# Distributed Analysis of Financial and Logistic Services for Manufacturing Supply Chains

Markus Rabe[1], Heiko Weinaug[1]

[1]*Fraunhofer IPK, Pascalstr. 8-9,10587 Berlin, Germany,*
*{markus.rabe,heiko.weinaug}@ipk.fraunhofer.de*

**Abstract**

The FLUID-WIN project is developing new business process models and ASP based software tools to enable the smooth integration of logistic services and financial services into a B2B manufacturing network. A significant part of this project is a field study, which involves manufacturers and service providers from many European countries. The goal of the field study is to deliver a generalized model of the as-is-processes, and to identify the economic potentials as well as the barriers in terms of information availability, trust, required process changes, cost etc. Due to the high number of disciplines that have to be involved in this study (manufacturing order control, logistics, banks, factoring, ASP services, …) and the many languages and cultures found in the enterprises under investigation, a systematic approach was required in order to lead to one single and usable result.

**Keywords**

Supply Chains, Distributed Modelling, Financial and Logistic Services

## 1 Introduction

In order to stay competitive, many European companies started to purchase from the far east, which fact endangers the health of the European economy. The new situation of the EU-25 in 2004 has opened new chances: Eight of the ten new member states can be considered "former east European" (FEE). They offer products at lower prices, and have advantages with respect to far east competitors in terms of skills, geographic distance and comparable culture and background.

Today, logistic services are not integrated with the supply networks. This was not critical as long as suppliers and customers have been geographically close, but it receives utmost importantance for FEE companies that target to address the West-European markets. Analogously, there is merely no integration between the supply networks and financial services.

The goal of the FLUID-WIN project is to provide easy-to-adopt solutions for the quick integration of FEE suppliers into existing manufacturing networks. FLUID-WIN will develop means for a B2(B2B) service, based on Application Service Provider (ASP) technology. This new service will allow to attach a service business (such as logistics or financial services) to a manufacturing network that runs already a Web-based B2B network (fig. 1).

The project follows a technology-pull approach. Therefore, the project undergoes an *analysis phase* in order to define the required business processes and software, and to evaluate the economic potentials as well as the barriers to implement such new processes. During this study, companies from the three different domains manufacturing, logistics and finance are investigated by four consultant companies. The challenge is to integrate the different languages and cultures, experiences and backgrounds as well as different geographical locations of the interviewees and consultants into one consistent concept. Hence, a Template Model was developed in order to document, systematically, within one single consistent model all information and requirements which have been detected.

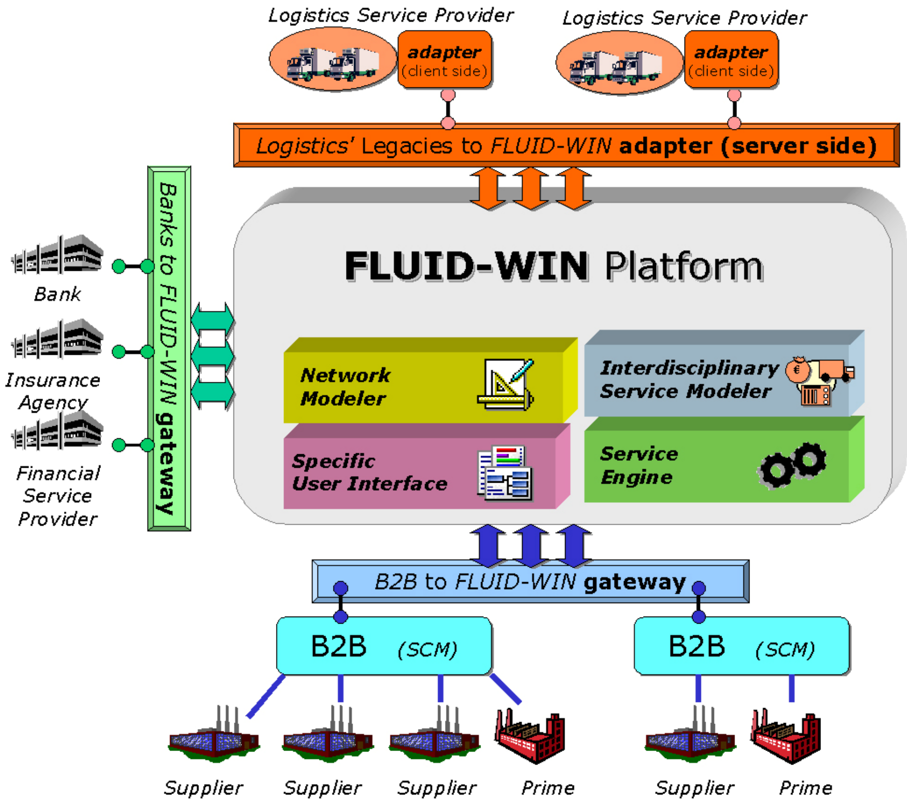


Fig. 1: FLUID-WIN Platform overview

## 2 Relation to Existing Theories and Work

The focus of this paper is on the *analysis* of manufacturing networks with supportive services. The methods and tools for the *operative integration* of such services are not considered here. Consequently, also considering the limited space available, this short state of the art is limited to the underlying modelling method (without discussing alternative modelling approaches), related issues of interoperability, selected approaches of value chain models and previous work on distributed business process models.

In order to follow the requirements of a *process oriented modelling* procedure, the Integrated Enterprise Modelling (IEM) Method [Mertins and Jochem 1999] is chosen as the basic modelling technique, with the tool MO²GO for its efficient use. This method is very flexible, and the tool supports the application specific definition of resource sets, evaluation schemes etc.. Furthermore, through the object-oriented approach of the IEM the use of reference classes is very efficient, simplifying the task of defining common terms, structures and attributes.

The aim of *interoperability* approaches is the seamless interaction of systems without (or at least with low) additional effort. Enterprise interoperability is seen as the capability of a single enterprise to manage (1) all internal processes and systems without frictional loss in their communication and (2) to be able to seamlessly interact with other enterprises for various purposes. Hence, enterprise interoperability covers various aspects and is often interpreted in different ways and with different expectations. In order to structure this field, the InterOP Network of Excellence project proposes a systematized interoperability framework (fig. 2). This framework has three basic dimensions:

- The framework defines the interoperations that can take place from the enterprise *interoperability concerns* (or viewpoints) data, services, process and business. The categorisation is mainly based on the ATHENA Technical Framework. The objective of an enterprise is to realise business. To realise business, processes are needed. Processes employ services which in turn need data.

- The dimension *interoperability approaches* is given by ISO 14258 [ISO 1999]. Two systems are considered as “integrated” if there is a detailed standard format for all constituent components. In the “unified” approach there is a common meta-level structure across constituent models, providing a means for establishing semantic equivalence. In the “federated” approach models must dynamically accommodate rather than having a predetermined meta-model.
- Many interoperability issues are specific to particular application domains. Nevertheless, general *interoperability barriers* can be identified. The conceptual barriers relate to the syntactic and semantic differences of information to be exchanged as well as the expressivity of the information. These barriers concern the modelling at the high level of abstraction (such as for example the enterprise models of a company) as well as the level of the programming. A technological barrier is the lack of a set of compatible technologies which prevent collaboration among two or more systems. Hence, technological problems relate to the incompatibility of information technologies. The organisational barriers relate to the responsibility and authority.

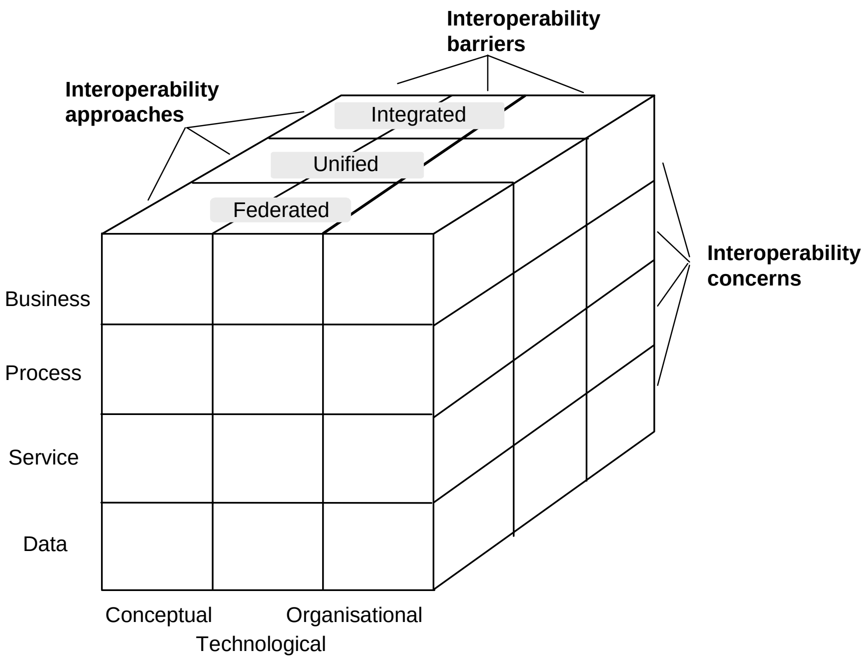


Fig. 2: Enterprise interoperability framework [InterOP 2006]

ATHENA (Advanced Technologies for interoperability of Heterogeneous Enterprise Networks and their Applications) is an Integrated Project co-funded by the European Commission. Building on its vision statement "By 2010, enterprises will be able to seamlessly interoperate with others", ATHENA aims to enable interoperability by providing a comprehensive framework on interoperability. The ATHENA results span the full spectrum of interoperability from technology components to applications and services, from R&D to demonstration and testing, and from training to the evaluation of technologies for societal impact. A specific point of interest is the provision of a scheme for designing and implementing cross-organisational business processes (CBP) [Greiner et al. 2006]. Within the 3 levels business, technique and execution it describes methods addressing different stakeholders involved. For example, the exchange of businesses process models that were developed in different modelling tools or by different persons is explained. Furthermore, a consistent procedure is proposed from the modelling process to the simulation as well as the execution of these processes [ATHENA 2005]. In an aircraft cross-organisational example it was demonstrated how the business processes can be modelled by different participants, how these processes can be simulated in the simulation environment Nehemiah and how the resulting processes can be directly used and implemented in SAP.

The importance of the interoperability for research as well as for industrial business can be seen in the number of organisations which aim to handle various aspects of this topic. The InterOP NoE has established a Virtual Laboratory on Enterprise Interoperability – VLab [Bourrières 2006] with various regional sections across Europe, e.g. the German forum for interoperability (DFI). Also, the ATHENA IP has initiated an open, neutral and independent Enterprise Interoperability Centre (EIC). The EIC is focused on delivering practical specifications defining interoperability requirements and profiles for business processes.

There are few commonly accepted approaches for models in the manufacturing supply network area. The *Supply Chain Operations Reference* Model (SCOR) was designed for the effective communication among supply chain partners [Supply Chain Council 2006]. SCOR is a reference model, as it incorporates elements like standard descriptions of processes, standard metrics and best-in-class practices. Furthermore, SCOR has turned out to be a good base for enhanced models [cp. Stich and Weidemann 2002]. However, still SCOR has no broad and common acceptance in industries, and the authors have experienced in their studies that most of the companies under consideration – especially the smaller ones – did not have any skills with respect to SCOR.

The *Value Chain Operations Reference* Model (VCOR) [VCG 2006] follows a broader and more integrative approach than SCOR and tries to support the seamless and efficient management of distributed research, development, sales, marketing, sourcing, manufacturing, distribution and other processes. Provided by the Value Chain Group (VCC) the VCOR version 1.0 was a support tool to integrate process flow interdependencies across the product lifecycle, supply network and customer relationship domains, backed by a common language and standard metrics. The current version 2.0 defines additional process flow interdependencies across tactical and operational level processes. For instance, the new finance and information process covers categories such as plan finance, plan information, govern finance, and govern information. Summarizing, VCOR has a more substantial approach than SCOR. However, VCOR has not even reached the industrial awareness of SCOR.

The need of taking into account different models is the result of slightly different objectives or different requirements for enterprise models. The synchronisation and management of different distributed enterprise models (SDDEM) is required under several aspects (e.g. consistence of information modelled in different models, responsibilities for modelling and model maintenance, security of model information, extraction of knowledge represented in the model, configuration of IT systems across organisations, flexible adaptation to different enterprise networks, etc.) [Berio, Mertins and Jaekel 2005].

The authors have developed an approach for the analysis of supply chain networks, which was based on Reference Models and a Guideline with several components [Rabe and Weinaug 2005]. This approach has been successfully applied for the analysis of requirements and potentials in regional supply networks, making the business processes of networks from Italy, Spain and Poland comparable and determining the consequences for new business processes and their software support [Rabe and Mussini 2005].

# 3 Research Approach

During the Full Field Study about 30 companies from the three different FLUID-WIN domains manufacturing, logistics and finance have been investigated. The major challenge was to integrate the different languages and cultures, experiences and backgrounds as well as different geographical locations of the interviewees and consultants into one consistent concept. Furthermore, the separate interview results had to be integrated into one common view – called General Model – which describes the domain dependencies and cross-organizational workflow.

Consequently, three kinds of models were used during the field study:

1. The *Template Model* gave orientation during the interview. It is a guide for relevant processes and topics to be investigated by the interviewers. Furthermore, it is the base for modelling the As-Is Models. All consultants (R&D partners) use the same Template Model as the base for modelling, through all the domains under investigation. This ensures the comparability and analyzability of the modelled processes.
2. The *As-Is Models* are the results of the interviews and reflect the current situation, the wishes and gaps of each interviewed company, separately. All As-Is Models are based upon the same Template Model, but include interview specific processes as well as the identified user requirements, restrictions and potentials.
3. The *General Model* is the result of merging all As-Is Models. Therefore, it is one unique, assembled, multidisciplinary model and gives an overview of the processes in all three sectors and their relations.

Later, the *B2(B2B) Model* will be developed which describes the reference To-Be processes and new methods, and is therefore the base for the programming tasks in the project.

# 4 Results

## 4.1 Template Model Structure

The Template Model (fig. 3) consists of different areas which explain the detailed processes and dependencies of manufacturing companies ("Company I" and "Company II"), logistic service providers (LSP) and financial service providers (FSP). The same Template Model can be used for all interviews, independent of the interviewed domain. The interviewer simply uses the part of the model which reflects the domain of the interviewee.

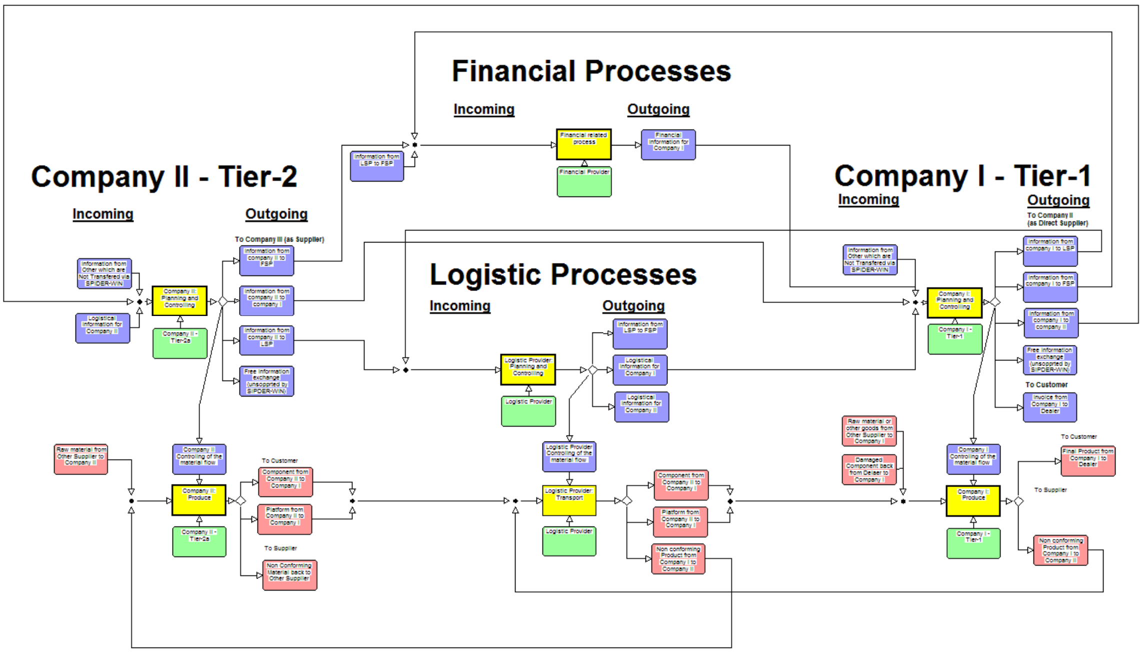


Fig. 3: IEM Template Model for the Supply Chain and Related Services (Top Level)

The challenge is to integrate the different languages and cultures, experiences and backgrounds as well as different geographical locations of interviewees and consultants into one consistent concept. Therefore, a specific way of handling the different models is initiated in order to ensure the consistency and comparability of the partial models as well as the possibility to merge them into one General Model. The modelling is performed in the following sequence:

1. Separate Modelling of LSP, FSP and Manufacturing enterprises by domain responsible consultants, leading to twelve enterprise models
2. Domain oriented merging of the enterprise models which belong to a common supply chain
3. Integration of the domain oriented models into one unique General Model
4. Revision by the manufacturers, especially the content related to FSP and LSP collaboration
5. Revision by LSP/FSP, especially in the area of manufacturer collaboration

## 4.2 Domain Oriented Parts of the Template Model

The *manufacturing domain* part of the template model has several specifics. First, there is no single manufacturing domain. The domain processes symbolize different tier levels of a supply chain. This fact has relevance for the merging of the different enterprise specific models. Furthermore, with this design the bridging functionality of the logistic domain in the physical goods transport can be precisely described. This part of the template model could be based on the results of the SPIDER-WIN project [Rabe and Mussini 2005], but had to be amended by logistic and finance relevant activities within the manufacturers' workflow.

The *financial domain* template gives room for different services that are provided by banks and related service providers in the trade finance sector and can be adapted to include the actual details of the documents and decisions taken by each bank. The template identifies the general process that all banking clients (manufacturing or logistics) go through since from the bank's perspective they are expected to be tackled in the same way. There are paths in the model through which clients pass only once or rarely (like once a year) and others which are repeated for each and every transaction of the same type.

The *logistic domain* template presumes that the logistic processes within the network are already managed by an external logistic services provider. In the case of 3PL and 4 PL logistics, it is important to apply IT solutions that ensure continuous process monitoring and transparency as well as information flows in an accurate way providing hereby effective work coordination among all parties.

## 4.3 Class Structure

The aim of the reference class structures is to support the merging, comparison and evaluation of the different enterprise specific models by a clear and common wording for project domains. The information class structure is mainly based on the xCBL standard. Especially in the manufacturing domain the SCOR scheme was used for the definition of the terms and the content of the actions (SCOR compliant processes modelled as yellow rectangles in the IEM methodology). The FLUID-WIN Template Model was designed to be compliant with the version 7 of the SCOR scheme. However, SCOR does not fit in detail to the financial and logistic domain.

The information categories are divided into the two main classes "Company-Internal Order" and "Cross-organizational Information Exchange" (fig. 4). Both classes refer to an enterprise level. "Cross-organizational Information Exchange" means that a single enterprise can use the subclasses of the information categories within data exchange with other companies. The "Company-Internal Order" information categories are used within the company, only.

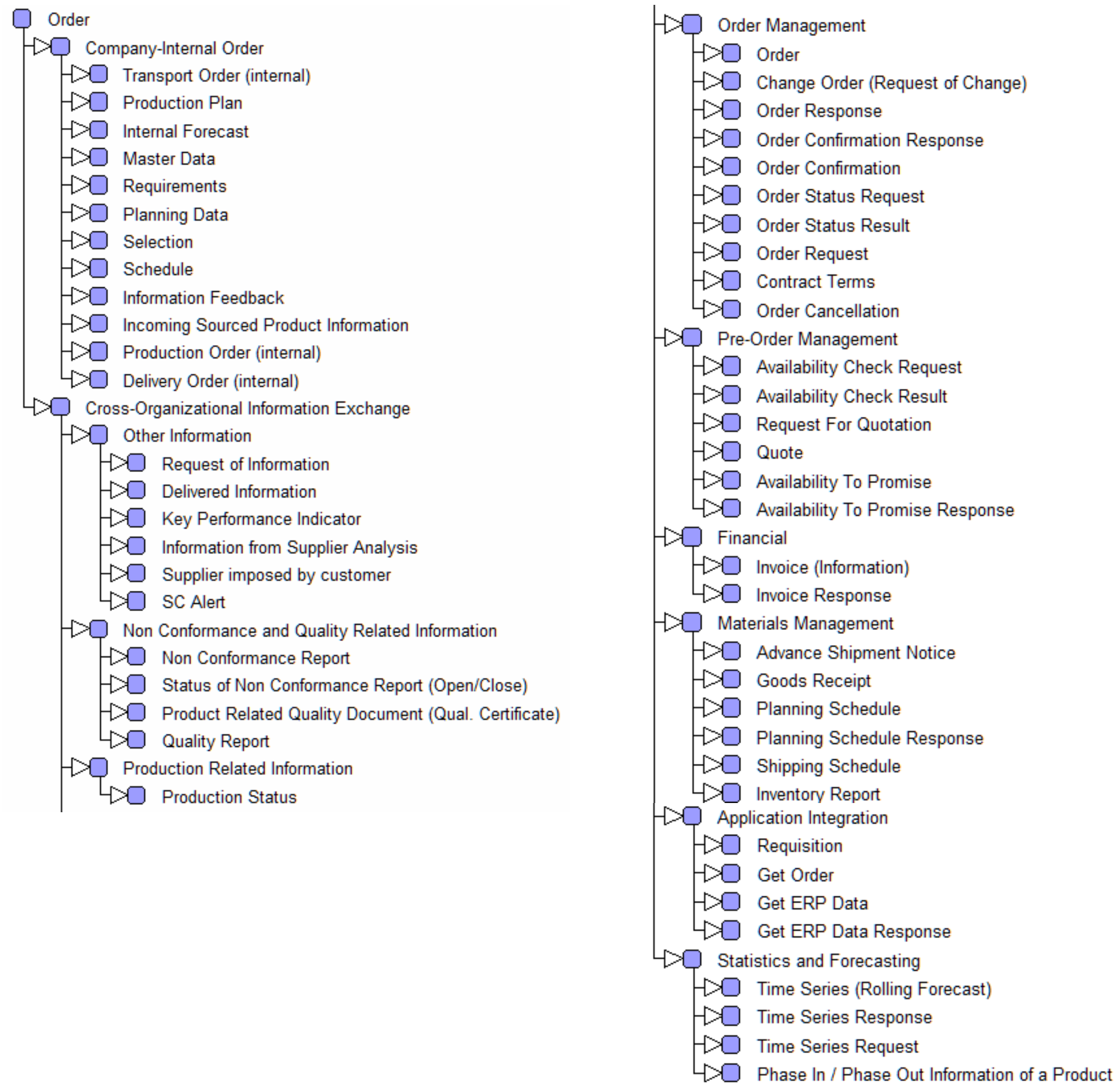


Abb. 4: Information class structure (orders) of the FLUID-WIN Template Model

# 5 Conclusion

The study has demonstrated, that a well-adapted reference model is an important base for the conduction of cross-enterprise business process studies. The additional effort required for the preparation and adaptation of the reference model was by far overcompensated, as the result was a smooth and efficient field study, leading to transparent and comparable results. Especially, taking into account the communication barriers induced by different application domains, different languages and different types of products, this systematic and simultaneously open approach enabled an extremely quick and efficient elaboration of a very large and complex model.

The IEM method has proved to be an extremely efficient tool that allows consultants from different countries and different disciplines to cooperate straight forward, establishing a clear common view of a multidisciplinary research field. Specifically, it was helpful to switch terms between two languages (the native interview language and English), providing glossaries of the company specific terms as a side effect. The reference class trees, adapted for the study and then carefully maintained through the interview phase significantly improved the development of models with comparable structures, without urging the interviewers into pre-defined processes.

Due to its flexibility, IEM allows to integrate existing standards in the model. This has been successfully done with the SCOR for the manufacturing domain of the model, while SCOR showed no relevant support for the integration of the logistics and financial service processes. Also, SCOR was not very helpful in the interviews themselves, as only rarely the interviewees have been aware of SCOR in sufficient detail.

Based on the study results, a "general model" of the as-is-situation was extracted, which describes general and specific process elements, systematically documented within one single, consistent model. It contains the SCOR compliant process names, specific "information categories", relations between processes and information categories and further application rules.

Currently, the authors are preparing guidelines for the use of IEM for distributed cross-enterprise studies which generalize the results.

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