Towards an Agile E-Commerce

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***Abstract*—Creating an agile e-commerce is still a challenging issue. The alignment between business and IT plays a key role as changing business demands must be implemented immediately. To avoid misunderstandings and to lead to a better business-IT alignment we provide an ontology model, describing enterprise objects and their relations. As business rules guide or influence business behaviour, we use business rules which can be easily created and changed by business people. A system works directly with the ontology and the business rules. So, if changes occur, the business can express their changes and the IT system can react accordingly. As it easier for business people to express their knowledge and needs in a semi-formal way, we present a 3-phase procedure which helps to transform the semi-formal expressed knowledge into the formal representation needed for IT systems.**

***Keywords*-context-awareness; rule based; complex event processing.**

I. INTRODUCTION

Continuously changing challenges, like shorter product cycles, increasing customer expectations, changing regulations, forces today's enterprises to be more agile [1][20]. Henbury regards agile enterprises as capable of rapid adaptations in response to unexpected and unpredicted changes and events, market opportunities and customer requirements [14]. As e-commerce becomes the preferred way of doing business [10], an enterprise must be able to adapt its e-commerce immediately when changes occur.

The adaptation of the e-commerce requires the

1) definition of the business model, i.e., knowledge about users, products and business rules
2) dynamic adaption of the business model according to happenings in the environment (events). The dynamic adaptation of this business model leads to the adaption of the Information Technology (IT) to match new business strategies, goals and needs, the so-called business-IT alignment.
3) personalization, for example the analysis of the user behavior. While the user is navigating through the web site his clickstream is observed and according to his interest and behaviour the web pages are personalized [3].

For the definition of the business model, a common approach is the use of adaptive hypermedia and adaptive Web systems. Adaptive software systems are based on a business model representing user knowledge, goals, interests and other features to distinguish among different users. The challenge for the adaption of the business model is the use of different languages by different actors in the alignment process. For instance, IT managers can read and understand UML but such languages may not provide adequate information for business people [15].

As ontologies promote a common understanding among people [19], we present an ontology describing business objects and rules. This ontology is used as the knowledge base for the e-commerce and web site adaptation. If changes occur, the business user can express his changes in the ontology and the system uses the updated knowledge base. This approach supports enterprises, especially e-commerce, to be more agile and to be able to react to changing environments immediately.

This paper is structured as follows. First, we introduce a simplified scenario, which is used in this paper to show our approach. Then we describe the knowledge base. As business users can express their needs better in a semi-formal way we propose a method which enables users to express their needs using a structured template which can easily transformed into the formal representation. Finally, we show the benefit of the model-based approach for the business-IT alignment.

II. SCENARIO

To explain our approach, we use a simplified scenario of a book store. The book store provides information about books, authors, and search functionality. A customer can register himself and can enter further information.

The store distinguishes between the four browsing strategies proposed by [18]: direct buying, search/deliberation, Hedonic browsing and knowledge building. A visitor using the direct buying strategy has a specific product in mind which he wants to buy. His browsing pattern is therefore very focused and targeted. Visitors using the search and deliberation strategy are also focused with a future purchase in mind. Their objective is to acquire relevant information to help make a better choice. The hedonic browsing is dominated by exploratory search behaviour and therefore more sessions are spent viewing the broader product category level pages than product information. The visitor using the knowledge building strategy is acquiring relevant product information potentially useful in the future. They tend to focus more on information pages.

The strategy of the book store could for example be to help the users following the direct buying strategy by the providing of relevant information related to the content they have already visited. For instance, if a user searches for a

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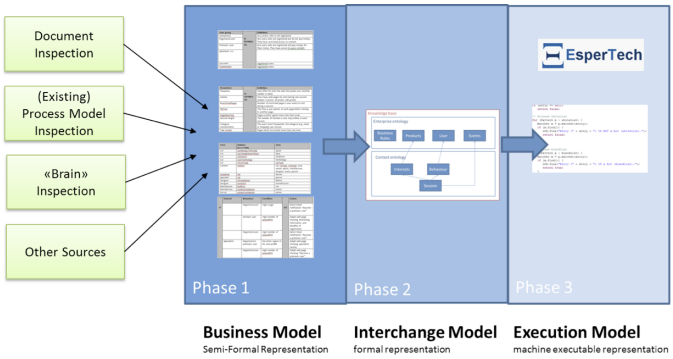

Figure 1. 3-Phase-Procedure.

specific criminal story set in Cologne from Frank Schätzing, the users navigates to the web page containing a list of all books of Frank Schätzing and then he starts looking for the criminal story. To reduce the list of results he enters into a search field Cologne. The System recognizes from his click path that he is interested in criminal stories of Frank Schätzing and Cologne. The system retrieves that Frank Schätzing has written the criminal story "Tod und Teufel" playing in Cologne and provide the user a link to this book. With this also, people who do have a specific book in mind can be inspired. The click stream is analysed and interpreted and related books are given as links on the web page. To stay agile, the book store does not want to fix business objects, like products, for instance in a database, and the link between these objects. Additionally, coding the business rules, expressing actions which should be triggered depending on specific conditions, like sending an E-Mail when a user gets often to restricted web pages, in java or other programming languages leads to inflexible enterprises as IT experts are required to implement changing rules. The bookstore must have the freedom to change the product catalogue according to the customers' needs and also have the ability to change the user groups and the actions which should be triggered according to their behaviour and interests. Additionally, a business user should have the freedom to express changing business rules in an easy way.

In the next section, we present an ontology with which an enterprise can be described. To make it easier for business people, we propose a 3-phase-procedure where business people can express their knowledge in a semi-formal way, which can be transformed into a formal and afterwards if necessary into an executable form.

III. Personalization Ontology

In [8], we described a method for ontology development in the e-government field, which we have adapted for the e-commerce area. The method comprises four levels of formalisation: informal (knowledge captured in natural language), semi-formal (knowledge represented in a semi-formal way in structured templates), formal (knowledge formalized in OWL [5] and SWRL [6]) and executable form (knowledge formalized in e.g., Esper-Rules [9] and Java).

The method consists of three phases (Figure 1):

Phase 1 – Defining the business model: capturing user groups, product catalogue and business rules in a semi-formal way.

Phase 2 – Defining the interchange model: transform the semi-formal expressed terms, facts and rules into OWL and SWRL.

Phase 3 – Defining the execution model: transform the formal model into a machine executable form.

These phases are described in more detail in the next sections.

A. Business Model

Writing down the terms, facts and rules (all together called 'business rules') in a semi-formal way so that business people can easily understand them because they are close to 'normal English' and IT people can understand them as well as they are clearly structured. We use the templates provided by Barbara von Halle [23]. The first step is about defining the user groups. As an example, we use the browsing strategies introduced in the last section. Using the template a user group can be defined as follows:

Behavior	IS	Definition
Search/ Deliberation	DEFINED AS	a strategy which intends to acquire relevant information to help make a more optimal choice.

Secondly, as the various user groups provide different navigation patterns, the measures for how to recognize the user groups have to be also specified. For instance to recognize a hedonic browser, the page types must be analysed. A person who uses the hedonic browsing strategy focuses on category pages. So, the number of category pages is very high. Additionally, he visits a lot of product pages. However, he does not repeat visiting a web page very often. So, first of all these page types must be defined.

Parameter	IS	Definition
Product page	DEFINED AS	As a page describing a specific product

After expressing these parameters the conditions by which a user can be assigned to a specific user group can be defined. For the hedonic browsing strategy it might look like the following template.

IF	Condition	THEN	Consequence
	The focus of a session is on requesting category pages, the category variety is high and the product variety is high, repeat viewing is low		Hedonic browsing

Thirdly, to find out in which products a person is interested in, the product catalogue must be described. With this information the user behaviour and his interests are expressed. For this the IS DEFINED AS template can be used. As products are related somehow to other produces another template is necessary expressing those relations.

Term	Relation (IS A / VERB)	Term
a criminal book	Is A	book

As actions should be triggered if a user is interested in a specific product and shows a specific behaviour, these actions must be defined. For this reason we use also the templates. We reuse the definition templates to define the action.

IF	Interest	Behavior	THEN	Actions
	Book, Author and other specific attributes	Direct buying		Show list of related books, related to the author and the other specific attributes

B. Interchange Model

The second phase of designing the personalisation ontology is focussed on the transformation of the models into a precise, machine understandable form. The purpose of this formal model derived in this phase is twofold: First, the semi-formal representation chosen in the first step can be easily understood by business people but has the disadvantage that it cannot be executed by a computer because the rules can be ambiguous. In order to be validated and executed, the user groups, product catalogue and the business rules have to be represented in a language with well- defined semantics. Second, there can be different run-time environments for the execution of business processes. The interchange format shall serve as a common language from which the execution formats can be derived unambiguously, if possible even automatic.

To fulfil these purposes the interchange format must have a clear and precise semantics. The enterprise objects and the business rules are represented in OWL and SWRL. Because of the partially ambiguous business models the transformation is not automated: the business objects (user groups, product catalogue) have to be transferred into OWL and the rules into SWRL manually. However, the development of a semantic representation from the semi- structured representation of the business models is straightforward. The interchange model consists of two main ontologies (Figure 2): the enterprise ontology and the context ontology. The enterprise ontology describes the enterprise itself, the product catalogue, the user groups, the actions. The context ontology provides information about the users' session, like navigation path, historical events, current behaviour and interest.

This interchange model is used as the knowledge base to retrieve information about the user and his interests and to provide him with relevant information. For instance, if the system notices that a visitor has visited web pages about Frank Schätzing, criminal story and Cologne, he can retrieve from the database through the relations between the different topics, that the visitor might be interested in the book "Tod und Teufel". If another person visits the web page about "Tod und Teufel" and "Mordshunger" the system can assume that the person is interested about criminal stories from Frank Schätzing and can provide him with a proper list.

1) Enterprise Ontology: Enterprise ontologies have been developed also with the intention "to assist the acquisition, representation, and manipulation of enterprise knowledge;

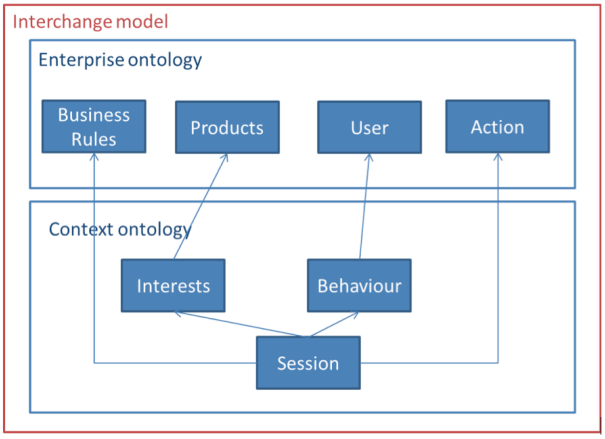

Figure 2. Interchange model. This figure shows the main concepts of the ontologies.

structuring and organizing libraries of knowledge [...]" [21]. Usually, enterprise ontologies are created to define and organize relevant enterprise knowledge like processes, organization structure and strategy [13].

Ushold et al. designed a particular ontology, the "Enterprise Ontology", which aims to provide "a collection of terms and definitions relevant to business enterprise to enable coping with a fast changing environment [...]" [21]. The TOVE (Toronto Virtual Enterprise) project is being carried out by the Enterprise Integration Laboratory (EIL) at the University of Toronto. It provides a generic, reusable knowledge model providing a shared terminology for the enterprise. While both ontologies focus on business processes, there are common semantic concepts in both projects [11].

We use the enterprise ontology as a basis, but extend it by some sub classes. As the business rules implement the business strategy, trigger various events and are one of the main drivers of an enterprise the business rules must be made explicit. This allows changing the rules immediately. Therefore, we add a concept business rules to the strategy part of the enterprise ontology. The rules themselves are expressed using SWRL, which combines OWL and RuleML [12].

Another important part of the enterprise are the products. Semantically enriched and precise product information can enhance the offering of information. Product information consists of product properties and the relationship between products. For the description of the product catalogue existing domain ontologies, like wine or pizza, can be taken. A meta level for a product ontology can be found in [16]. This meta level helps to create a product ontology for each enterprise. Figure 3 illustrates a simplified ontology describing books for our book store scenario.

To express the various behaviour patterns of a user, we use the organisation part of the enterprise ontology and added user to the existing concept "Stakeholder". For the analysis of the behaviour, in particular the shopping strategies, we rely on the different shopping strategies as proposed by [18]. They can be recognized by using different browsing patterns. To find the different page types Moe categorizes pages as category pages, product pages, home page or information pages. During

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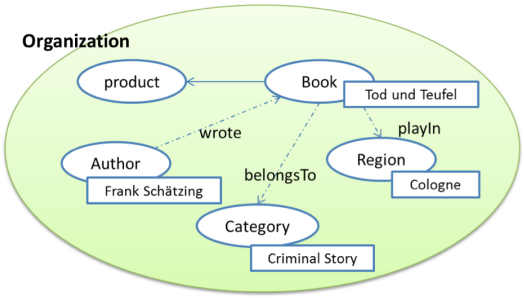

Figure 3. Simplified product description.

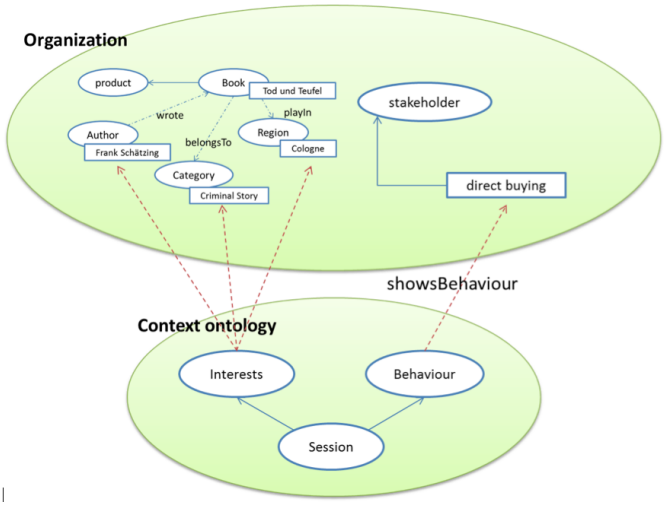

Figure 4. Relation context and organization ontology.

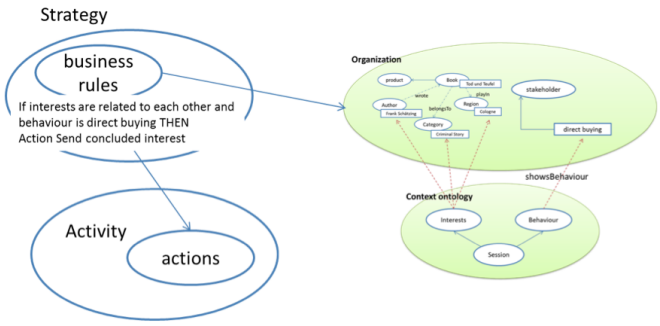

Figure 5. Business rules combining context and actions.

the user's visit the percentage is identified, how often he/she visits an information page, category page or product page. If the user visits informational pages more often, the shopping strategy is more likely to be a knowledge building. Whereas, a visitor who visits a lot of category pages, seems to follow the hedonic browsing strategy. These user categories are added to the enterprise ontology as sub classes of user.

There exist two main parts of adaptation: internal adaptation, and external adaptation. Internal adaptation supports the usability. Usability can be associated with the aspects: content, ease of use, promotion, made-for-the-medium, and emotion [2]. [4] identified the following internal adaptations: adaptation of content and services delivered by accessed pages, adaptation of navigation, adaptation of whole hypertext structure and adaptation of presentation properties. External adaptation means the context is used to adapt external applications, like newsletter or e-mail services. For the external adaptation, we use web services which are described using OWL-S [17].

2) Context Ontology: The behaviour and the user's interests can be analyzed while a visitor is navigating through a web site. This represents the situation of a visitor. According to Dey and Abowd [7], context is all information, which can be used to characterize the situation of an entity. Therefore, we use a context ontology which helps to interpret the users' current situations. This ontology consists of three main concepts: session, interest and behaviour.

As shown in Figure 4, the concepts *interests* and *behaviour* are linked to the organization ontology: the behaviour is related to the *Stakeholder*-concept and the *interests* concept relates to the product concept. During a session the links are continuously updated.

The ontology is split into two parts to distinguish between the static and dynamic parts. Whereas, the information provided in the enterprise ontology is more or less static, the context ontology provides dynamic and user specific information.

As business rules trigger events when a specific condition is met, rules combine both the context ontology and the enterprise ontology. So, rules use the whole knowledgebase.

We use rules to combine the context and the (re)actions. On the condition part of the rules the context is defined. This context is analyzed during run time by a rule engine. If a specific context is kept the rules trigger the appropriate actions. Figure 5 shows a simplified rule, combining the context with a service. In this case the rule expresses that if a visitor uses the direct buying strategy and is interested in a specific book, the visitor should get a list of concluded interests (in our case the book "Tod und Teufel").

If changes in the enterprise environment occur the business user is able to adapt the product catalogue and the business rules immediately (directly in the ontology or using the intermediate step of the semi-formal language).

C. Execution Model

In phase 3, parts of the interchange model created in phase 2 will be migrated into machine executable forms if necessary. As already described the interchange model can be used as a knowledge base, because the model helps to recognise the users' behaviour and interests and a system can retrieve relevant information in the knowledge base.

However, some parts of the model must be transformed into another executable representation. The interchange model contains information specified by the business people. But, it does not contain information about technical details, like cookie or session ids, what actions a user performed or which agent a user uses. This information must be expressed in a machine executable form.

In our system, we consider each request (action) that is sent by the visitor's browser to the content management system as an event. Each of those events is linked to a certain visitor and contains annotations that describe the requested content or the

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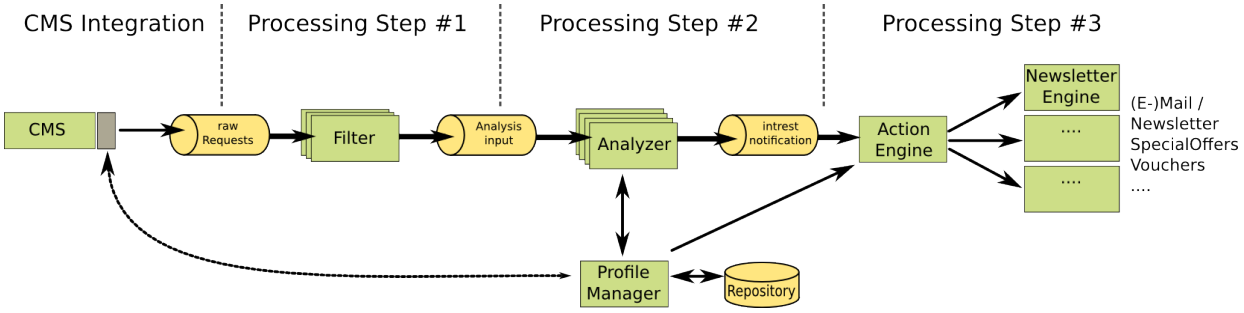

Figure 6. The used processing system with its components and the different processing steps.

requested action. The content annotation is stored in the CMS as meta information for the available content and is based on the concepts of the enterprise ontology. An event thus has the following simplified structure:

UserCookieID	e.g.	156978GH
PageTags	e.g.	author:FrankSchaetzing
PageType	e.g.	productDetail
RequestAction	e.g.	addToShoppingCart
UserAgent	e.g.	Firefox
SessionID	e.g.	S47111147

These events are processed in three steps (Figure 6) where the first step filters the requests to remove requests that are for example generated by search engine bots. In the second step the requests are analyzed with the help of a set of rules that extend the context ontology of the corresponding user as needed. For example, for the event shown above, a rule would detect the adding of the particular wine to the shopping cart and would thus add a concept to the context ontology that represents the interest of this user in the given wine. The third processing step allows the rule based triggering of external action like sending an email to a customer. However, this part will not be discussed in further detail in this paper.

IV. Status of the Implementation

We use the presented combination of semantic technologies with event processing systems in a dynamic website personalization engine which we are currently developing in a joint research project with the Wyona AG (www.wyona.com). The aim of this engine is to build up a context ontology for a website visitor while he/she is browsing through a website like for example an online shop. The generated context ontology is used to support the user in his search for products that suite his interests and to generate personalized advertisement campaigns.

Due to this outlined process, a context ontology is built for each user while she/he is still browsing through the website. To allow the CMS to utilize the gathered information, a profile manager provides a simple query interface. The CMS can use this interface to retrieve related content to the current users' request. For such a query, the CMS specifies the current visitors ID together with the tags that annotate the page that the user currently requests. The profile manager uses this information to deduct tags from the context ontology together with the enterprise ontology as discussed in Section 3.2.2. The results are handed back to the CMS which in turn uses those tags to select content that might be interesting for the current visitor. Thus, our current realization approach follows the concept of event-driven architectures to realize a rapid processing of the visitors requests. With the help of the aforementioned process for the ontology and rule definition based on a simple table based schema, we aim to allow non-IT specialists to change and optimize the behavior of the fairly complex processing system.

V. Conclusion

As e-commerce becomes the preferred way of doing business an enterprise must be able to adapt their e-commerce immediately when changes occur. We provide an ontology model which enables business users to express their knowledge about their products, user groups, actions and business rules. If changes occur the business user can adapt the business rules and the business objects immediately (directly in the ontology or using the intermediate step of the semi-formal language).

The 3-phase procedure is currently done manually however we are going to develop a system, with which an automatic transformation is possible. We intend to use the resulting descriptions as the knowledge base for a self adapting web shop system to verify the usefulness of the generated information. Furthermore it is planned to evaluate the usability of the presented concepts together with business users.

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References

[1] T. Allweyer, "Die Organisation des Wissens, Wie japanische Unternehmen eine brachliegende Ressource nutzbar machen." Witten, W3L GmbH, 2. Nachdruck, 2007.

[2] R. Agarwal and V. Venkatesh, "Assessing a Firm's Web Presence: A Heuristic Evaluation Procedure for the Measurement of Usability", Information Systems Research, vol. 13, No. 2, 2002, pp. 168 - 186.

[3] P. Brusilovsky and M. T. Maybury, "From Adaptive Hypermedia to the Adaptive Web", In Communications of the ACM, 45(5), 2002, pp. 31-33.

[4] S. Ceri, F. Daniel, M. Matera, and F. M. Facca, "Model-driven development of context-aware Web applications", ACM Trans. Internet Technology, 7(2), 2007.

[5] F. van Harmelen and D. L. McGuinness, Editors, "OWL Web Ontology Language Overview", W3C Recommendation, Available at: http://www.w3.org/TR/owl-features/, 2004, Retrieved: 26.08.2012.

 ISBN: 978-1-61208-240-0

[6] I. Horrocks, P. F. Patel-Scheider, H. Boley, S. Tabet, B. Grosof, and M. Dean, "SWRL: A Semantic Web Rule Language Combining OWL and RuleML", W3C Member Submission, Available at: http://www.w3.org/Submission/SWRL/, 2004, Retrieved: 26.08.2012.

[7] A. K. Dey and G. Abowd, "Towards a Better Understanding of Context and Context-Awareness", In Proceedings of CHI2000: Conference on Human Factors in Computing, The Hague, The Netherlands, 2000.

[8] D. Feldkamp, K. Hinkelmann, and B. Thönssen, "Kiss-Knowledge-Intensive Service Support: An Approach for Agile Process Management", Proceedings of RuleML 2007, 2007, pp. 25-38.

[9] "Esper - Complex Event Processing", Product Web Page, Available at: http://esper.codehaus.org, Retrieved: 26.08.2012.

[10] P. Fingar, "Component-based Frameworks for E-Commerce", Communications of the ACM, Vol. 43(10), 2000, pp. 61-66.

[11] C. Sechlenoff, R. Ivester, and A. Knutilla, "A Robust Process Ontology For Manufacturing Systems Integration", In Proceedings of 2nd International Conference on Engineering Design and Automation, Maui, 1998.

[12] "The Rule Markup Initiative", Available at: http://ruleml.org, Retrieved: 26.08.2012.

[13] A. Gomez-Perez, M. Fernandez-Lopez, and O. Corcho, "Ontological Engineering, with examples from the areas of knowledge management, e-commerce and the Semantic", Springer, London, 2004.

[14] C. Henbury, "Two definitions of agility", Available at: http://www.cheshirehenbury.com/agility/twodefinitions.html, 2006, Retrieved 26.08.2012.

[15] V. Hrgovcic, W. Utz, and R. Woitsch, "Knowledge Engineering in Future Internet", In D. Karagiannis, Z. Jin (Eds.) Knowledge Science, Engineering and Management, Springer, Vienna, 2009.

[16] T. Lee, I. Lee, S. Lee, S. Lee, and D. Kim, "Building an operational product ontology system", Electronic Commerce Research and Applications 5, 2006, pp. 16-28.

[17] D. Martin, M. Burstein, J. Hobbs, O. Lassila, et al., "OWL-S: Semantic Markup for Web Services", W3C Member Submission, Available at: http://www.w3.org/Submission/OWL-S/, 2004, Retrieved: 26.08.2012.

[18] W. M. Moe, "Buying, Searching, or Browsing: Differentiating Between Online Shoppers Using In-Store Navigational Clickstream", Journal of Consumer Psychology, 13(1&2), 2003, pp. 29-39.

[19] N. F. Noy and D.L. McGuinness, "Ontology Development 101: A Guide to Creating Your First Ontology", Stanford Knowledge Systems Laboratory Technical Report KSL-01-05 and Stanford Medical Informatics Technical Report SMI-2001- 0880, 2001.

[20] A. W. Scheer, O. Adam, A. Hofer, and F. Zangl, "Nach Cost Cutting, Aufbruch durch Innovation", In IM Fachzeitschrift für Information Management and Consulting, vol. 18, Sonderausgabe, 2003.

[21] M. Ushold, M. King, S. Moralee, and Y. Zorgios, "The Enterprise Ontology", The Knowledge Engineering Review, Vol. 13, Special Issue on Putting Ontologies to Use, 1998.

[22] R. Woitsch, D. Karagiannis, D. Plexousakis, and K. Hinkelmann , "Plug your Business into IT: Business and IT-Alignment using a Model-Based IT-Socket", eChallenges e-2009 Conference (eChallenges 09), Istanbul, IOS Press, 2009.

[23] B. Von Halle, "Business Rules Applied, Building Better Systems Using the Business Rules Approach", Wiley and Sons, New York, 2002.

 ISBN: 978-1-61208-240-0