although these processes are rather generic, they still do not cover all possible occurrences. They are templates that need to be refined further to fit specific needs and conditions. Therefore, E-MEMO includes a set of variants of each generic model. Order processing, for instance, has a variant that requires payment only after delivery, as well as one that requires payment in advance. Starting with a generic strategy and a high level value chain, a user of E-MEMO can profile an e-commerce system by selecting the appropriate generic business processes. To support the customisation of the selected processes, the user is presented with a visual representation of the process that serves as a basic template. It may include "abstract processes". An abstract process is an abstraction that covers a number of further abstract processes or of concrete process specifications respectively. For example: the abstract process 'handle incoming order' can be replaced (notice that we are not using specialisation) by 'handle order through internet' or 'handle order by telephone'. To support the implementation of these processes, each pre-designed concrete process includes references to the required information or to the communication needs (in terms of technical protocols to be satisfied, roles to communicate with or media to be used).

With the still growing size of the process library provided by E-MEMO, it is possible to pre-configure a large variety of actual business processes. If this variety is not sufficient in a particular case, there are two additional means to adapt a process model

to individual needs. Firstly, the generic process templates may include "user exit points". A user exit can be introduced if in certain parts of a process model additional variety is expected for future times. For example, while we already know a number of pricing mechanisms, we cannot exclude new ways of pricing in the future. For this purpose, a corresponding process model would include an exit point to indicate that there is room for individual specifications. Secondly, MEMO-OrgML can be used to change parts of a process model or to enhance it. While this is certainly the most versatile approach to adapting re-usable models, it is also the least favourable because it jeopardizes the integrity of a process model. The example in fig. 2 illustrates the process of template-based refinement.
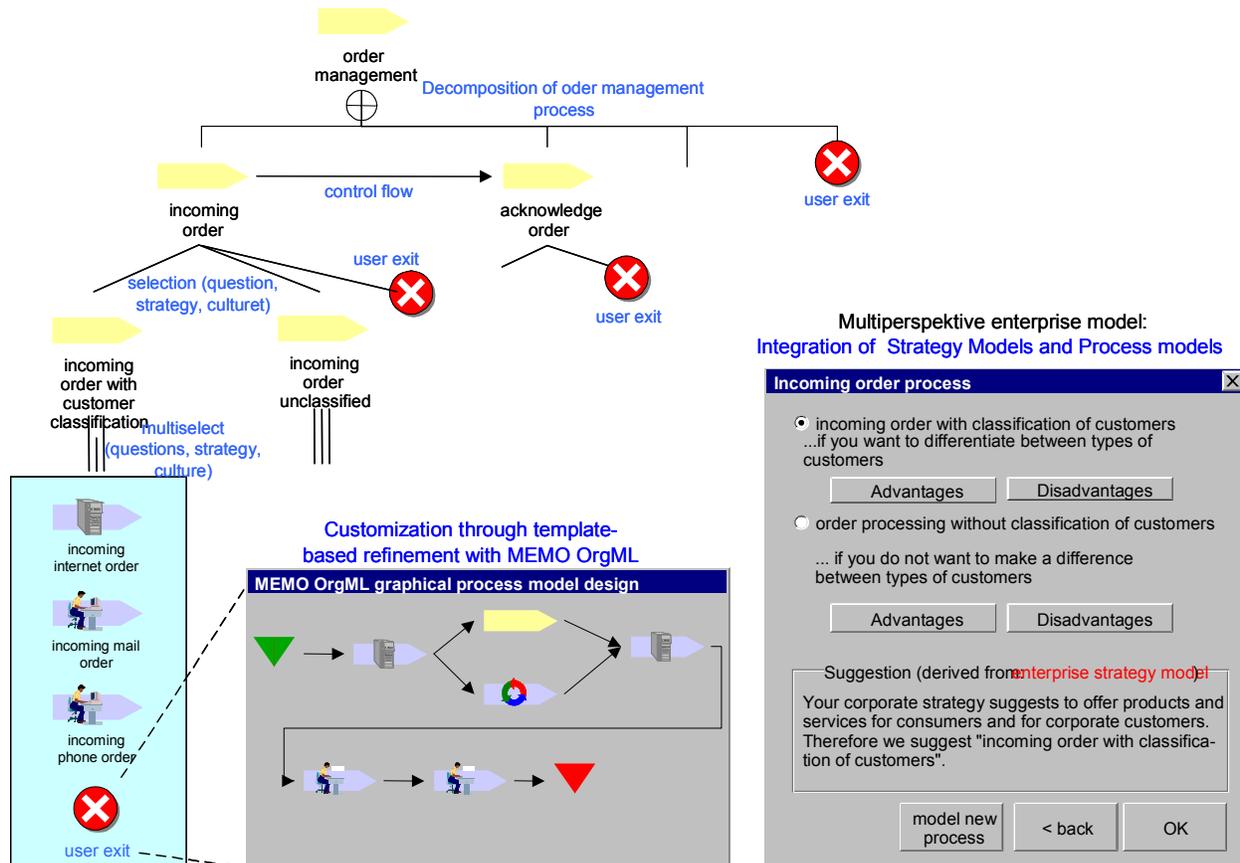

Figure 2. Working with E-MEMO

Conclusions and Future Research

E-MEMO supports the development of e-commerce systems by allowing for multi-perspective representations of a problem domain that are enriched with specific concepts for e-commerce. Due to the semi-formal specification of the modelling languages that are part of the model, it is possible to support automatic model checking and the generation of code, e.g. a workflow specification for a workflow management system. However, for many users it is still to big an effort to build models from scratch – even with a domain specific modelling language. The generic models that have been developed within ECOMOD promote a more efficient way of designing an individual e-commerce system, because they are deduced from a strategy model with respect to corporate culture and environmental restrictions. Also, experience we gained with small and medium sized companies suggests that generic models inspire people to think about innovative ways to do business. They are enabled to benefit quickly from the potential of versatile e-commerce infrastructures – without being forced to neglect their core business. Hence, they help with initialising and motivating projects to develop e-commerce systems. We are working on further support for the use of the E-MEMO modelling languages – especially with respect to process modelling. While it is fairly easy to check for syntactic correctness of a process model and – to a limited degree – for semantic correctness in a formal sense, it is much more challenging to judge the quality of a business process, which is essential for a system of generic ready-to-use processes. Therefore we work on formal rules that help with checking a process model against appropriate quality measures.

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