PROCESS MODELLING AS BASIS FOR DEVELOPMENT AND INTEGRATION OF NEW INFORMATION SYSTEMS

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ABSTRACT

The European Commission's objective for the next ten years is to shift the balance between the modes of transport by revitalizing the railways, and promoting the maritime and the inland waterways, and linking up the different modes of multi-modal transport.

The development and integration of efficient transport management systems is a premise in order to enable satisfactory information and documentation exchange in multi-modal transport chains.

In this paper we address methods developed to identify business processes, process modelling, and process re-engineering for the development and integration of new information systems. The methods developed is general, though the examples are based upon the D2D (Door-to-door) project, an EU funded research- and demonstration-project. The scenario in focus is the distribution of tractors from European manufacturer to Australian dealer. The paper describes a step-by-step approach to logistics process improvement with special focus on applying process modelling as a tool to analyse the current state, and document new and improved / re-engineered solutions.

The authors have through a number of projects worked with process modelling methodology and system integration in the transport industry in general, and the shipping industry in particular.

References

[1] Hammer, Michael, Champy, James (1993). *Reengineering the Corporation: a manifesto for business revolution.* New York, Harper Business.

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[4] Ericsson (1993). *Business Process Management.* Gothenburg, Sweden. Ericsson Quality Institute.

1. INTRODUCTION

Process modelling and the development of new business models make up a wide-ranging topic. The topic has attracted a great deal of interest in the course of the past 10 to 15 years. Every year, a huge number of books, academic journals and popular magazines that illustrate the focus and the rapid developments in these areas are published. Among the best-known management theories are Total Quality Management (TQM), Business Process Re-engineering (BPR), Benchmarking, and Business Process Management (BPM). In all these theories have business processes played a major role.

BPM permits strategies to be efficiently put into practice. BPM means focusing on, and understanding what gives results and value to one's customers. An important part of BPM consists of developing and using process models of a company's own fields of activity as a basis for training, communication, working routine descriptions, improvement initiatives, quality control, system development and more.

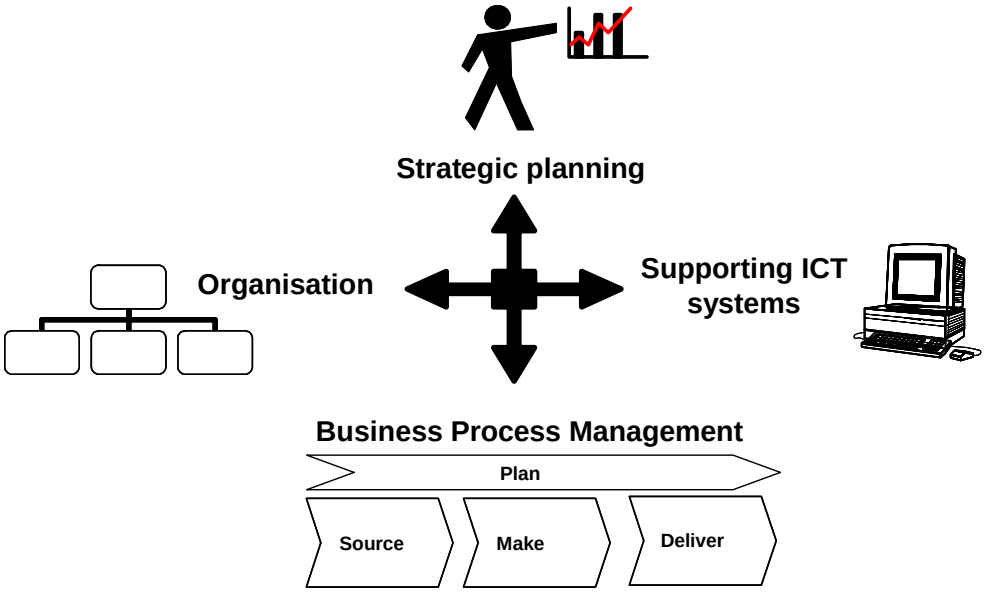


Figure 1: Business Process Management balance strategic objectives, processes, ICT and organisation

In any business, the overarching goal must be to balance the organization, working processes, the supporting ICT (Information and communication technology) systems and resources. Business process management will monitor and adjust the processes, organization and ICT in order to meet the objectives outlined in the strategic planning.

In the context of logistics and integration of multi-modal transport chains, several participants have their own individual roles to play, and the ability to deliver good performance is pending on each participant's understanding of the total chain including interfaces and communication between the different actors. The integration of actors in a logistics chain can be a challenging task, and the challenges are similar to those addressed by Business Process Management. In order to be able to create integrated total solutions to one's customers in a logistics chain, it is essential to survey the scope of services offered, and the degree of cooperation and integration with these customers.

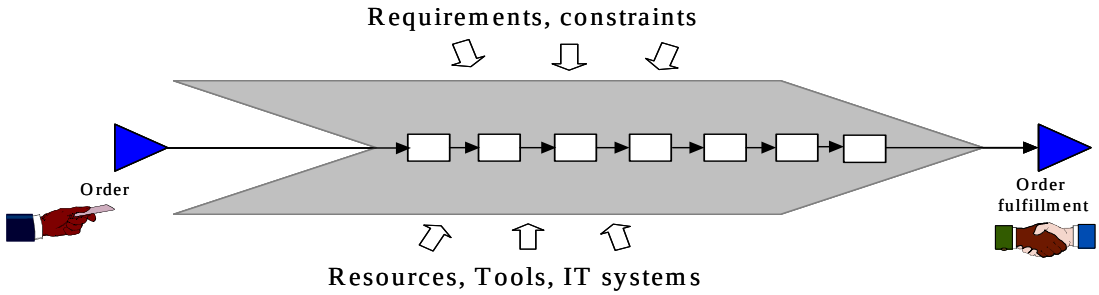
One way to achieve good integration and transparency between actors in a logistics chain is integration of transport chain management supporting systems. Today many actors use stand-alone systems and send information by e-mail and fax to the other actors in the transport chain. This is one of the major reasons to low overall transport chain performance related to asset utilization, fleet optimisation, responsiveness, and information quality. Integrated systems will improve the information exchange in the logistics chain and hence its performance.

This paper addresses these challenges by showing a way to employ process modelling to support the analysis and development of a company's position in a logistics chain through system development and integration.

2. PROCESS MODELLING

There are several definitions of the term "Business process". According to Ericsson [4], a business process is normally defined as a chain of logical connected, repetitive activities that utilizes the enterprise's resources to refine an object (physical or mental) for the purpose of achieving specified and measurable results / products for internal or external customers. Hammer [1] defines a business process as a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer. Andersen [3] presents an emerging view that a process is a number of roles collaborating to achieve a goal and an organized collection of business behaviour that satisfies a defined business purpose, performing according to specified targets. Andersen's view fits better to "the third wave" as described by Smith & Fingar [2] that addresses a high degree of dynamics in organizations and business processes enabling fast response to changes to markets, customer requirements, and strategy.

1. A process is an interrelated series of activities that convert business input into business output with a value that a customer is willing to pay for



2. A process has a customer (internal or external) and it crosses organisational borders

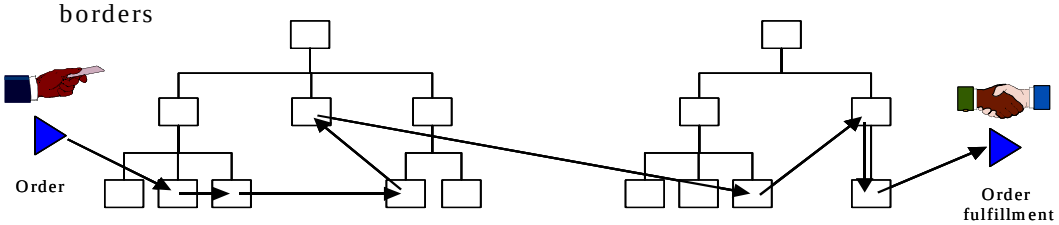


Figure 2: Process definition

Process modelling may be applied for several purposes. Some examples are strategy development, scenario analysis, process improvement, process reengineering, process management (TQM/ISO) and performance measurement, which address different aspects and initiatives in business development.

Other reasons for process modelling are related to logistics and supply chain management that focus on operational analysis, logistics cost modelling and simulations, logistics set-up and transport chain analysis, and integration of actors in logistics chains as well as basis for ICT development, which is the focus of this paper.

Andersen [3] further presents a set of reasons for viewing the business processes as the unit of analysis. The reasons are among others:

- Every single process has an internal or external customer - focusing on the process ensures a better focus on the customer.
- By defining process boundaries and the suppliers and customers of the processes, better communication and clearer requirements specifications are achieved.
- By managing complete processes that run through many departments rather than individual departments, the risk of sub-optimization is reduced
- Managing processes provides a better foundation for controlling time and resources

These arguments are all valid for analysing the logistics chain as a whole. In the context of system development and integration, defining the process boundaries and the suppliers and customers of the processes is of special importance, because it addresses the basis for better communication and enlightens different requirements between the actors in a logistics chain.

2.1. Presentation & Tools

Process models may be presented in several ways, and many business standards have been promoted. In the field of logistics, there is however no obvious alternative. We have studied the Supply Chain Operations Reference model (SCOR) with its Supply Chain Management approach as one, but have chosen to apply Porter's value chain model that highlights a sequence of core processes in the centre with an adjacent set of management and support processes.

There are basically two approaches to process modelling. In the earlier times the main approach was to develop *process maps* that were applied as illustrations supporting descriptive text. Illustrating the process and improve communication of it, would in many cases reduce required documentation considerably. Following the developments in IT, and the need to identify the real business requirements for IT development and implementation, a market for more advances modelling tools evolved.

These tools enable *modelling* of several aspects of a business. A modern *business model* will not only show process maps, but also contain description and sub-models of strategy development, performance measurement, organisation, ICT and others. The ability to show

several business aspects and how they relate, in one single model is, as we see it, the main advantage of an advanced and extensive process model.

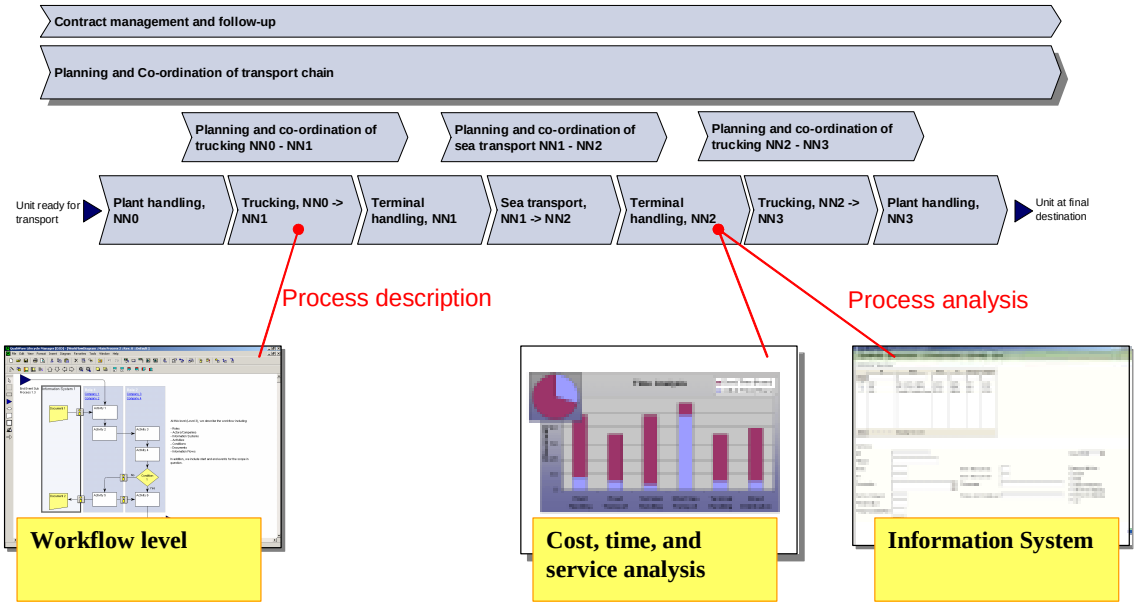


Figure 3: An advanced business process model can include detailed process description, process analysis and sub-models of e.g. Information Systems and Organisation and how they relate.

2.2. Method

The literature contains many methodologies or "guidelines" for performing process modelling and analysis projects. Based on experience gained through several projects we have developed a simple 3-step method. The method comprises the preparation, analysis and presentation steps with a strong emphasize on iteration, especially in the analysis phase. Structuring collected data ignites discussions and feedback that will require more data collection, restructuring and analysis.

In the *Preparation phase* we scope the project and its objectives by setting boundaries and identifying the main actors and stakeholders along the process subject to modelling. We also describe how to select suitable references to be used in the project, and how to develop the process model(s), as well as build and mobilise a project team and develop a progress plan. An important challenge is to find the best people to form the project team. Of special importance is that they represent a broad knowledge to the area of focus in the project.

The *analysis phase* consists of data collection, structuring and modeling (visualization) of the AS-IS-situation (if relevant). AS-IS analysis often requires field studies and interviews with actors along the chain. An AS-IS model will facilitate a discussion on strengths and weaknesses of the existing process. We stress that not too much emphasize is put on describing the AS-IS situation. The main objectives of the project will always be to improve the chain performance and hence should resources be spent on analysis and improvement work, such as defining needs and requirements to re-organisation and re-engineering of business processes, system development and integration. The main

deliverables of the analysis phase is an AS-IS and a TO-BE model. The TO-BE model may in turn serve as basis for defining requirements to new ICT solutions. New/re-engineered solutions must be validated

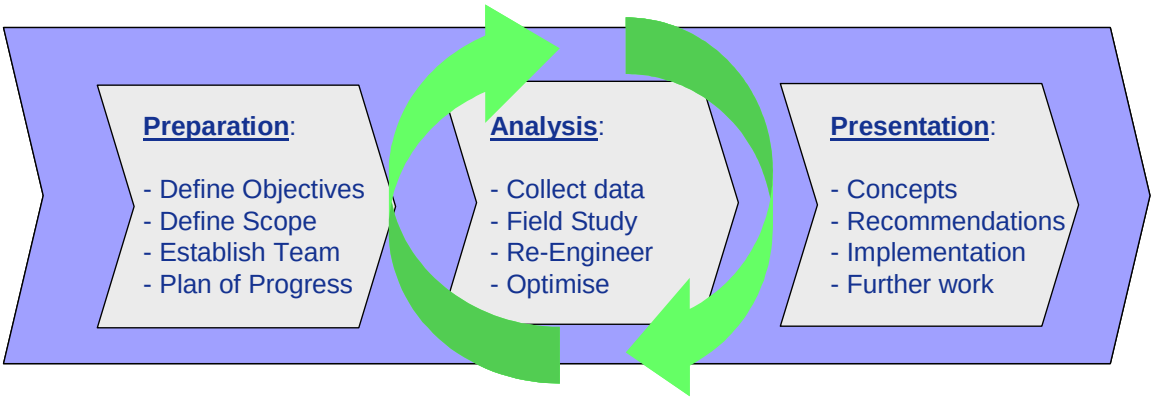


Figure 4: 3-step approach to process modeling and analysis

Presentation and communication of the process model is paramount. The goal is to ensure that people involved in the process, all stakeholders, understands the concepts and recommendations. Some important elements are roles, activities, information flow and information systems as well as cargo flow. Visualisation of these elements will communicate how actors along the chain will co-operate and apply the new ICT solutions to increase chain performance.

One reason for using advanced modelling tools are easy *updating* and *management of the improvement* of the process. They are also more capable of illustrating complex relationships and reuse of information-elements in further work and new initiatives to improve performance. Good presentation functionality such as html- and report generators are also included.

2.3. Modelling approach

We normally structure the process models in a hierarchical way with increasing levels of detail, from the overall business model to detailed activity descriptions. The illustration show an example on how a process can be described using both processes and workflow descriptions.

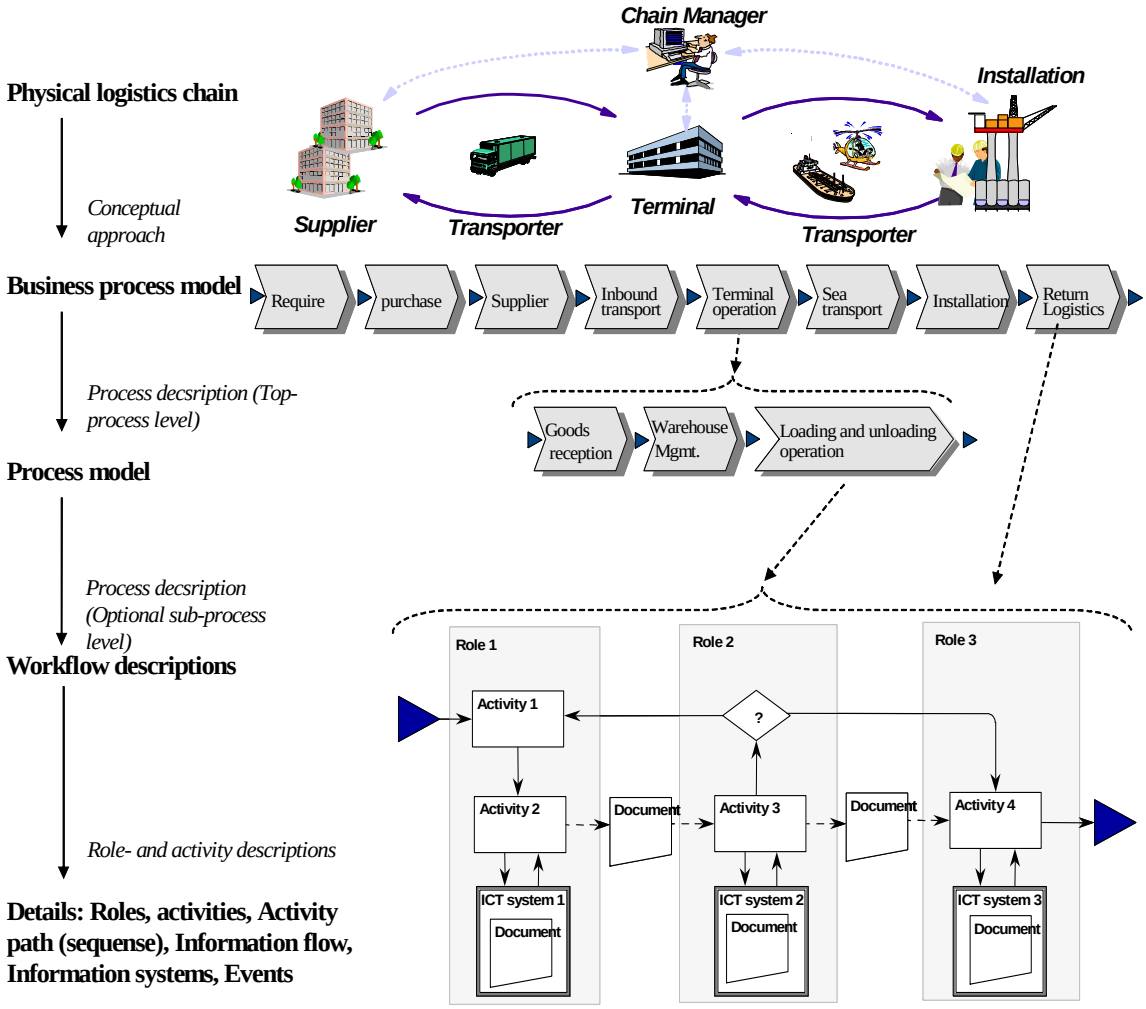


Figure 5: A hierarchal approach to process modeling

A top-down approach is often used in process modelling. First data about the physical logistical chain must be gathered. This data is used to create a conceptual model in order to understand the logistical chain and to identify scope of the process modelling. A business process model is established based on the scope of the project and includes the top-level processes. These top-level processes can be used to describe the different actors and/or main business units. Equal for all top-level processes is that they cover the different steps in the physical logistics chain.

A top-level process can be further detailed by another sub-process level or by a workflow description according to the model's level of complexity. A process model will preferably not have more than 4 levels in order to ease the understanding (better navigation and overview) of the model.

Workflow description consists of roles, activities, information systems, and events in a sequence which illustrates how the process works. The level of detail is only limited by the scope of the project, but experience show that unnecessary details should not be included. A process model could also be supported by a matrix with additional information such as role details, work descriptions, information system descriptions, and message/document descriptions.

3. CASE

The case is based upon the D2D (Door-to-door) project, which is an EU founded research and development project. The objectives of the project were demonstration of an integrated management and communication system for door-to-door intermodal freight operations. Some of the goals were; improved communication and information exchange, development of an integrated freight transport monitoring system for loading units, goods and transport equipment, and examination of future solutions and "smart" technology for the automation of processes in door-to-door intermodal transport operations.

In accordance to confidentiality agreements between participants in one of the D2D project demonstrators, we will present descriptions of the method applied and the different steps in the re-engineering work that has been accomplished.

The D2D project has chosen to develop TCMS (a transport chain management system), to meet the project objectives. TCMS will support the integration of the different actors in an integrated logistics chain, simplify the documentation flow, and increase visibility.

The conceptual challenge and objectives in the D2D project are illustrated in Figure 6 and Figure 7. The illustration in Figure 6 shows multiple information flows. The challenge in many logistics chain today is the information exchange between many actors using different formats on relevant documents, and different exchange methods such as fax, e-mail, EDI, paper-forms, e.g.

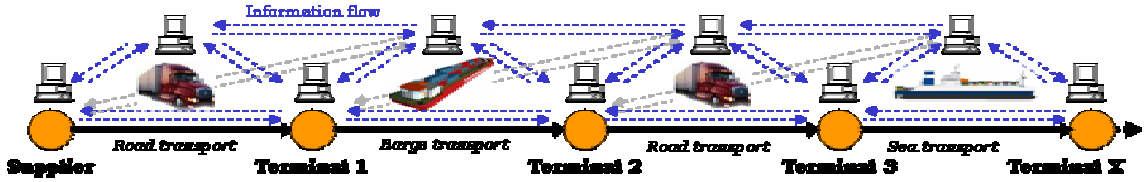


Figure 6: Present state (AS-IS) description with complex information flow between actors in a logistics chain.

Figure 7 illustrates a future improved conceptual state (TO-BE) and the essens in the desirable achievements in the D2D project. The concept is based on integrating ICT systems and electronically messages in the transport chain. The illustration shows that information is exchanged over a common information management platform.

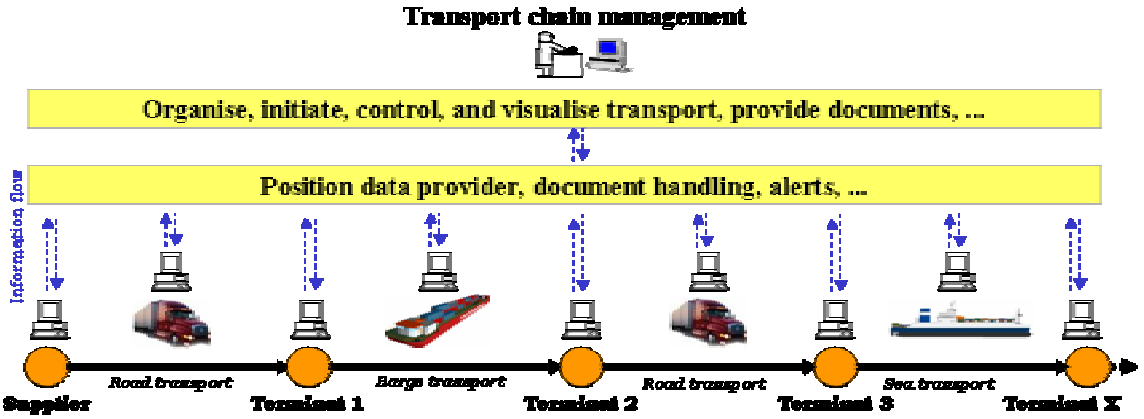


Figure 7: Transport chain information concept (TO-BE)

In relation to system development there are many things to bear in mind. A process model will first and foremost have its advantages when initiating a system development project and to create an understanding of the possibilities which the development and/or integration of a new system would represent. Secondly, a process model could support the implementation of a new system. The process model can help both managers and operational people to understand the new processes and in what way the new system would have impact on their routines.

Common mistakes in ICT system development projects are related to the development of the system based on insufficient and misunderstood information and failure to include the operational experience. Often, too much attention is given to management. Another mistake is to include too many details in the process model descriptions that make it harder to understand.

The actual system development and technology issues will not be addressed in this paper. The process models developed have been applied to document requirements related to functionality and how systems is intended to be used, which in turn forms basis for development of thorough system specifications.

3.1. As-is documentation of John Deere demonstrator

One of the demonstrator cases in the D2D project is supported by John Deere. John Deere is a manufacturer of heavy agricultural machines, and their demonstration chain is the inter-modal transport of tractor units from Mannheim in Germany to dealers in Australia. Figure 8 illustrates the John Deere transport chain.

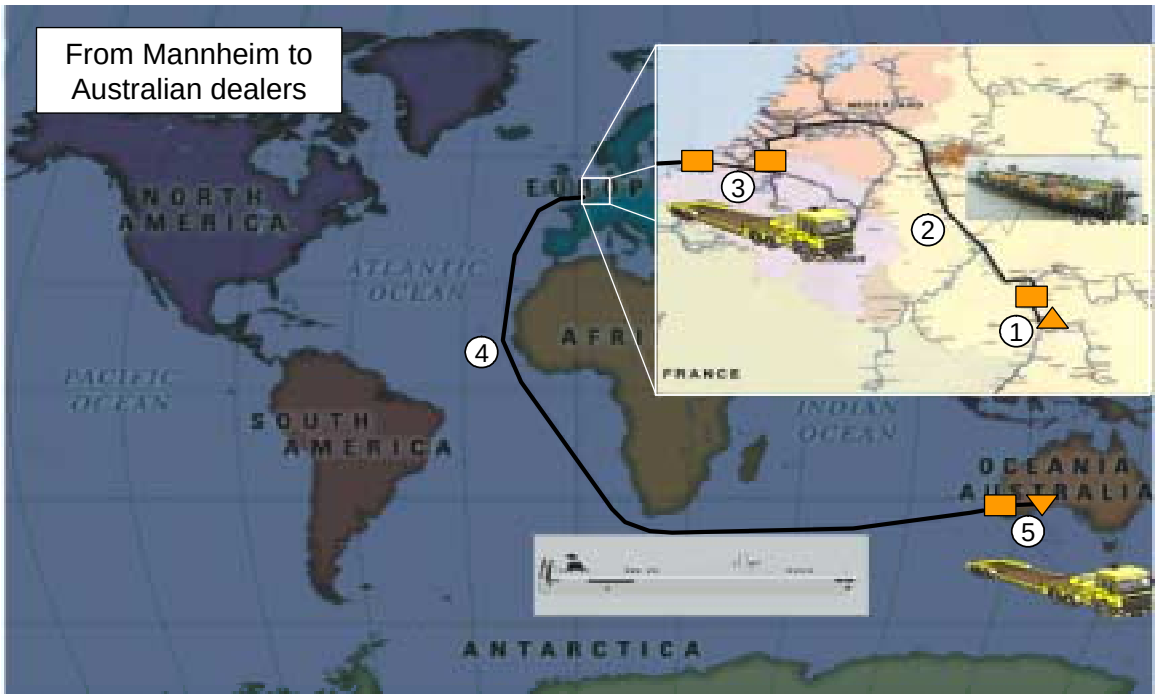


Figure 8: The main physical transport legs in the John Deere chain are:

1. *Truck transport from Plant in Mannheim to the Rhine barge terminal in Mannheim*
2. *Barge transport from Mannheim to Antwerp*
3. *Truck transport from Antwerp to Zeebrugge*
4. *Deep-sea transport from Zeebrugge to Australian port (Freemantle)*
5. *Truck transport from Australian ports to John Deere tractor dealers*

The study has focused on mapping both the physical process flow and the information flow between actors in the chain, and the individual ICT systems that supports this. The goal for this work has been to create a common understanding of each actor's role in the logistics chain, as well as mapping the infrastructure, and the messages that are being exchanged in the chain.

An important aspect of the mapping is the level of details that has to be identified and structured in the process model. The level of detail is depending on the requirements from the system developers and the reengineering consultants, and the complexity of the logistics chain itself.

Figure 9 illustrates the main processes in the transport chain for tractors from the John Deere plant in Mannheim in Germany to the port of Fremantle in Australia. Some processes are described with sub-level processes. All processes are also described at a workflow level. The focus in this model is the interaction between different actors, ICT-systems, and the information-flow in the logistics chain.

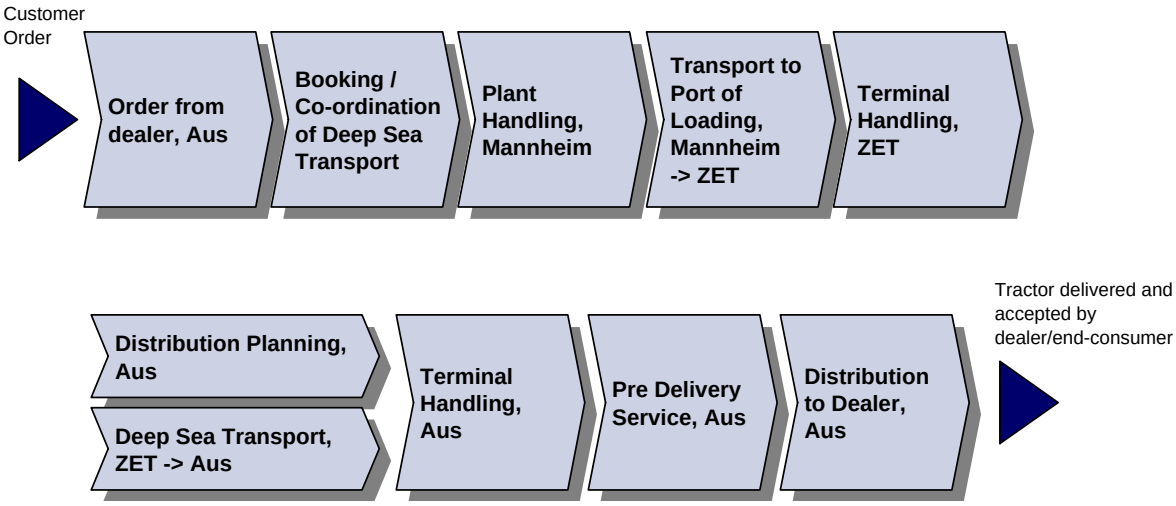


Figure 9: John Deere supply chain process model

The process model has been created trough meetings, interviews and correspondence with representatives from different actors from all parts of the chain. The processes in the model are all related to the transport tasks relevant for the demonstration of a transport chain management system.

Our experiences have shown us that the best way to create a process model is to sit together with operational and management experience and going trough and create each process description one-by-one. To create a process model based on work-descriptions from e.g. a quality handbook and/or trough e-mail correspondence can be challenging.

Figure 10 show a simplified conceptual workflow description of a single process. The workflow description illustrates a single process showing the different roles, activities and ICT systems, *collaborating to achieve the defined business purpose* [3], i.e. the process result/output which in this case is; “order fulfillment”.

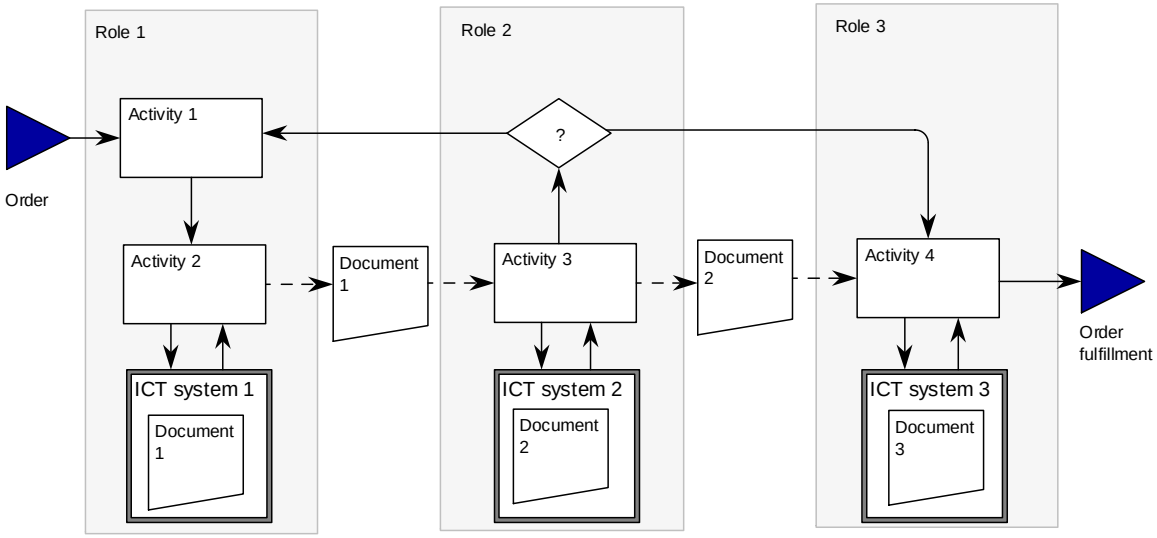


Figure 10: Present state (AS-IS) workflow description

3.2. Analyse and Re-engineer John Deere demonstrator

The present state process model formed the basis for analysis and re-engineering. The objective of the analysis was to identify and prioritize areas for improvement of the documentation flow in the logistics chain.

The re-engineering work has focused on simplifying the process in order to facilitate the development and integration of a transport chain management system. The focus has been on showing how the transport chain management system can work together with other systems. This has been done by re-engineering existing processes and information flow.

The analyzing work also resulted in a prioritized list of messages and functionality to be included in the demonstrator. The list contains massages, such as documents, faxes, and e-mails, together with relevant sender(s) and receiver(s) as well as the existing communication protocol and the new message formats, e.g. EDI, ASCII and XML, to be integrated together with the transport chain management system. Figure 11 shows an example of a list of messages in a logistics chain.

Message	Sender	Receiver	Existing Communication Protocol	New Format (ASCII, EDIFACT, XML)
Long-term Forecast	Company A	Company B	Phone/fax/E-mail	ASCII
Vessel schedule	Company B	Company A	IFTSAI	EDIFACT
Traffic schedule	Company A	Company B, Company C	E-mail	ASCII
Shipping specification	Company A	Company B, Company C	E-mail	ASCII
Transport document	Company D	Company A, Company C	Physical hand-over	ASCII
Manifest	Company C	Company B, Company E	Fax/E-mail	ASCII, XML
Barge Arrival Notification	Company E	Company B,Company D	E-mail	ASCII
Outturn report	Company D	Company B, Company E	E-mail	XML
Trucking instructions	Company B, Company E	Company F	E-mail	Excel file
CMR Document	Company F	Company E, Company G	Physical hand-over	ASCII

Figure 11: Example of a list of messages in a logistics chain including both AS-IS and TO-BE communication formats

Figure 12show a conceptual re-engineered process description (TO-BE) where the different ICT systems are integrated and the information is exchanged between the systems themselves, and not between the roles, as in the AS-IS description in Figure 10.

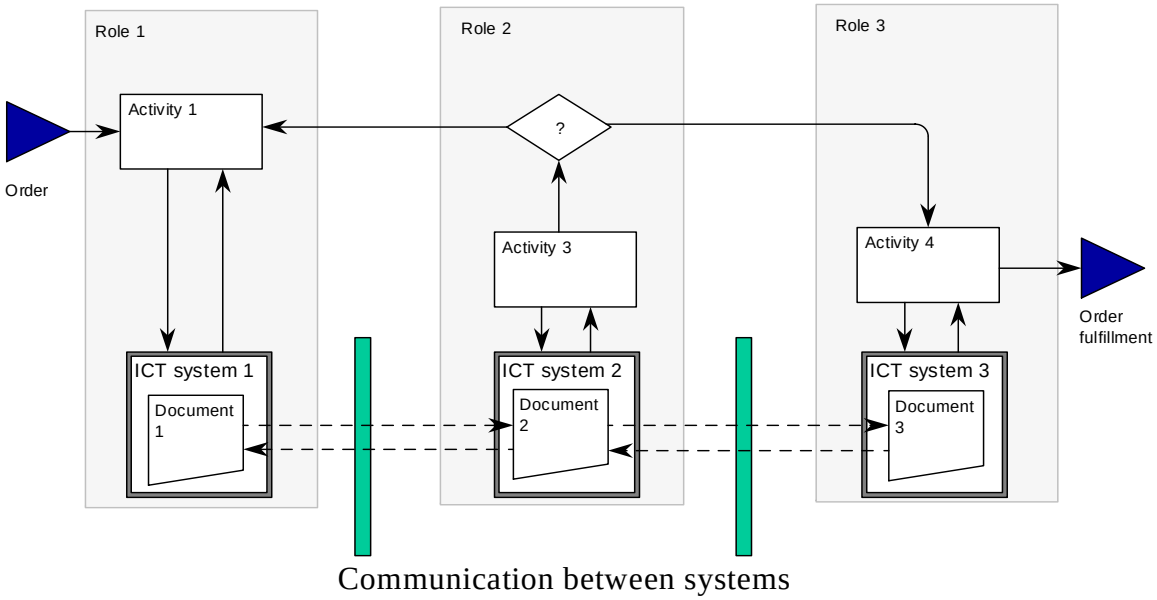


Figure 12: Re-engineered (TO-BE) workflow description

3.3. Demonstrator model

After the re-engineering of the process model, it became necessary in the D2D project to create a demonstrator process model. The demonstrator model's objectives were to establish a plan and illustrate how the new ICT system, TCMS, would be implemented in the organization and the logistics chain. It was also necessary to create a model of the functionality that would be a part of the new ICT system when implemented in the organization.

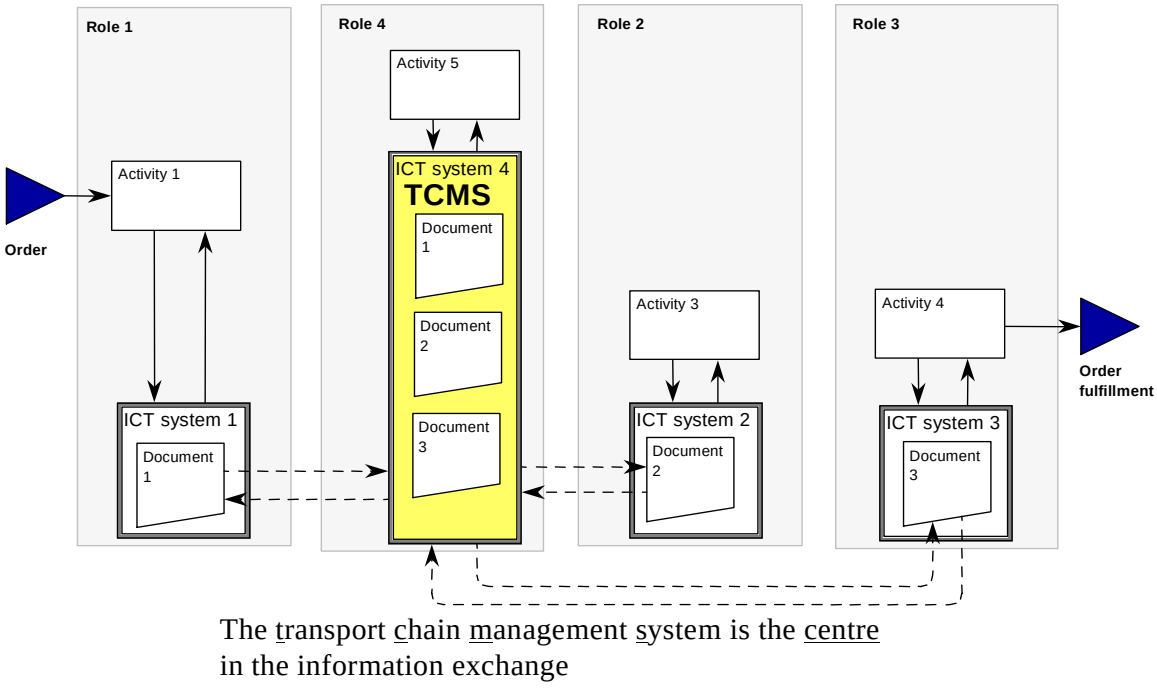


Figure 13 Demonstrator process work flow description

The workflow description is for illustration purpose only. It shows the integration of the new transport chain management system. The re-engineered process with the new system shows that all information exchange is done true the TCMS system. This system is the centre in the information flow. The other actors and systems are notified trough status messages and/or information documents distributed electronically to/from TCMS.

It is not clear whether the best way to organize a transport chain's information flow is trough integration of different systems or via a centralized information exchange such as the TCMS system. But, in complex logistics chains with many different alternative service providers, it will be impossible to integrate with every ICT system used. Here, a centralized information exchange based on standardized communication protocols would show advantages.

4. CONCLUSIONS & LESSONS LEARNED

Re-engineering and integration of TCMS in the John Deere demonstrator logistics chain will improve the documentation flow. Analyses have shown that the documents are sent in many different formats. Converting all documents to EDI-formats, required by TCMS, will be a challenge. Integrating TCMS with existing information systems cannot start until the different messages have been converted and handled by an information system.

This demonstrator case has shown that there are many challenges to re-engineering processes for the development and integration of new ICT systems, e.g. the process' complexity. The process complexity has been a challenge. In the work that has been completed so far, the experience has revealed that too many details in the model will confuse the understanding of the chain, and hence complicate system development. System development must be based on thorough system specifications. A process model can support the understanding of such descriptions. We recommend to first creating the process model before outlining the system specifications.

Experience has shown that in order to re-engineer the logistics chain, it is important to prioritize part of the chain and focus on a limited number of documents for the demonstrator purpose.

This demonstrator case has shown one suitable way of re-engineering a logistics chain, and creating a fundament for integration and development of a new transport management system.

The final conclusion is that knowledge and information about the logistics chain must be captured, modeled, distributed and validated by all participants in order to re-engineer the processes and to support the implementation of new ICT systems to improve overall performance of the chain. We think that process modelling is a suitable approach to achieve success in this respect.