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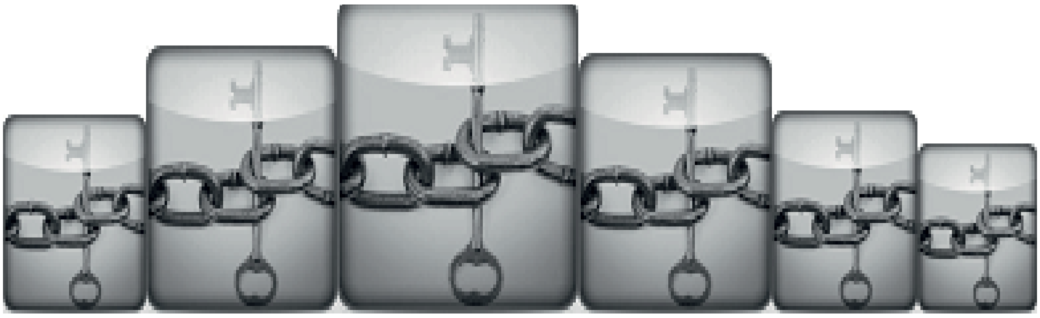

WP-5100 Alternative logistics concepts fitting different wood supply situations and markets

Logistikmodeller för virkesförsörjningen på olika marknader

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FlexWood
Flexible Wood Supply Chain

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Abstract

After a background introduction to supply chain management and logistics, this document provides an exploratory literature review structured in three sections. First, we review literature on performance measurement of supply chain and then, on the definition and assessment of the agility, the competitiveness and the customisation capacity of a supply chain. Second, we review reference models for supply chains and their management processes as well as typologies to characterise supply chain, value chain, service and collaborative planning in a supply chain. Third, we review the scarce literature on mapping supply chain in the forest products industry and various publications and concepts that could potentially contribute to WP-5100.

Preface

The redaction of this document fulfils an objective related to Task 1 of Working Package 5100 (WP-5100) in the research project *Flexible Wood Supply Chain* (FlexWood), a major European Union funded research initiative. Consequently**, the diffusion of this document is restricted to the 14 FlexWood partners until the end of the FlexWood project.** FlexWood use the assumption that wood supply chains in the forest products industry are not able to make full use of the real value of raw materials. The overall objective of FlexWood is therefore to build a novel logistics system that would provide value recovery and generation along the wood supply chain. FlexWood involves fourteen partners representing nine countries and is comprised of leading SMEs, universities and research centres and associations, which contribute complementary experience and expertise. For more details, see: http://www.flexwood-eu.org.

WP-5100 is led by the FORAC Research Consortium of Laval University (Canada) in partnership with Skogforsk – The Forestry Research Institute of Sweden (Sweden). The research is conducted under the supervision of Dr. Sophie D'Amours, professor in industrial engineering at Laval University and director of research and administration of FORAC Research Consortium, with the collaboration of Dr. Luc Lebel, professor in forest operations at Laval University and Dr Mikael Rönnqvist, professor in management science at the Norwegian School of Economics and Business Administration. The research team is completed by Karin Westlund, research professional in the logistics program at the Forestry Research Institute of Sweden (Skogforsk), Anna Furness-Lindén, research professional in the technology program at Skogforsk, and Jean-François Audy, doctoral student and research professional at the FORAC Research Consortium, Laval University. Jonathan Gaudreault, research professional at the FORAC Research Consortium, provides a link with other research projects at the FORAC Research Consortium.

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Summary

A common understanding is that logistics is flows of goods, information and money within a defined system. When the system is defined as for example as a factory – the logistics is quite easy to visualize; goods will be processed and refined on stations inside the factory, customer demand will be translated into information on production plans, selling price will generate monetary flows into the factory for salaries etc. However, nowadays, it's very rare (if even at all existing) to have a complete industrial production in-house. Comparative advantages have made us trade, more and more so over time and over industrialization and globalization. According to a study made in European companies, see figure I, the share of a products value from supplier is constantly increasing. Following this unquestionable trend, the discipline of supply chain management inevitably has evolved in the industrial world. (Figure 1 – Johnson, 1998) Rather than company by company, clusters of companies, supply chains, make up a meaningful system unit to analyze and manage when it comes to logistics.

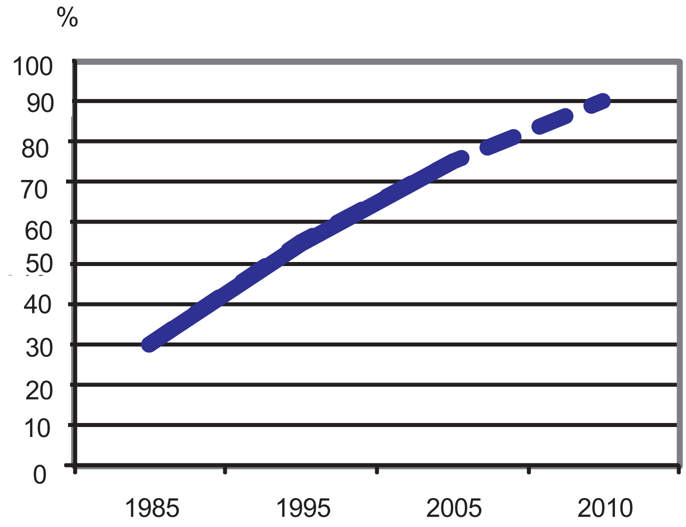

Figure 1.
Share of supplier value of the total value of product produced.

There is endless literature on supply chain management, and numerous suggestions and refined versions of the concept (ref. demand chain mgmt, s c engineering…), but the common perception is quite stable. The supply chain challenge is to manage and optimize the value creating flows of activities that run through, and hence are interdependent on, several legal units. In order to efficiently manage modern production processes, we need to manage supply chains.

Also forest industry has evolved in this general direction. In old days, the growing timber was owned by the company owning, the sawmills and paper mills. The timber was harvested and hauled to mill gate by employees. However, in most countries today, forestry is complex value chains with several independent actors, all yet depending on each other and the competitiveness and profit of the supply chain as a whole. Contractors, carrying out logging, silviculture, planning, hauling and timber transportations are contracted by companies either owning the timber land and/or the mills. The mills in turn of course have their primary and secondary markets spread worldwide. It makes great sense to apply general supply chain theory and knowledge to the forestry processes.

As a first task in WP 5100, an extensive literature review is carried out, screening the SC world for literature and possible models to use when mapping and analyzing a supply chain in general and a supply chain in a partly commodity processing flow in particular.

Process management has been around for a long time and the interest for the discipline is remaining high. Extensive literature tells about several process management descriptions, but it doesn't seem to be any really commonly known, widespread model. However, discussing and analysing "processes", it is important to define the "process" aimed for in the study. Process management for a single process within a supply chain will differ from process management within a whole production system, i. e system management. This is a major challenge when striving towards portraying a "typical wood supply chain of region X". In order to be as concrete as to discuss and compare different supply chains in terms of KPIs and precise metrics, the need for a focal point within the supply chain evolves. Hence, the process management, rather than the system management view, is needed in order to achieve project goals.

Amongst other more or less well established modelling methodologies (ARIS House of Business Engineering model, R/3 model, Retail-H model, Aachem PPC model, PRO-NET model and GSGF model, all described in the document), the SCOR model was chosen as the bases of the further WP 5100 work. The SCOR-model is developed of the Supply-Chain Council (SCC). SCC was founded in 1996 and is a non-profit organization. Today SCC consists of about 1 000 corporate members spread over the world. Membership is open to all for applying and practice.

According to the SCOR, initially, you need to capture the supply chain configuration. A supply chain, independent of industry, can be described by the five elementary processes; plan, source, make, deliver and return. The processes in the value chain are further separated to in different hierarchical levels, where the level one describes the scope of the supply chain using the five elementary processes, level two tells about the configuration and using level three, the actual activities are portrayed, and measured. SCOR discusses supply chain performance focusing on five main metrics; Reliability – achievement of customer demand fulfillment on-time, complete, without damage etc. Responsiveness - the time it takes to react to and fulfill customer demand Agility - the ability of supply chain to increase/decrease demand within a given planned period Cost - objective assessment of all components of supply chain cost Assets - the assessment of all resources used to fulfill customer demand.

In order to be able to use the SCOR, the model needs to be further refined to fit and capture specific features of the wood supply industry. This modification will be done, based on theory presented and in iterative processes while case studies are being performed.

Introduction

We know that the configuration of Wood Supply Systems (WSS)[1] and their associated logistics concepts contribute greatly to the global performance of the forest products industry sector. We also know that the configuration and logistics concepts are motivated by precise contextual elements and adapted to fit precise needs and respond to various constraints applied by the operational environment. Sometimes, however, systems have inherited features and processes from past history. These features are often preserved without rationally scrutinizing their maintained relevance. We know that the context is changing more rapidly than ever before and that great potential lies in actively handling system adaptations.

The overall background of WP-5000 is an identified need to support the evaluation and design of innovative WSS for a better integration of the forest to mills within the supply chain of the forest products industry. Specifically for WP-5100, we have three objectives in our study which analyse alternative configurations and logistics concepts that fit different wood supply situations and markets. These objectives are:

- Develop a framework to describe and represent any wood supply system in which the agility, competiveness and customisation capability of the system are highlighted;
- Use the developed framework to study wood supply systems in different parts of the world;
- Analyse and compare each studied wood supply system to identify basic designs of planning systems. Describe each of them with their logistics concepts and analyse their positive and negative impacts on agility, competiveness and customisation capability.

To provide a theoretical basis for the research works in WP 5100, an exploratory literature review was included in the WP-5100 detailed project plan (Audy et al., 2009**). We emphasise the qualifier 'exploratory' since the reviewed material could potentially contribute to WP-5100.** The review was structured according to four themes (see Table 1). For each of them, we explore existing research works and applications in the forest products industry and in other industries.

[1] The WSS studied in WP-5100 spans from the measurement of the forest to the delivery of raw material at the mill gates and the focus is on short-term planning decisions and operations in the system. Thus, silvicultural and other pre-commercial operations as well as mid/long-term planning decisions are not explicitly targeted in the study, even though they will be indirectly discussed to capture their positive and negative impacts on the system.

Table 1.
Themes in the literature review.

i)	Identify and describe the key features of a WSS.
ii)	Find suitable key performance indicators (KPIs) tailored to measure the performance of WSS regarding the key features identified in (i).
iii)	Summarise the theory on supply chain mapping, and identify generic methodologies that are used to represent and describe (i.e. map) supply chains.
iv)	Review existing research aiming to measure and map supply chains in the forest products industry as well as other research that could provide input information (e.g. lists of actors, decisions and main constraints in WSS) in the development of our framework.

The document is structured as follows. In Section 0, we provide a background introduction to supply chain management and logistics. Section 0 includes the review on themes (i) and (ii) and Sections 0 and 0 are, the review on themes (iii) and (iv), respectively. Finally, a conclusion is provided.

1. Background on supply chain management and logistics

The Flexwood team benefits from 14 partners with expertise in various and complementary domains. The research works in WP-5100 are largely based on the research domain of supply chain management and logistics. Thus, in this section we provide a short background introduction to supply chain management and logistics. We also discuss about supply chain management and logistics in WSS.

The terms supply chain and supply chain management first appeared in 1982 (Kannegiesser, 2008) and since that time, various definitions of both terms have been proposed in the literature, see e.g. Stadler (2008) and Kannegiesser (2008) for more details.

A supply chain is a "network of organisations that are involved, through upstream and downstream linkages [of, essentially, material, information and financial flows], in different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer" Christopher (2005).

According to Kannegiesser (2008), there are two core ideas in the supply chain concept:

- A better collaboration between companies in the same supply chain will help to improve delivery service, better manage utilisation and save costs particularly for holding inventories (Alicke, 2005);
- Individual businesses can no longer compete as solely autonomous entities, but rather as supply chains (Christopher, 2005) or, in other words by Lambert and Cooper (2000), "one of the most significant paradigm shifts of modern business management is that individual organisations can no longer compete as solely autonomous entities, but rather as supply chains".

Supply chain management is "the task of integrating organisational units along a supply chain and coordinating material, information and financial flows in order to fulfil (ultimate) customer demands with the aim of improving the competitiveness of a supply chain as a whole" (Stadler and Kilger, 2008). Thus, supply chain management "encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies." (CSCMP, 2010a).

Based on their review of SCM definitions, Mentzer et al. (2001) propose that SCM as a management philosophy has three main characteristics:

- A system approach viewing the supply chain as a whole with the total flow of goods inventory managed from the supplier to the ultimate customer;
- A strategic orientation toward cooperative efforts to synchronise and converge intra-firm and inter-firm operational and strategic capabilities into a unified whole;
- A customer focus to create unique and individualised sources of customer value, leading to customer satisfaction.

Logistics originated in the 1950s, motivated by the complexity in the coordination and management of material and personnel in the military sector (Kannegiesser, 2008). Logistics is "the process of planning, implementing and controlling the efficient, effective flow and storage of goods, services and related information from their point of origin to point of consumption for the purpose of conforming to customer requirements" (Kannegiesser, 2008). "Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flows and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements" (CSCMP, 2010a).

A common understanding is that logistics is flows of goods, information and money within a defined system. When the system is defined as a factory, for example, the logistics is quite easy to visualize: goods will be processed and refined at stations inside the factory, customer demand will be translated into information on production plans, selling price will generate monetary flows into the factory for salaries, etc. However, nowadays, it's very rare (if it even exists at all) to have complete in-house industrial production. Over time, many comparative advantages, have led to increased trade along with industrialization and globalization. According to a study made with European companies (Soellner, 1997), the proportion of generated value from the supplier of the total value generated by the manufacture of a product is constantly increasing (see Figure 2).

Following this trend, the discipline of supply chain management has inevitably evolved in the industrial world. Rather than proceed company by company, clusters of companies (i.e. supply chains) make up a meaningful unitary system that can be analyzed and managed when it comes to logistics.

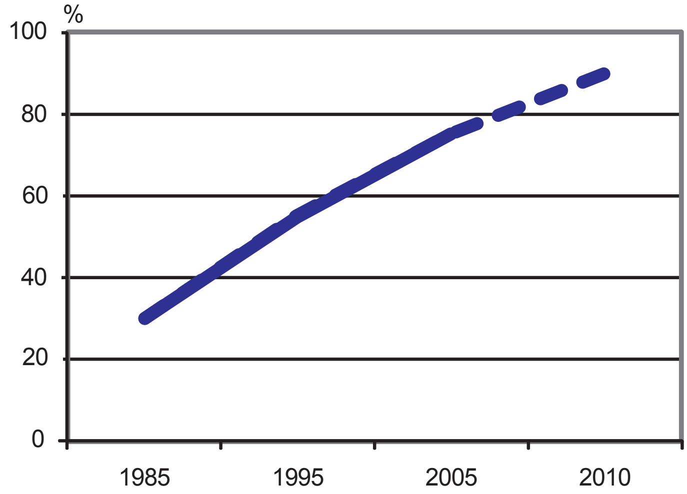

Figure 2.
Share of supplier value of the total value of product produced (Soellner, 1997).

The literature on supply chain management is endless and there exist numerous suggestions and refined versions of the concept (e.g. demand chain management, supply chain engineering), but the common perception remains unchanged. The supply chain challenge is to manage and optimize the value creating flows of activities that ensue, and hence are interdependent on several legal units. In order to efficiently manage modern production processes, we need to manage supply chains.

Moreover, the forest industry has evolved in this general direction. In the old days in many forested countries, growing timber was the property of the company that owned the sawmill(s) and the pulp and paper mill(s). The timber was harvested and hauled to mill gate by employees. However, in most countries today, forestry consists of complex value chains with several independent actors that yet depend on each other and the competitiveness and profit of the supply chain as a whole. Contractors, carrying out logging, silviculture, planning, hauling and timber transportation are contracted by companies that either own the timberland and/or the mills. The primary and secondary markets for the mill products are of course spread worldwide. It makes great sense to apply general supply chain theory and knowledge to forestry processes.

2. Performance measurement, agility, competitiveness and customisation capacity of a supply chain

This section aims at providing an exploratory review of themes (i) and (ii), which are:

i) Identify and describe the key features of a WSS.

ii) Find suitable key performance indicators (KPIs) tailored to measure the performance of WSS regarding the key features identified in (i).

We consider themes (i) and (ii) together using research on supply chain perormance measurement system. Performance measurement can be defined as "the process of quantifying the efficiency and effectiveness of an action" (Neely et al., 1995; Gunasekaran and Kobu, 2007). A performance measurement system can be defined as "the set of metrics used to quantify both the efficiency and effectiveness of actions" (Neely et al., 1995). Here, metric refers to the definition of the measure, how it will be calculated, who will be performing the calculation, and from where the data will be obtained (Neely et al., 1995).

A review of the literature and discussions with different experts in forest operations (Glen Murphy, Oregon State University; Reino Pulkki, Lakehead University; Luc Lebel, Laval University; Jean Favreau, FPInnovations-Forest Operations, personal communications, March to May 2010) have resulted in a conclusion that there is an absence of publications on supply chain performance measurement applied to a WSS. However, we did find publications on performance measurement system for some business entities in the WSS and we summarise these.

Based on a wide survey of forest harvesting entrepreneurs (n = 336) in the province of Quebec (Canada), Drolet and LeBel (2009) report that forest harvesting entrepreneurs focus essentially on production metrics such as 'cubic metre per productive hour' or 'utilisation rate'. Moreover, a list of the 17 best performance metrics according to the 336 forest harvesting entrepreneurs in the survey is provided. Pomerleau (2003) provides a list of performance metrics that allow the procurement department of a forest company to manage the performance of three subcontracted operations: i) harvesting, ii) construction of first class's road and iii) construction of second class's road. For each operation, the metrics are classified in four categories: cost, quality, productivity and yield.

The EFORWOOD project (EFORWOOD, 2010) provides a set of sustainability indicators to assess the sustainability performance of a WSS. The sustainability indicators are regrouped in the three fundamental components that define the sustainable development: economic (e.g. investment and R&D, gross value added), social (e.g. education and training, innovation) and environmental (e.g. forest biodiversity, energy generation and use). A computerized decision-support tool, ToSIA, that embedded the calculation of these indicators for a specific scenario of WSS, has also been developed in this project.

The first level of the SCOR model version 9 (see Subsection 0 for a discussion on the SCOR model) provides a set of ten metrics on SC performance that, according to the Supply Chain Council, are generic for supply chain of any industrial sector (SCC, 2008). (Table 2. Summarises the ten metrics).

Table 2.
Definition of the strategic performance metrics in the SCOR model version 9 (SCC, 2008).

Performance attribute	Definition	Metric of level 1
Supply chain reliability	The performance of a supply chain in delivering the correct product, to the correct place, at the correct time, in the correct condition and packaging, in the correct quantity, with the correct documentation, to the correct customer.	Perfect order fulfilment
Supply chain responsiveness	The speed at which a supply chain provides products to the customer.	Order fulfilment cycle time
Supply chain agility	The agility of a supply chain in responding to marketplace changes to gain or maintain competitive advantage.	Upside supply chain flexibility
		Upside supply chain adaptability
		Downside supply chain adaptability
Supply chain costs	The costs associated with operating the supply chain.	Supply chain management cost
		Cost of goods sold
Supply chain asset management	The effectiveness of an organisation in managing assets to support demand satisfaction. This includes the management of all assets: fixed and working capital.	Cash-to-cash cycle time
		Return on supply chain fixed assets
		Return on working capital

Metrics could also be found in survey and literature reviews on SC performance measurement (Neely et al., 1995; Gunasekaran et al., 2004; Shepherd and Günter (2006); Gunasekaran and Kobu, 2007; Arzu Akyuz and Erman Erkan, 2010; Payne, 2010), in levels 2 and 3 of the SCOR model (SCC, 2008) and in the Gartner Business Value Model (Smith et al., 2006). Beamon (1998) also report performance measures in supply chain modelling according to six perspectives: cost, customer, responsiveness, cost & customer responsiveness, cost & activity time, and, finally, flexibility.

In practice, many of the SC metrics are correlated and have a cause-effect relationship (Cai et al., 2009, Payne, 2010). For instance, a production department aims to maximize productivity with a long production program which entails inventories and late deliveries. Payne (2010) provides an example of a relationship map among a set of SC metrics (see Figure 3).

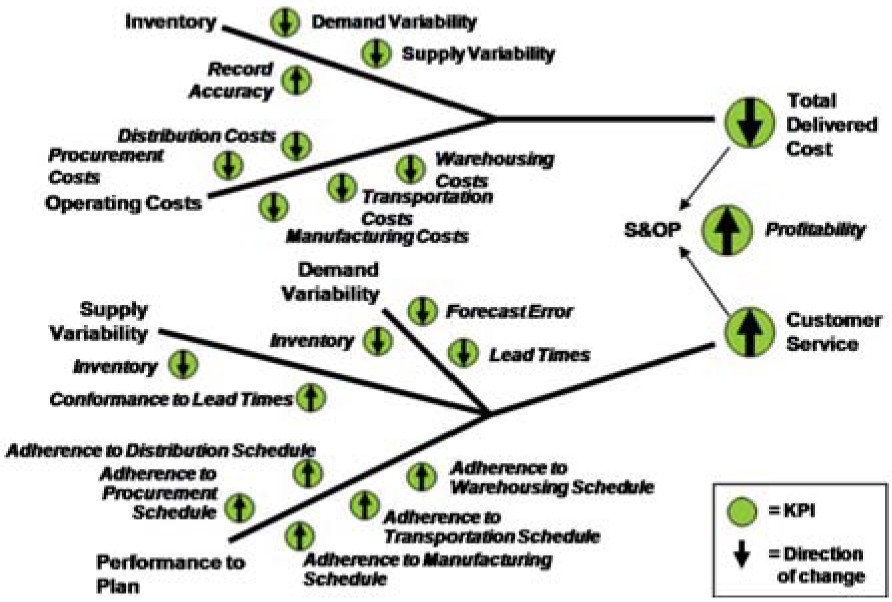

Figure 3.
Relationship map among a set of SC metrics (Payne, 2010).

According to Cai et al. (2009), their exists pairs of metrics with a high correlation with each other. These pairs of metrics must be identified and the nature of their pair-wise relationships can be classified in three categories: parallel, coupled and sequential. A parallel relationship involves two metrics independent of each other (i.e. the efforts to accomplish them are not related), while the opposite is true for a coupled relationship. A sequential relationship usually implies a simple cause–effect relationship (i.e. the effort of accomplishing a metric result in extra cost to the other).

As mentioned in the WP-5100 description (Annex I - "Description of Work"), three attributes of wood supply chain planning systems will be specifically studied: agility, competitiveness and customisation (note: named as tailoring).

2.1 AGILITY

Based on a review of the several definitions proposed in the literature, Li et al. (2008) provide a unified definition of agility: "An organisation's supply chain agility is the result of integrating the supply chain's alertness to changes (opportunities/challenges) – both internal and environmental – with the supply chain's capability to use resources in responding (proactively/reactively) to such changes, all in a timely and flexible manner." This unified definition of supply chain agility conceives agility in terms of two key dimensions (alertness and response capability), two directions (internal and environmental), two modes (reactive and proactive), and two measures of the degree of agility (timeliness and flexibility).

According to Li et al. (2008, 2009), there are two key components for agility: alertness to changes and response capability. Moreover, Li et al. (2008) divide agility into six dimensions: strategic alertness (SA), strategic response capability (SRC), operational alertness (OA), operational response capability (ORC), episodic alertness (EA) and episodic response capability (ERC). Including two items by dimension to evaluate with a five-point Likert-type scale (with 1 – low, 5 – high), Li et al. (2008) provide a list of 12 measurement items to assess supply chain agility (see Table 3).

Table 3.
Measurements of agility by Li et al. (2008).

SA 1 – Detect strategic opportunities/challenges in a timely manner (e.g. new competitor movement, new economic tendency, new technology, and new market).
SA 2 – Use many channels to keep aware of strategic opportunities/challenges.
SRC 1 – Reconfigure supply chain resources in a timely manner to respond to strategic opportunities/challenges.
SRC 2 – Reconfigure supply chain resources in a flexible manner to respond to strategic opportunities/challenges.
OA 1 – Detect changes in supply/demand in a timely manner.
OA 2 – Use many channels to keep aware of changes in supply/demand.
ORC 1 – Reconfigure supply chain resources in a timely manner to respond to changes in supply/demand.
ORC 2 – Reconfigure supply chain resources in a flexible manner to respond to changes in supply/demand.
EA 1 – Detect changes in supply chain daily execution in a timely manner.
EA 2 – Use many channels to keep aware of changes in supply chain daily execution.
ERC 1 – Reconfigure supply chain resources in a timely manner to respond to changes in daily supply chain execution.
ERC 2 – Reconfigure supply chain resources in a flexible manner to respond to changes in daily supply chain execution.
Legend: strategic alertness (SA), strategic response capability (SRC), operational alertness (OA), operational response capability (ORC), episodic alertness (EA) and episodic response capability (ERC).

In the SCOR model, the agility of an SC is one of the five performance attributes (see Table XXX) and is about "responding to marketplace changes to gain or maintain competitive advantage". Three level 1 metrics are provided: Upside Supply Chain Flexibility (AG.1.1), Upside Supply Chain Adaptability (AG.1.2) and Downside Supply Chain Adaptability (AG.1.3) (see Table 4). A parameter value (i.e. number of day or percentage increase or decrease) must be set on each metrics according to the business context of the industry sector. We set this parameter value according to a recommendation by the Chief Technology Officer of the Supply Chain Council (Caspar Hunsche, personal communication, August 2010) and their mandated firm for benchmarking with the SCOR model (Erin Willians, personal communication, August 2010).

Table 4.
Three level 1 metrics of agility in the SCOR model.

Metrics	Definition
Upside Supply Chain Flexibility	The number of days required to achieve an unplanned sustainable 20% increase in quantities delivered.
Upside Supply Chain Adaptability	The maximum sustainable percentage increase in quantity delivered that can be achieved in 30 days.
Downside Supply Chain Adaptability	The percentage reduction in quantities ordered sustainable at 30 days prior to delivery with no inventory or cost penalties.

To fit better with the two key components of agility according to Li et al. (2008, 2009), we should consider the 'SC Responsiveness' performance attribute in the SCOR model which is defined as ''the speed at which an SC provides products to the customer" with one metric: Order Fulfilment Cycle Time. In the context of a WSS, we can use it as an average order fulfilment cycle time. For instance in a cut-to-length harvesting system with direct truck delivery, this average order fulfilment cycle time will be the summation of the average times: 1) between order received and harvesting equipment moved to the harvesting track; 2) after the moving of the equipment until harvesting begins; 3) in inventory on the ground in the harvesting track area; 4) forwarding to the roadside (considering the average forwarding distance of the track); 5) in inventory at the roadside; and 6) loading, transportation (considering the average[2] travelling distance to the delivery mills) and unloading at the mills. Of course, circumstances could require differentiating several average times (e.g. seasonality with distinct average order fulfilment cycle time during the year).

Also, for logical purposes, we will also add the 'SC reliability' performance attribute in the SCOR model which is defined as "the performance of the supply chain in delivering the correct product, to the correct place, at the correct time, in the correct condition and packaging, in the correct quantity, with the correct documentation, to the correct customer" with one metric: Perfect Order Fulfillment (in percentage). A differentiation by type of product could be required.

2.2 COMPETITIVENESS

Based on the recent work by Lee and Wilhelm (2010), we detail three main concepts to support our further evaluation of the competitiveness of a WSS: comparative advantage, sustained competitive advantage, and competitiveness at the firm/company level. We also discuss the competitive intensity in an industry and the typology for the competitive strategy of a supply chain.

[2] An average distance that takes into account the proportion of the total volume delivery to each mill.

2.2.1 Comparative advantage

Krugman and Obstfeld (2006) mention that "a country has a *comparative advantage* in producing a good if the opportunity cost of producing that good in terms of other goods is lower in that country than it is in other countries". We can adapt this definition to the aim of the project by changing 'country' to 'wood supply chain'. Also, the meaning of opportunity cost should be extended beyond the restrictive monetary aspect to consider, e.g. hours of labour required to harvest a specific quantity of cubic metres.

2.2.2. Sustained competitive advantage

Barney (1991) provided a widely accepted definition of *competitive advantage* relative to a company (Lee and Wilhelm, 2010): "a firm is said to have a competitive advantage when it is implementing a value creating strategy not simultaneously being implemented by any current or potential competitors." Li et al. (2006) described *competitive advantage* as "the extent to which an organisation is able to create defensible position over its competitors" and based on previous works, propose five dimensions of competitive advantage: price/cost, quality, delivery dependability, product innovation and time to market. Some authors (e.g. Tracey et al. (1999), Li et al. (2006), Cao and Zhang (2008), Lakhal (2009)) propose evaluating a set of statements on each dimension with a five-point Likert-type scale. We summarize them in (Table 5).

Barney (1991) states that a firm is said to have a *sustained competitive advantage* when it has a competitive advantage and its competitors are unable to duplicate the benefits of its value creating strategy. Again, we can adapt these definitions to the aim of the project by changing 'firm/organisation' by 'wood supply chain'.

Lee and Wilhelm (2010) report many studies on how firms generate and sustain a competitive advantage through using innovative management skills and one of these skills is supply chain management practices. Indeed, Li et al. (2006) mention that "effective supply chain management has become a potentially valuable way of securing competitive advantage and improving organisational performance since competition is no longer between organisations, but among supply chains."

Moreover, we should note that the latter part of the citation of Li et al. (2006) is one of the many repetitions in the MS, OR & SCM literature (i.e., Management Sciences, Operations Research and Supply Chain Management) of the first core idea in the supply chain concept (see Section 1).

Table 5.
Statements on the five dimensions of competitive advantage.

Price/cost: an organisation is capable of competing against major competitors based on low price.
We offer competitive prices.
We are able to compete based on our prices.
We are able to offer prices as low or lower than our competitors.
Quality: an organisation is capable of offering product quality and performance that creates higher value for customers
We are able to compete based on quality.
We offer products that are highly reliable.
We offer products that are very durable.
We offer high quality products to our customer.
Product innovation and Product line breadth: an organisation is capable of introducing new products and features in the marketplace
We respond well to changing customer preferences regarding products.
We respond well to changing customer preferences regarding accompanying services.
We provide customised products.
We alter our product offerings to meet client needs.
We respond well to customer demand for ‘new’ features.
Time to market: an organisation is capable of introducing new products faster than major competitors
We are first in the market in introducing new products
We have time-to-market lower than industry average.
We have fast product development.
Delivery dependability, frequency and flexibility: an organisation is capable of providing on time the type and volume of product required by customer(s).
We supply accurate projected shipping dates.
We supply accurate projected delivery dates.
We deliver customer order on time.
We provide dependable delivery.
Our customers are pleased with the frequency of our delivery.
We can alter our delivery schedule per each customer’s requirements.
We are flexible in developing delivery schedules
We work with each customer to develop a delivery schedule that is acceptable.

2.2.3 Competitiveness at the firm/company level

Lee and Wilhelm (2010) mention that "competitiveness has been a controversial notion and few agree on a precise definition (Ezeala-Harrison, 2005), although numerous definitions have been proposed". Among the different definitions reported by Lee and Wilhelm (2010), we select the two definitions formulated at the firm/company level instead of industry or nation/country level. Thus, we can again adapt these definitions to the aim of the project by changing 'firm/company' to 'wood supply chain'.

Ambastha and Momaya (2004) defined competitiveness as "the ability of a firm to design, produce and or market products superior to those offered by competitors, considering price and non-price qualities" The TCI Network (2010) (former The Competitiveness Institute) defines competitiveness for a company as "the ability to provide products and services as (or more) effectively and efficiently than relevant competitors".

2.2.4. Competitive intensity in an industry

We refer to the competitive intensity inside an industry as an indicator of the level of the various pressures that force companies to continuously take action, both in terms of operational performance as well as strategic positioning, to stay competitive in its industry. Using a seven-point Likert scale, Hallgren and Olhager (2006) provide an evaluation in four statements of the competitive intensity of an industry (see Table 6).

Table 6.
Statements on the competitive intensity of an industry.

We are in a highly competitive industry.
Our competitive pressures are extremely high.
Competitive moves in our market are slow and deliberate, with long time gaps between different companies' reactions (reverse coded).
We don't pay much attention to our competitors (reverse coded).

2.2.5. Competitive strategy

Competitive strategy addresses "how an organisation chooses to compete in a market, particularly the issue of positioning the company relative to competitors with the aim of establishing a profitable and sustainable position" (Hallgren & Olhager, 2006). Distinguishing among three major strategies to competitiveness (i.e. cost leadership, differentiation, and focus), the typology for competitive strategy of a company by Porter (1985) is probably the most well-known typology according to Hallgren and Olhager (2006). Cost-leadership means that the company takes the competition head on, offering a product that is equivalent to those offered by competitors, but more efficiently (e.g. cheaper price) than competitors. The differentiation is to avoid direct competition by differentiating the products and/or services offered to deliver higher customer value, making it possible to charge a premium price. The focus strategy is to target one or more market segments of the company's markets.

There are two opposing schools of thought concerning the typology by Porter, i.e. the first maintains that to perform, a company can have only one strategy, while the other maintains that a company can have many strategies (Yamin et al., 1997). Furthermore, as reported by Hallgren and Olhager (2006), several authors reduce the three strategies of Porter to two: cost leadership or differentiation strategies even in a focus strategy. Using a five-point Likert scale (from "absolutely crucial" to "least important"), Hallgren and Olhager (2006) propose identifying the importance of four goals (see Table 7)) in order to evaluate to which strategy a company strives.

Table 7.
Strategy of a company according to four goals.

Low price.
Low manufacturing unit cost.
Ability to rapidly change over product on short notice.
Ability to vary volume of product produced on short notice.

Treacy and Wiersema (1993) discriminated between strategies aiming for operational excellence, customer intimacy, and product leadership. Reimann et al. (2010) provide a set of statements to measure, each of them using a five-point Likert scale (see Table 8).

Table 8.
Statements on competitive strategy.

Operational excellence
We continuously improve our processes in order to keep costs low
We constantly improve our operating efficiency.
We continuously strive for product cost reduction.
Product leadership
We continuously refine and improve existing products.
We have a high share of new products in our product portfolio.
We undertake new product development above the industry average.
The design and functionality of our products is crucial to our competitive positioning.
Our brand is different from other brands in terms of actual product attributes (features that can be physically identified by touch, smell, sight, taste etc.)
Our brand is different from other brands in terms of overall perceived quality (including non-tangible, psychological perceptions of the customer).
Customer intimacy
Our company's strategy to achieve competitive advantage is based on our thorough understanding of our customers' needs.
We design or produce our products to order.
Orders are packaged and shipped in a way appropriate to each customer.
Our employees are encouraged to focus on customer relationships.
We conduct advertising at a level above the industry average.
We conduct promotions at a level above the industry average.

2.3. CUSTOMISATION

Customisation for a firm/company[3] refers to the design of its offers to the market, including the corresponding manufacturing or service capacities, based on a targeted segmentation of customers. In other words, '(...) when firms design their offers to the market, they decide on the appropriate combination of personalization levels in each market segment, in function of their capabilities, the market and client needs, and shareholder interests' (Poulin et al., 2006). As quoted from Montreuil and Poulin (2005), 'The goal with personalizing is to gradually develop the competitiveness of the firm by having an offer that closely matches the evolving personalized expectations of customers in the targeted segments and by having the [manufacturing] capability to profitably deliver the offer on a reliable basis'.

Poulin et al. (2006) propose a framework classifying customisation (called 'personalisation') in eight different alternatives: popularising, varietising, accessorising, parametering, tailoring, adjusting, monitoring and collaborating (see Table 9).

Table 9.
Customization framework by Poulin et al. (2006)

Customisation option	Characteristics
Popularising	Limited number of products to match a wide variety of customer needs, for those who want off-the-shelf products. Focus on evolving the popular product mix in line with evolving customer needs.
Varietising	Extensive mix of products to satisfy almost all customer needs. Retailers pick those they want to offer off-the-shelf and rely on quick delivery from the distribution network for fast delivery of the others.
Accessorising	A limited set of core products matched with a wide array of accessories. Final assembly of accessorised products performed to order either by the user, the retailer or a fulfilment centre.
Parametering	Customer defines the desired product through the setting of parameters and the selection of options. He is guided through the specification process. Manufacturing is strictly to order.
Tailoring	Product designed/engineered to customer needs. The customer is closely involved in the product realisation process.
Adjusting	Product adjusted to customer needs after usage. Distributed information systems capture customer feedback.
Monitoring	Product is replaced by more adequate product as the customer needs evolve, ensuring continually a best-fit product. This involves regular and interactive customer feedback.
Collaborating	Client is viewed as a collaborator with an open dialogue. Expert field systems interact with clients, seeking to continually optimise client return.

[3] In WP-5100, we will focus at the WSS level rather than at the firm/company level.

Poulin et al. (2006) applied their framework to a golf gear supply chain. Azouzi et al. (2009) use a simplification of this framework in a case study in the furniture industry. The framework by Poulin et al. (2006) has been developed according to a 'product industry' perspective. Consequently, we should expand the framework to handle the customisation alternative existing in the 'service industry' (e.g. harvesting, transportation) of the WSS.

A concept that is a close opposite to customisation is commoditisation. Matthyssens & Vandenbempt (2008) define commoditisation as ''a dynamic process that erodes the competitive differentiation potential and consequently deteriorates the financial position of any organisation''. The ''commoditisation of an industry describes an increase in similarity between the offerings of competitors in an industry, an increase in customer price sensitivity, a decrease in customer cost of switching from one to another supplier in an industry, and an increase in the stability of the competitive structure'' (Reinmann et al., 2010).

Reinmann et al. (2010) propose four dimensions for the commoditisation level of an industry: product homogeneity, price sensitivity, switching cost and industry stability. Reinmann et al. (2010) also propose evaluating a set of statements on each dimension with a five-point Likert scale (see Table 10).

Table 10.
Statements on industry commoditization level.

Product homogeneity
In our industry, most products have no intrinsic differences from competing offerings.
In our industry, product offerings are highly standardised.
In our industry, homogeneity of technology and markets is high.
In our industry, many products are identical in quality and performance.
Price sensitivity
In our industry, customers check prices even for low-value products.
In our industry, customers buy the lowest-priced products that will suit their needs.
In our industry, customers rely heavily on price when it comes to choosing a product
Switching cost
In our industry, customers' costs in switching to another supplier (switching cost) are low.
In our industry, applying another supplier's product would be easy for the customer.
In our industry, the process of switching to a new supplier is quick and easy for the customer.
In our industry, switching to a new supplier does not bear risk for the customer.
Industry stability
In our industry, there are no frequent changes in customer preferences.
In our industry, there are no frequent changes in the product mix of suppliers
In our industry, technology changes are slow and predictable.
In our industry, product obsolescence is slow.

2.4. OTHER PERFORMANCE ATTRIBUTES IN THE SCOR MODEL

The SCOR model considers a total of five SCM performance attributes of the SCOR model. We report the two performance attributes not previously considered (SCC, 2008):

- The costs associated with operating the supply chain. Two metrics: Supply Chain Management Cost and Cost of Goods Sold.
- The effectiveness of an organisation (note: we have no focal company, so we should use "the effectiveness of the business entities in the wood supply chain" instead of "an organisation") in managing assets to support demand satisfaction. This includes the management of all assets: fixed and working capital. Three metrics: Cash-to-Cash Cycle Time, Return on Supply Chain Fixed Assets, Return on Working Capital.

3. Mapping of supply chains

This section aims to provide an exploratory review of themes (iii), which is:
iii) Summarise the theory on supply chain mapping, and identify generic methodologies that are used to represent and describe (i.e. map) supply chains.

In Subsection 0, we review six supply chain management reference models as well as two models of supply chain management processes. Then, in Subsection 0, we review typologies to characterise supply and value chain, a service and collaborative planning in a supply chain.

3.1. MODELS

Fettke et al. (2006) provide a survey and a classification scheme of business process reference models. They analyse 30 models based on several criteria such as: the origin of the model (e.g. science, practice), accessibility (i.e. open or closed), the application domain, the process modelling languages used, the size of the model and the construction method. One reference model has an application domain for supply chain management, the SCOR model, while another model has an application domain in production, planning and control system, the Aachen PPC model. We review both of them in the following subsections.

In a recent PhD Thesis, Blecken (2009) provides an overview of 26 reference models that fulfil the following criteria:

- The reference information model is the outcome of the construction of a modeller who declares information about universal elements of a system relevant for application system or organisation developers to solve a specific task at a given time in a given language in such a way that a point of reference for an information system is created;
- The reference model addresses either the tasks or activities of supply chain management and logistics or the reference model has a dedicated focus on business processes.

Based on its overview, Blecken (2009) provides a review of six reference models which fulfil the following criteria.

- The reference model addresses tasks and activities of supply chain management and logistics.
- The reference model provides some guidance with respect to business processes of supply chain management and logistics.
- The size and level of detail of the reference model are sufficient to provide concrete recommendations for organisations.
- The reference model has been evaluated through the application in practice or in case studies.
- The reference model employs a standardised (semi-) formal language.

In this subsection, we review the six supply chain management reference models that fulfil the criteria of Blecken (2009) as well as two models of supply chain management processes.

3.1.1. SCOR model version 9

The Supply Chain Operations Reference model (SCOR model) has been developed to describe the business activities associated with all phases of satisfying a customer's demand (SCC, 2008). The model focusses on one enterprise and spans from its supplier's supplier to its customer's customer. The SCOR model is organised around five processes types, (see Table 11). By describing supply chains using these process building blocks, the SCOR model can be used to describe supply chains that are very simple or very complex using a common set of definitions (SCC, 2008). The SCOR model being a hierarchic model, the five processes types (level 1) then extend in two other levels: process categories (level 2) and process element (level 3). For the execution process types Source, Make and Deliver, Levels 2 and 3 then extend according to three supply chain configuration possibilities of the Customer Order Decoupling Point (see above for details on CODP): make-to-stock, make-to-order and engineer-to-order. The SCOR model also includes supply chain performance metrics, best practices and, for each process type, enables elements. Bolstorff and Rosenbaum (2007) provide a step-by-step methodlogy using the SCOR model version 8 to support managers in achieving improvement projects in their supply chain processes.

Table 11.
Processes types of the SCOR model (Bolstorff and Rosenbaum, 2007).

Generic process	Definition
Plan	Assess supply resources, aggregate and prioritise demand requirements, plan inventory for distribution, production, and material requirements, and plan rough-cut capacity for all products and channels.
Source	Obtain, receive, inspect, hold, issue, and authorise payment for raw materials and purchased finished goods
Make	Request and receive material, manufacture and test products, package, hold, and/or release products
Deliver	Execute order management process, generate quotations, configure product, create and maintain product/price database, manage accounts receivable, credits, collections, and invoicing, execute warehouse processes including pick, pack, and configure, create customer-specific packaging/labelling, consolidate orders, ship products, manage transportation processes and import/export, and verify performance;
Return	Defective [products], warranty, and excess return processing, including authorisation, scheduling, inspection, transfer, warranty administration, receiving and verifying defective products, disposal, and replacement

The SCOR model is still evolving. A preview of the new version 10 of the SCOR model was released online June 30, 2010 (SCC, 2010). The main novelty is the introduction in the SCOR model of standards definitions for workforce assets (i.e. the 'inventory' of skills in a supply chain), (see Table 12).). The SCOR model is silent on human resources and training in prior versions.

Table 12.
Workforce asset in SCOR model version 10 (SCC, 2010).

Workforce assets	Definition
HS-Skills	The capacity to deliver pre-determined results with the minimum input of time and energy.
HE-Experiences	The knowledge or skill acquired by observation or active participation over a period of time in a particular profession. Experience refers to know-how or procedural know-ledge, rather than propositional knowledge: on-the-job training rather than book-learning.
HA-Aptitudes	A natural, acquired, learned or developed ability to do a certain kind of work at a certain level.
HT-Training	A particular skill or type of behavior learned through instruction over a period of time. Training refers to propositional knowledge, rather than know-how or procedural knowledge: book-learning and classroom-learning rather than on-the-job training.

3.1.2. ARIS House of Business Engineering model

A part of the review by Blecken (2009) is presented here, since the references on the ARIS House of Business Engineering model are available only in German:

"ARIS (Architecture of integrated information systems) provides a framework for the development, improvement, and implementation of integrated information and communication systems and aims to align enterprise information systems with all external and internal requirements. ARIS thus provides a framework which partitions the description of the model into perspectives and layers each with their own sets of modelling elements and languages.

ARIS provides several perspectives on an organisation, viz. the organisational view, data view, function view, control view, and output view. These perspectives are used as a means to reduce complexity of the overall system. Moreover, the redundant use of objects in the model is circumvented. The different perspectives can make use of different modelling techniques and languages.

The organisational view denotes the class of organisational units and thus the organisational structure. Within the organisational structure, several task bearers are distinguished. The data view comprises all environmental data and messages which can trigger functions or which are created by the execution of functions. The function perspective illustrates all processes which transform input objects into output objects. Here, the notions of function, activity and process are used indiscriminately. Objectives of the organisation are also attributed to the function perspective since functions serve to pursue and are controlled by these objectives. The output view contains all material and imamterial input and output services including the financial flow. Lastly, the control or process view integrates all the latter perspectives and creates the framework for the systematic analysis of the bilateral relationships between the perspectives. The control view serves to model the control flow of the model, i.e. the temporal-logical sequence of the business process. While the first four perspectives describe the structure of the model, the latter process perspective portrays the dynamic, behavioural aspects of the business process flow.

ARIS foresees modelling the perspectives described before in a sequential and iterative process. The process models the three layers (functional) concept, data processing and implementation layer for each of the perspectives. The objective is to transform process-oriented models into information systems. In a first step, the functional concept is described independently of the applied information systems (requirements specification). Here, languages are chosen which are comprehensible from a business perspective but also formal enough that they can serve as the basis for an IT implementation. The data processing layer follows, in which it is defined how the contents of the functional concept layer can be implemented with information systems. Here, the requirements for the interfaces of implementation tools such as database systems or programming languages on the functional concepts are aligned (design specification). Lastly, the implementation layer is concerned with the construction of programming code and executable software.” The entire ARIS model is displayed in (see Figure 4).

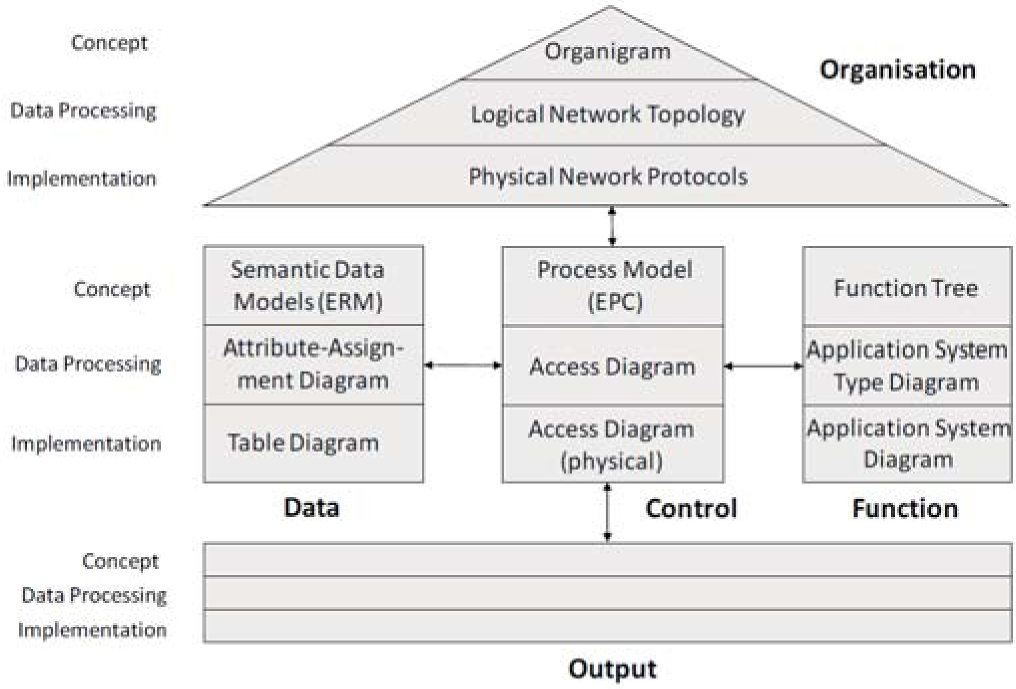

Figure 4.
ARIS House of Business Engineering model (Blecken, 2009).

3.1.3. R/3 model

A part of the review by Blecken (2009) is presented here, since the publication references on the R/3 model in English are scarce:

"The R/3 Reference Model is a comprehensive business process model that contains more than 4000 entity types in the data model and more than 1000 business processes and over 100 inter-organisational business scenarios in the process reference models. The R/3 Reference Model provides a comprehensive view of the main processes and business solutions available in the SAP R/3 system. It was developed based on SAP's empirical know-how of best practices in business processes of various industries. It is a tool that supports configuration of organisation-specific business processes. SAP has created a business blueprint which is a description of the R/3 Reference Model. The business blueprint has the objective to clarify what processes are decisive for supporting the organisations' activities and how these are linked. The R/3 Reference Model employs event-driven processes chains to provide templates for many different situations from "asset accounting" to "procurement" and "treasury".

Five views are provided by the R/3 Reference Model: A Process view which displays the network event-driven process chains; a Function view which presents a summary of the business functions required for R/3; an Information flow-view which models the information flow between event-driven process chains; a Data view which clusters data structures required for the business processes; and an Organisation view illustrating the relationships between the organisational units of the enterprise."

3.1.4 Retail-H model

A part of the review by Blecken (2009) is presented here, since the publication reference on the Retail-H (Becker and Schütte, 2006), is available in German only:

"Retail companies are the intermediaries of manufacturing companies and end consumers. They are characterised by a both temporal and spatial bridging function. Retail information systems are information systems which cover "not only merchandise tasks but also business administrative tasks as well as general controlling and company planning tasks." Retail information systems traditionally displayed certain weaknesses in terms of intra- and inter-company communication and coordination and legacy software architecture. The Retail-H was developed to address these shortcomings.

The Retail-H summarises the tasks of a retail company. The different views, function, data, and process, are distinguished similarly to the ARIS architecture. The function view lists all elementary functions of procurement, warehousing, distribution, administration, and strategic and tactical planning. The data view depicts the static structures in the form of ERMs. The process view determines the temporal-logical sequence of activities and combines functions and data together with the temporal aspect.

On the left side of the Retail-H (see figure 5), the area of procurement is shown; the right side is composed of distribution and sales tasks. Warehousing is located in between these two and thus interconnects procurement and distribution. Procurement consists of contracting, purchasing, goods receipt, invoice verification, and creditor accounting. Distribution is comprised of marketing, sales, goods issue, billing and debtor accounting. The foundation of the model is composed of the functional areas general ledger and fixed-asset accounting, cost accounting and human resource management. Overarching the Retail-H are organisational tasks, viz. company planning, executive information systems and controlling. The information systems in the "roof" of the Retail-H aggregate data from the underlying layers to significant performance indicators which provide the basis for executive management decisions."

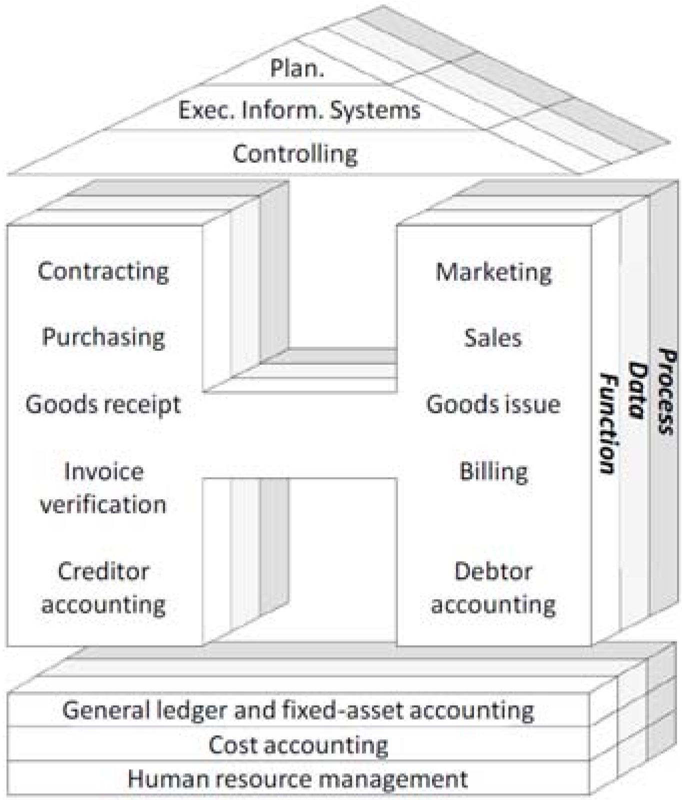

Figure 5.
The Retail-H model (Blecken, 2009).

3.1.5. Aachem PPC model

A part of the review by Blecken (2009) is presented here, since the publication reference on the Aachen PPC model (Schuh and Gierth, 2006), is available in German only:

"The Aachen Production Planning and Control model (Aachen PPC model) takes a holistic perspective on the production system. A company's and furthermore its suppliers' resources and processes need to be geared to create added-value and have to be aligned with the customers' requirements. The main objective is the optimisation of the production system. Thereby, a production system encompasses the entire production organisation including all concepts, methods, and tools. The interaction of these elements characterise the effectiveness and efficiency of the entire production flow. The Aachen PPC model has been developed to enable the implementation of projects focussing on the reorganisation of PPC as well as development, selection, and implementation of PPC concepts and systems.

Furthermore, the Aachen PPC model has the objective to describe production planning and control from different perspectives. Hence, reference views are created among which are the task view, process view, function view, and data view. There are a number of additional views such as the object-oriented view, the goal view, and others which are not elaborated here. The tasks view specifies and details the tasks of PPC in a hierarchical abstraction for the manufacturing company and its suppliers. Inter-company network tasks, intra-company core tasks and cross-sectional tasks are distinguished. The core tasks define the requirements for PPC from the manufacturing organisation. In the process view these tasks are extended by a temporal-logical sequence. Interfaces to other processes and external partners are defined. Several manufacturing-type dependent processes are available here which can be customised to the organisation at build-time. The function view serves to describe the requirements for IT systems for production planning and control. Reference functions are described in a flat hierarchy and are structured analogously to the task view in order to support rapid identification of functions necessary to support certain tasks. Finally, the data view delivers the required data. All data necessary to execute PPC systems are contained.

Similar to ARIS, a number of perspectives are used to enable the holistic modelling of a PPC system. Furthermore, detailed process descriptions, function catalogues and data structures are delivered with the model. While the model excels both in depth and application breadth, it remains strongly focussed on manufacturing tasks and does not address distribution and procurement tasks in a detailed manner."

3.1.6. PRO-NET model

A part of the review by Blecken (2009) is presented here, since the publication reference on the PRO-NET model (Erzen, 2001) is available in German only:

"Erzen (2001) develops the reference model PRO-NET for textile supply chains focussing on improving the cooperation in these supply chains with respect to order planning and production control. In order to achieve this, Erzen combines elements of process and coordination management. The model can thus be integrated in an inter-organisational concept which includes design, planning and implementation of cooperation in textile supply chains.

Erzen's reference model can be classified as an organisational object model describing the behaviour of a system. It is intended for business process management and describes tasks and processes within its application domain. The focus is on the information flow rather than on the material flow. The reference model for order processing is complemented with a methodology for organisations to compare their processes to the reference processes and if needed adjust their processes according to the reference model and thus realise potentials for improvement. Object of the model is the description of cooperative customer-supplier relations with respect to order processing on the basis of framework orders, such as those typically found in textile supply chains. External and internal production as well as suppliers and customers are within the scope of the model.

Erzen presents his reference model with hierarchical flowcharts which capture all activities involved in order processing of textile supply chains. The model incorporates roles and responsibilities as well as objectives of supply chain partners and distinguishes between strategic, tactical and operational layers. Colours are used to point out to which layer activities are attributed. However, Erzen's reference model also suffers certain shortcomings: The lack of a formal language limits the modelling options and the possibility to extend the reference model and adapt it to order processing in other supply chains. Furthermore, the lack of a formal language also hampers the use of the model to support the implementation of IT systems or IT-supported workflow management. The reference model does not include data or function models which are needed when implementing IT systems to support order processing. Finally, the reference model does not support adaptation by use of build-time and run-time operators and thus the reusability of the model is reduced."

3.1.7 GSGF model

According to Azevedo et al. (2009), two mains reference models are currently recognized when defining supply chain management processes: the Global Supply Chain Forum (GSCF) model of Ohio State University (Lambert, 2004; Lambert et al., 2005) and the previously discussed SCOR model of the Supply Chain Council (SCC, 2008). The GSCF model is organised around eight supply chain processes, (see Table 13).

The GSCF model does not fulfil all the criteria of a reference model according to Blecken (2009), e.g. the model does not employ a standardised (semi-) formal language. Several related models on supply chain management processes are found in the literature. The interested reader is referred to the survey by Blecken (2009) that includes the well-known planning matrix for supply chain management of Fleischmann et al. (2008) and to the recent state-of-the art model on supply chain management processes proposed by Azevedo et al. (2009).

Table 13.
Processes of the Global Supply Chain Forum model (Lambert, 2004).

Process	Definition
Customer Relationship Management	Provides the structure for how relationships with customers are developed and maintained.
Customer Service Management	Represents the firm's face to the customer by providing information to the customer and administering the product and service agreements.
Demand Management	The process that balances customer requirements with supply chain capabilities with forecasting and by synchronising supply and demand, increasing flexibility and reducing variability.
Order Fulfilment	Includes all activities related to filling customer, defining customer requirements, designing a network and enabling the firm to meet customer requests while minimising the total delivery cost.
Manufacturing Flow Management	Includes all activities necessary to obtain, implement and manage manufacturing flexibility in the supply chain and move products through the plants.
Supplier Relationship Management	Provides the structure for how relationships with suppliers are developed and maintained.
Product Development and Commercialisation	Provides the structure for working with customers and suppliers to develop products and bring them to market.
Returns Management	The process by which activities associated with returns, reverse logistics, 'gatekeeping' and return avoidance are managed within the firm and across key members of the supply chain.

3.1.8. **Azevedo et al. (2009) model**

Mentzer et al. (2007) have proposed a three-category classification for a process: "(i) core processes that are needed to attain business goals by enabling goods and services to reach an external customer; (ii) support processes that are needed to make the core processes work as well as possible, but which are not critical to the success of the company; (iii) management processes which are broader knowledge domains used to control and coordinate the core and support processes. Recently, Azevedo et al. (2009) justify the modification of the terminology 'management processes' for 'management competences'.

Recently, Azevedo et al. (2009) propose a state-of-the art model for the *core processes* in SCM (see Figure 6). WP-5100 aims the processes at the operational level, so we target the processes in 'Value Commitment', 'Order Fulfilment' and 'Inventory Replenishment'. Product development and product return are beyond the scope of the project, thus the processes in 'Product Return' and 'Value Development' are not covered.

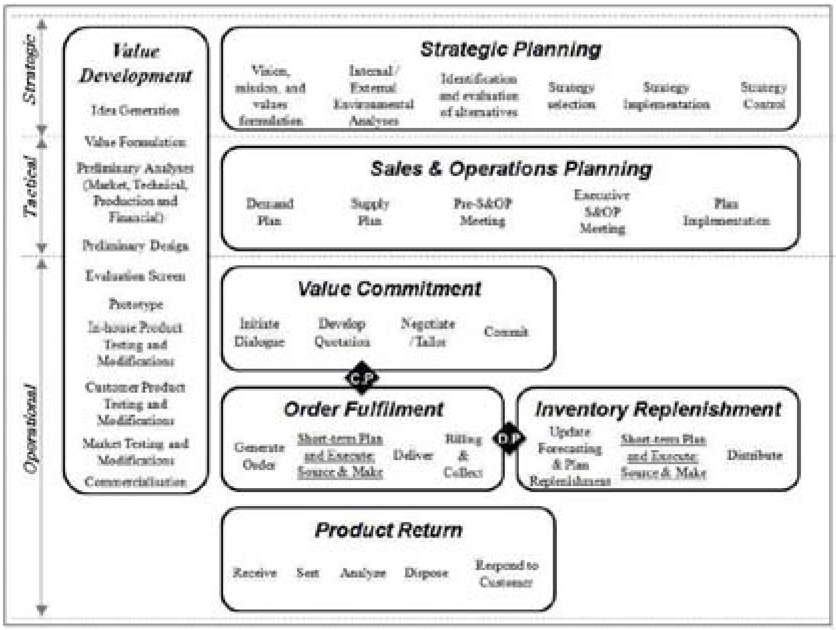

Figure 6.
Supply chain management core processes model by Azevedo et al., (2009) (Azevedo et al., 2009).

3.1.8.1. Commitment point and the decoupling point

Two key concepts are illustrated in above Figure 6.

- Designated by the black diamond C.P., the commitment point is defined by "the stage where parties need to commit to the transaction or to a series of transactions (...), a decision with implications for both sides" (Daniel et al., 2003).
- Designated by the black diamond D.P., the decoupling point or, the usual typology in the literature, the Customer Order Decoupling Point (CODP). Wikner and Rudberg (2005) provide the common definition of the CODP in the literature: "(…) the point in the flow of goods where forecast driven production and customer order driven produc-

tion are separated" or, in other words by Rudberg and Wikner (2004), "(…) the point in the value-adding material flow that separates decisions made under uncertainty from decisions made under certainty concerning customer demand (…)". Four typologies of CODPs are traditionally defined in the literature: engineer-to-order, make-to-order, assemble-to-order and make-to-stock (Wikner and Rudberg, 2005). More typology of CODPs can be found, e.g. sale-to-order and deliver-to-order in Poulin et al. (2006). Rudberg and Wikner (2004) and Wikner and Rudberg (2005) also extend the traditional typology of CODPs to add an engineering dimension, e.g. engineer-to-stock.

The CODP is sometimes referred to as the order penetration point (Wikner & Rudberg, 2005). It can also be referred to as the postponement point or where the product is differentiated (Poulin et al., 2006). In its review on postponement (see also the review by Yang et al. (2004) and Boone et al. (2007)), van Hoek (2001) mention that "postponement means delaying activities in the supply chain until customer orders are received with the intention of customising products, as opposed to performing those activities in anticipation of future orders."

The CP and CODP concepts are tightly connected with the processes dealing with the customer, mainly the sales. However, the SCOR model doesn't address the sales to the customer while our framework should be able to capture sales done at the operational level. Based on the same structure of the SCOR model, the Supply Chain Council provides the Customer Chain Operations Reference model, CCOR model (SCC, 2004), to address sales. The CCOR model uses five basic processes: plan, relate, sell, contract and assist.

3.2. TYPOLOGIES

Meyr and Stadler (2008) and Kannegiesser (2008) provide a typology to describe, respectively, a supply chain and a value chain, by a set of attributes relevant for decision-making. Attributes may have nominal properties (e.g. a product is storable or not), ordinal properties (e. g. an entity's power or impact on decision-making is regarded higher or lower than average) or cardinal properties (i. e. the attribute can be counted, like the number of legally separated entities within a supply chain) (Meyr and Stadler, 2008). The typology presented by Kannegiesser (2008) is an extension of the typology of Meyr and Stadler (2008). We report each of them in the following subsections.

3.2.1. Typology to characterise a supply chain

Meyr and Stadler (2008) discriminate between two groups of attributes: the functional attributes to be applied to each organisation, entity, member, or location of a supply chain as well as the structural attributes describing the relations among its entities. We report each set of attributes in **Error! Reference source not found.** and Table 15). For the details of each characteristic and attribute, we refer to Meyr and Stadler (2008).

Table 14.
Functional characteristics and attributes details (Adapted from Meyr and Stadler, 2008).

Type	**Characteristics**	**Possible or range of attributes or definition**
Procurement	Number of products procured	Few to many
	Type of product procured	Standard to highly specific product
	Sourcing type	Single sourcing, double sourcing, multiple sourcing
	Flexibility of suppliers	Flexible quantity, fixed quantity, minimum quantity, maximum quantity
	Supplier lead time	Short to long
	Supplier reliability	Reliable, unreliable
	Materials' life cycle	Short, middle, long
Production	Organisation of the production process	Flow shop, cellular, job shop, flow line
	Repetition of operations	Mass production, batch production, making one-of-a-kind product
	Changeover characteristics	Lower to higher setup time (or cost)
	Bottlenecks in production	Identification of the potential bottleneck(s) depending on the mix of demand
	Working time flexibility	Capability and lead times to adapt working time to changing demand pattern: low to high
Distribution	Distribution structure	One-stage, two-stage, three-stage
	Pattern of delivery	Cyclic, dynamic
	Deployment of transportation means	Standard routes, variable routes or capacity on individual link in the distribution network or cost function without capacity
	Loading restrictions	List of the requirement(s) (e.g. only full truckload)
Sales	Relation to customers	Contract to pure market
	Availability of future demands	Known (order), forecasted
	Demand curve	Static, sporadic, seasonal
	Products' life cycle	Short, middle, long or number (e.g. several years)
	Number of product types	Few to many or number (e.g. hundreds)
	Degree of customisation	Standard products to highly specific products
	Bill of materials	Serial structure, convergent structure, divergent structure, mixture of the three
	Portion of service operations	n.a.

Table 15.
Structural characteristics and attributes details (Adapted from Meyr and Stadler, 2008)

Type	Characteristics	Possible or range of attributes or definition
Topography of a supply chain	Network structure	Serial, convergent, divergent, or a mixture of the three
	Degree of globalisation	Single country to several continents
	Location of decoupling point(s)	May differ between the product groups
	Major constraints	List of the main bottlenecks of the supply chain (as a whole) are
Integration and coordination	Legal position	Inter-organisational, Intra-organisational
	Balance of power	Focal firm to polycentric supply chain
	Direction of coordination	Purely vertical, purely horizontal, mixture of both
	Type of information exchanged	List of information exchanged.

3.2.1. Typology to characterise a value chain

Kannegiesser (2008) provides a typology to describe the characteristics of a value chain network in five sets of attributes: network, procurement, production, distribution and sales. The author applies this typology to the chemical industry, an industry that also produces mostly commodity products in as large volume as the forest product industry. We report each set of attributes in (Table 16 to 20). For the details of each characteristic and attribute, we refer to Kannegiesser (2008).

Table 16.
Network characteristics and possible attributes (Kannegiesser, 2008)

Characteristic	Possible attributes
Geographical topography	Global, regional, local
Legal position	Intercompany, intracompany
Geographical configuration	Multinational, international, classic global, complex global
Spatial dispersion	Concentred, host-market, specialised, vertical integration
Value creation focus	Production, distribution
Value creation steps	Single-step, multi-stage

Table 17.
Procurement characteristics and possible attributes (Kannegiesser, 2008)

Characteristic		**Possible attributes**
Product	Type	Commodity, specialty
	Life cycle	Short, middle, long
	Number	Low, medium, high
	Customisation	Standard, variants, customer-specific
	Perishability	Fast, medium, not perishable
Market	constellation	Monopoly, oligopoly, polypoly
	Price mechanism	Exchange, auction, negotiation
Supplier	structure	Single, few, many
	Type	Internal, external
	relation	Contract, spot
Offer	Certainty	Forecasted, stochastic, unknown
	Volatility	Stable quantity, volatile quantity, stable price, volatile price
	Elasticity	Inelastic, relatively inelastic, unitary elastic, relatively elastic
Procurement	Flexibility	Flexible quantity, fixed quantity, flexible price, fixed price

Table 18.
Production characteristics and possible attributes (Kannegiesser, 2008)

Characteristic		**Possible attributes**
Resource	Purpose	Single-purpose, multi-purpose
	Mode	Continuous, campaign, batch
	Throughput	Variable, static
Process	Method	Synthetic, analytic, regrouping, process
	Factors	Labour, assets, material, energy
	Change-overs	Flying, process, stop
Output products	Number	Single, few, many
	Factors	Static, variable
Input product	Number	Single, few, many
	factors	Static, variable

Table 19.
Distribution characteristics and possible attributes (Kannegiesser, 2008)

Characteristic		Possible attributes
Inventory	Sourcing	Single-sourcing, multi-sourcing
	Stages	Single-stage, multi-stage
Transportation	Routes	Standard routes, variable routes
	Modes	Single, multiple dedicated, multiple alternatively
	Lead times	Single-period, multi-period

Table 20.
Sales characteristics and possible attributes (Kannegiesser, 2008)

Characteristic		**Possible attributes**
Product	Type	Commodity, specialty
	Life cycle	Short, middle, long
	Number	Low, medium, high
	Customisation	Standard, variants, customer-specific
	Perishability	Fast, medium, not perishable
Market	Constellation	Monopoly, oligopoly, polypoly
	Price mechanism	Exchange, auction, negotiation
Customer	Number	Single, few, many
	Type	Internal, external
	Relation	Contract, spot
Demand	Certainty	Forecasted, stochastic, unknown
	Volatility	Stable quantity, volatile quantity, stable price, volatile price
	Elasticity	Inelastic, relatively inelastic, unitary elastic, relatively elastic
Sales	Flexibility	Flexible quantity, fixed quantity, flexible price, fixed price
	Service	Standard, differentiating

3.2.2. Typology to characterise a service

The two previous typologies have been devoted to a products-based supply chain. An important service sector (e.g. harvesting, transportation) exists in the wood supply chain. Supported by e.g. the survey by Cook et al. (1999), the principal attributes to be considered in service management are identified by Gliatis and Minis (2007). The typology of service classification by Gliatis and Minis (2007) is grouped in six distinct service dimensions based on consideration for the customer, the service provider and their interaction:

- Customer’s buying motive: attributes related to the motives that direct customer’s behaviour.
- Customer's buying practices: attributes related to the way a customer practices its buying preferences.
- Ways of service delivery: attributes related to the methods used by service organisations to deliver service offerings.
- Ways of service production: operation related attributes.
- Service output characteristics: attributes related to the nature of the end result of services.
- Service management considerations: important attributes for management to consider while making decisions concerning service execution.

We report the characteristics of each dimension in (Table 21 to Table 26).

Table 21.
Customer’s buying motive characteristics (Gliatis and Minis, 2007).

Characteristic	Definition
Type of customer	Institutions or individual customers. Institutions refer to non-individual customers that are likely to have more divergent needs and characteristics (e.g. larger quantities, more sophisticated services, etc).
Perceived risk	Perceived risk is the customer’s perception, rather than objective reality, that something may go wrong in an exchange. The dimensions of risk are: functional, physical, financial, psychological, social and time risk.
Service importance	Importance is viewed as the level of customer’s interest in the service, the extent to which they think about it, the degree of importance it has to their everyday life, the amount of enjoyment it brings, their desire to keep informed on the particular service
Purchase effort	Purchase effort is the amount of money, time and energy that the buyer is willing to expend to acquire the service.

Table 22.
Customer's buying practices characteristics (Gliatis and Minis, 2007).

Characteristic	Definition
Customer's commitment	The customer's ability to switch between competing offerings. If the customer's power towards the service provider is low then it is likely to have a high degree of commitment.
Necessity of customer's presence	Extent to which customers must be physically present with the service provider during service delivery.
Demand fluctuations (patterns)	The extent of demand fluctuations (variations) over time. Two parameters are considered: the cycle periods of these demand fluctuations (predicted, random) and the underlying causes of them (customer habits or preferences, action by third parties, non-forecastable events, etc.).
Type of relationship	Whether the service organisation enters into a "membership" relationship with its customers (telephone subscriptions, banking etc) or there is "no formal" relationship (restaurants, car rental, etc).

Table 23.
Ways of service delivery characteristics (Gliatis and Minis, 2007).

Characteristic	Definition
Interaction between Customer and Service Organisation	Whether the customer goes to the service organisation, or the service organisation comes to the customer, or the customer and the service org. transact at arm's length
Nature of Service Delivery	Continuous Delivery of Service, Discrete Transactions
Service Delivery Channel	The type and number (outlets) of the market channels used to deliver services
Priorities Serving rules	The rules used from the service organisation to serve customers under a certain priority as they enter the service system

Table 24.
Ways of service production characteristics (Gliatis and Minis, 2007).

Characteristic	**Definition**
Object processed	The object that is processed (people, materials, information) by the service organisation in order to deliver a specific service.
Direct provider of the service (equip- ment vs. people)	Equipment-focussed services are those where the provision of certain equipment is the core element in the service delivery. People-focussed services are those where the provision of contact staff is the core element in service delivery.
Extent of Customer Contact	The extent of customer contact in the creation of the service. Customer contact refers to the physical presence of the customer in the system, and creation of the service refers to the work process that is entailed in providing the service itself. Extent of contact here may be roughly defined as the percentage of time the customer must be in the system relative to the total time it takes to serve him.
Customer's Influence	Degree to which the consumer by his/her presence, interaction and/or participation, in some way influences the service process. The customer can influence both the design and the delivery as well as the service content.
Customisation /Routinisation	A high degree of customisation is where the service process can be adapted to suit the needs of individual customers (fluid). A low degree of customization is where there is non-varying standardized process (rigid); the customer may be offered several routes but the availability of routes is predetermined.
Product / Process focus	A product-oriented service is where the emphasis is on what the customer buys. A process-oriented service is where the emphasis is on how the service is delivered to the customer.
Personnel judgment	Extent to which personnel exercise judgment in meeting individual needs. A high degree of discretion is where front-office personnel can exercise judgment without referring to superiors. A low degree of discretion is where changes to service provision can be made only with authorisation from superiors.
Value added, Back office / Front office	A back-office-oriented service is where the proportion of front-office staff to total staff is small. A front-office-oriented service is where the proportion of total office staff to total staff is large.

Table 25.
Service output characteristics (Gliatis and Minis, 2007).

Characteristic	**Definition**
Degree of tangibility	The extent to which a service act contains Intangible or Tangible elements.
Individual / Collective services	A collective service is provided whenever changes occur in the conditions of several persons, or of goods belonging to several economic units, as a result of the activity of a single economic unit, with the agreement of all concerned.
Ownership	Owned goods services, Rented good services.
Single service / Bundle of services	Bundle of services refers to additional services or elements that are added to facilitate successful completion of the primary transaction. The key advantage is that of 'one-stop-shopping' for an array of services.
Timing and Duration of benefits	The length of time over which the change affected may normally be expected to persist.

Table 26.
Service management considerations characteristics (Gliatis and Minis, 2007)

Characteristic	Definition
Extent to which supply is constrained	The extent to which peak demand can usually be met without a major delay or regularly exceeds capacity.
Management's degree of control	Decisions that management makes regarding process design. How many controls the company has planted into the service delivery system and how many routes are available to deliver service offerings.
Perceived risk for the company	Perceived risk is the company's speculation that something may go wrong in an exchange that could lead to loss exposure.
Production (& Transaction) cost	How much effort is required for a service to be produced by the service provider.
Degree of regulation	The extent of regulations that influence the process delivery. Two parameters should be considered: the extent of regulations that influence the process and the degree of compliance with this regulations.

3.2.3. Typology to characterise collaborative planning in a supply chain

A planning process in a supply chain exists within one business entity and also among two or more business entities. In the latter case, we refer to *collaborative planning* or, for a formal definition by Stadler (2009): "a joint decision making process for aligning plans of individual SC members with the aim of achieving coordination in light of information asymmetry". In a supply chain, one entity can be involved in collaborative planning both downstream (e.g. with customers) and upstream (e.g. with suppliers).

A *coordination scheme* is a "procedure for aligning individuals' plans of two or more decision-making units" while a *collaborative planning scheme* further requires that "individuals' plans are adapted in an effort of joint decision making, i.e. a willingness to cooperate and to contribute to the generation of a plan which will be accepted by these SC members (which may well be a subset of the overall SC)" (Stadler, 2009).

Stadler (2009) provides a typology to characterise a collaborative planning problem and scheme in a supply chain according to three broad categories:

1. The structure of the supply chain, the relationships among supply chain members and the requirements for the supply chain solution.
2. The decision situation facing each supply chain member.
3. The characteristics of the collaborative planning scheme.

We report the characteristics of each category in (Table 27 to Table 29).

Table 27.
Characteristics for the structure, the relationships and the solution requirements (Stadler, 2009).

	Characteristics
Structure	Number of SC tiers Number of SC members on each tier Business functions SC members fulfil
Relationships	Power of each SC member Extent of self-interest governing an SC member's behaviour Learning effects Rolling schedules
Solution requirements	Alignment of flows Search for the SC optimum Search for a fair solution

Table 28.
Characteristics for the decision situation (Stadler, 2009).

Decision models	Which decisions take place?
Phases of collaboration	When does collaboration take place?
Information status • Information hidden for each SC member. • Information exchanged.	What is the information status of each SC member? • Which information is hidden to the other party? • What is the type of information to be exchanged in the course of collaboration?
Degree of uncertainty	A deterministic or a stochastic situation?
Objective(s)	What are the objectives of the decision problem?

Table 29.
Characteristics of the collaborative scheme (Stadler, 2009).

Presence of a mediator
• Initial solution • Number of plans exchanged • Number of rounds • Parallel offers • Total number of offers
Final results • Quality of the solution • Side-payments

The term coordination/collaborative mechanism instead of coordination/collaborative scheme is also used in the literature. Frayret et al. (2004b) propose seven classes of generic coordination mechanism:

1. By direct supervision with coordination by plan.
2. By direct supervision with coordination during activities execution.
3. By mediation with coordination by plan.
4. By mediation with coordination during activities execution.
5. By mutual adjustment with coordination by plan.
6. By mutual adjustment with coordination during activities execution.
7. By standardisation.

Audy et al. (2010) extend three of these classes (i.e. 1, 3 and 5) to propose five collaborative mechanisms.

Coordination and collaborative planning involve the management of dependencies among activities occurring in the supply chain. Frayret et al. (2004b) review the various forms of interdependence between two or more activities and also review specific coordination mechanisms for each of them (see Table 30).

Table 30.
Type of interdependence and corresponding coordination mechanisms (Frayret et al., 2004b).

Type of interdependence	Characteristics	Coordination mechanisms
Pooled	Involved in organisational resources sharing Each part renders a discrete contribution to the whole and each is supported by the whole Resource allocation problem	Direct communication Use of common staffs to support these activities Rules-of-the-game to manage prescribed and forbidden actions Market-based pricing and bidding mechanisms
Sequential	Producer–consumer relationship Links two activities for which the output of one is the input of the other Three subtypes: Prerequisite constraint; Output/input transfer; Input usability	Coordination by plan Cross-activity programming Notification, sequencing, tracking Inventory management (e.g., JIT, EOQ) Standardisation, ask users, participatory design, concurrent engineering
Reciprocal	Links two activities for which their outputs are the reciprocal inputs of the other	Use of formalised contractual systems of both rules and supervisory hierarchical roles Coordination by mutual adjustment
Intensive	Related to the intrinsic sophistication of activity embeddedness	Collaborative relationships involving one-to-one mutual adjustment
Task/subtask	Involves top-down goal selection and decomposition, or bottom-up goal identification	Goal selection Task decomposition
Simultaneity	Occurs when activities must be carried out, or not, at the same time	Scheduling Synchronisation

4. Mapping of supply chain in the forest product industry and other various works

The aim of this section is to provide an exploratory review of themes (iv), which is:

iv) Review existing research aiming to measure and map supply chains in the forest products industry as well as other research that could provide input information (e.g. lists of actors, decisions and main constraints in WSS) in the development of our framework.

Some publications on SC mapping in the forest products industry have been found. Using four of the five basic processes of the SCOR model (i.e. Plan, Source, Make and Deliver), Frayret et al. (2007) propose an agent-based planning system for a network of softwood sawmills. De Santa Eulalia (2009) presents a methodological framework to provide a uniform representation of distributed advanced planning and scheduling systems using agent technology and makes its proof-of-concept in a network of softwood sawmills. Using the Value Stream Mapping methodology, Jacques (2009) demonstrates its application to illustrate material flows in different production units of the forest products industry (i.e. a typical sawmill, chemical pulp mill, OSB mill and wood pallets mill), and also to illustrate the material flows in a generic value creation network of the forest product industry.

Publications to provide input information in the development of our framework can be classified in three categories:

i) Publication in Management Sciences, Operations Research and Supply Chain Management (MS, OR & SCM) applied to the wood supply chain, see literature review Rönnqvist (2003), Frayret et al. (2004a), Weintraub et al. (2007) and D'Amours et al. (2008).

ii) Glossary in forestry (Pulkki, 2010 and in MS, OR & SCM (Klappich, 2010; CSCMP, 2010b).

iii) Publication on MS, OR & SCM concepts to be potentially highlighted in our framework. We list them:

- Different frameworks exist in the literature to assess the different dimensions, level or intensity of collaboration and integration in a supply chain, see e.g. Frayret et al., 2003 and Cruijssen et al., 2007 and, for a general discussion on several definitions of collaboration in the supply chain, Fugate et al. (2009).
- Type of control architecture for planning systems, see five types by Frayret et al. (2004b): centralised, proper hierarchy, modified hierarchy, heterarchy and quasi-heterarchy.
- Distinct between processor, product and process (from D’Amours et al., 2009).

- The abstract model used to represent a real complex network usually involves many components. To model a product transformation, three components are required: a processor, a product and a production process.

- The processor is the machine, the human being, the installation or the production line that is to perform the production / transformation work.
- The product may take different forms depending on its location along the production line or along the supply chain.
- The production process is what ties the processor to the product: it describes how the product will be transformed by the processor. It should be noted that a transformation on a product may involve not only a physical modification, but also a change of location. In that view, a truck may be a processor and the actual transportation can be seen as a process done on the product to be moved. Types of relationship to model a process are: one-to-one relationship (1 input, 1 output), one-to-many relationship (1 input, many outputs), many-to-many relationship (many inputs, many outputs).
- The processors are typically associated with a limited capacity (either in terms of throughput, hours available, batch size or time window availability) and an operating cost which can be a fixed cost, a cost per unit of time or a cost per batch. As for the product, it may influence some characteristics of the processses like the duration, the quantity of certain resources required and the resulting products, co-products (i.e. a valuable product that is created as a result of producing the main product) or by-products (i.e. low or zero value product deriving from a production process and that would be avoid if possible).

- Concepts of Available to Promise (ATP), Capable to Promise (CTP) and Profitable to Promise (PTP) (CSCMP, 2010b):
    - Available to Promise (ATP): The quantity of a product which is or will be available to promise to a customer based on their required shipment date. ATP is typically 'time phased' to allow for promising delivery at a future date based on anticipated purchase or production receipts.
    - Capable to Promise (CTP): A technique similar to Available-to-Promise, it uses the availability of individual components to determine if an end item can be configured and assembled by a customer-given request date and provides the ability of adjusting plans due to inaccurate delivery date promises. Capable to promise looks at both materials and labour/machine requirements.
    - Profitable to Promise (PTP): This is effectively a promise to deliver a certain order on agreed terms, including price and

delivery. Profitable-to-Promise (PTP) is the logical evolution of Available-to-Promise (ATP) and Capable-to-Promise (CTP). While the first two are necessary for profitability, they are not sufficient. For enterprises to survive in a competitive environment, profit optimisation is a vital technology.

- Three criteria that define how orders are won or lost (Hill, 1995):
  - Order winners: criteria that win contracts on the marketplace.
  - Qualifiers: criteria that qualify the company as a potential supplier.
  - Order-losing: criteria that lose contracts on the marketplace, and most likely potential future orders, if the firm does not meet the necessary standards of such criteria.
- The roles of order winners and qualifiers criteria are not stable: they change over time, they work in combinations, and they work in different ways on different markets and with different customers (Hörte and Ylinenpää, 1997).
  - Incoterm (international commercial terms), see e.g. Wikipedia (2010b).
  - Responsibility assignment matrix (RACI model, see table 31) with its several extensions, (see table 32).

Table 31.
RACI model (Wikipedia, 2010a).

Key responsibility	**Description**
R - Responsible	Those who do the work to achieve the task. There is typically one role with a participation type *Responsible*, although others can be delegated to assist in the work required.
A - Accountable (also Approver or final Approving authority)	Those who are ultimately accountable for the correct and thorough completion of the deliverable or task, and the one to whom *Responsible* is accountable. In other words, an *Accountable* must sign off (Approve) on work that *Responsible* provides. There **must** be only one *Accountable* specified for each task or deliverable.
C - Consulted	Those whose opinions are sought; and with whom there is two-way communication.
I - Informed	Those who are kept up-to-date on progress, often only on completion of the task or deliverable; and with whom there is just one-way communication.

Table 32.
Extensions of the RACI model (Wikipedia, 2010a).

Model	Key responsibility	Description
RASCI (RASIC)	R - Responsible	Those who are responsible for the task, ensuring that it is done as per the Approver.
	S - Support	Resources allocated to *Responsible*. Unlike *Consulted*, who may provide input to the task, *Support* will assist in completing the task.
RACI-VS (VARISC)	V - Verifier	Those who check whether the product meets the acceptance criteria set forth in the product description.
	S - Signatory	Those who approve the *Verify* decision and authorise the product hands-off. It seems to make sense that the *Signatory* should be the party *Accountable* for its successor.
RACIO (CAIRO)	O - Out of the Loop (or Omitted)	Designating individuals or groups who are specifically not part of the task. Specifying that a resource does not participate can be as beneficial to a task's completion as specifying those who do participate.

One similar model of the responsibility assignment matrix could also contribute to the framework, (see Table 33). The PACE model is used for “decision making process and supports reaching decisions faster while keeping all the actors informed, by reducing the "debate time" between the actors involved” (Wikipedia, 2010a).

Table 33.
PACE model (Wikipedia, 2010a)

Key responsibility	Description
Process Owner (or Process Leader)	One person has the Process Owner role to drive the decision making process on behalf of the Approver and is clear about that responsibility. The Process Owner is expected to bring well thought-out/researched options to the Approver who will make decisions regardless of consensus among all stakeholders.
Approver	The Approver decides by vetoing or choosing one of a series of well laid-out options presented by the Process Owner. The Approver is expected to possess the skills and experience to make decisions that will not be overturned, and helps to mentor/coach others until they gain requisite experience to become an Approver. Only the Approver may veto all options.
Consulted	Consulted people must not attempt to veto by going to the level above to overturn a decision.
Executers	Those who carry out the decision once made. Execution with excellence is expected regardless of intellectual buy-in.

Process management has been around for a long time and interest in the discipline remains high. Extensive literature furnishes several process management descriptions, but there doesn’t appear to be any really commonly known, widespread model. However, when discussing and analysing “processes”, it is important to define the “process” aimed at in the study. Process management for a single process within a supply chain will differ from process management within an entire production system, i.e. system management. This is a major challenge when striving towards portraying a “typical wood supply system of region X”. In order to be concrete when discussing and comparing different supply chains in terms of performance metrics, the need for a focal point within the supply chain evolves. Hence, the process management, rather than the system management view, is needed in order to achieve the study goals.

5. Conclusion

WP-5100 aims to develop a framework to describe and represent any wood supply system in which the agility, competitiveness and customisation capability of the system are highlighted. Next, WP-5100 seeks to use the developed framework to study wood supply systems in different parts of the world so that, by their analysis and comparison, basic designs of planning systems are identified. Finally, the aim is to describe each of these basic designs with their logistics concepts and analyse their positive and negative impacts on agility, competitiveness and customisation capability.

As outlined in the objective of Task 1 of WP-5100, this exploratory literature review includes a solid base of theories and concepts on four specific themes (see references to be integrated with future punctual needs.

The project aims to develop a common language to generic describe and settle a framework of type chains for the wood supply for different product outputs and in different countries. Our approach is to choose one of the models and use it in all case studies to be able to aggregate supply chains, and describe generic frameworks independent of country.

Our choice has fallen on the SCOR model. SCOR is a well established model used of industry sectors globally. The model provides also a general concept of describing the inbound processes and processes connected to supply and demand. Going through all of the predefined SCOR processes and try to "find" them for a specific supply chain will make the risk less.

To start describing different sets of supply chains and their detailed processes and links without a blueprint can lead to total differing descriptions, differing too much for a comparison. Having a road map where we try to "fit into" the relevant processes is helping to standardize the description of supply chains. It reduces the risk that not be able to compare the wood supply chains in the same way and makes also the reliability of the KPIs and benchmarks increases.

The standard processes make, source, deliver, return and plan will be used according to the SCOR model to reach metrics at level one. Hence, the performance attributes at level one will result in a set up of KPIs. The performance attributes are reliability, responsiveness, agility, cost and asset with associated metrics. Each of the metric is built up from sub metrics where some of the information can be gathered from annual reports. Hence, a task will be to interpret acceptable metrics for the generic wood supply chain since all metrics will be impossible to gather, regardless of annual reports. Information through the annual reports should be available but enterprise specific figures are likely impossible to gather. Hence, the task is to formulate acceptable metrics for the generic wood supply chains and the performance attributes suitable for this project's framework.

As described above, this is a drawback of the model which makes it impossible to follow the SCOR mapping model in detail to measure the SCOR standardize metrics. The explanation for this is that SCOR model is mainly built up from mapping a focal company. Describing a focal company internal through the SCOR model would give access to data that are not reachable from out-side. Another drawback is SCOR is developed from mainly the manufacturing industry. This implies that products are described as make-to-stock, make-to-order and engineer-to-order. The way of describing the make process this way can cause confusion, since the one supply chain can consist of all of these types. One supply chain can consist of all make processes but important thing is to analyse and pin-pint the decoupling point in them in between. It is common also for manufacturing companies to have all make processes. But, the challenge for the mapping of the forestry sector is to aggregate the make processes since there are grey scales in between the three different strategies. Together with the procurement, which is difficult to describe where on the scale it belongs, bulk procurement (make-to-stock) to specialized products like window frames (engineer-to-order), because of the long lead times for wood procurement. From being a raw material product engineerd-to-order it can end up as a bulk volume in the pulp industry caused of quality reduction during lead time.

A lot of work will hence be dedicated to adapt the model and the metrics of a non-focal-company but a set up of processes presenting the wood supply for a set up of products and regions in a generic way.

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7. Exploratory literature review (Task 1)

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Arbetsrapporter från Skogforsk fr.o.m. 2009

År 2009	
Nr 669	Almqvist, C., Eriksson, M. & Gregorsson, B. 2009. Cost functions for variable costs of different Scots pine breeding strategies in Sweden. 12 s.
Nr 670	Andersson, M. & Eriksson, B. 2009. HANDDATORER MED GPS. För användning vid röjningsplanläggning och röjning. 25 s.
Nr 671	Stener, L.G. 2009. Study of survival, growth, external quality and phenology in a beech provenance trial in Rånna, Sweden. 12 s.
Nr 672	Lindgren, D. 2009. Number of pollen in polycross mixtures and mating partners for full sibs for breeding value estimation. 15 s.
Nr 673	Bergkvist, I. 2009. Integrerad avverkning av grotbuntar. 21 s.
Nr 674	Rosvall, O. 2009. Kompletterande strategier för det svenska förädlingsprogrammet. 26 s.
Nr 675	Arlinger, J., Barth, A. & Sonesson, J. 2009. Förstudie om informationsstandard för stående skog. 21 s.
Nr 676	Nordström, M. & Möller J. J. 2009. Den skogliga digitala kedjan – Fas 1. 38 s.
Nr 677	Möller J.J., Hannrup, B., Larsson, W., Barth, A. & Arlinger, J. 2009. Ett system för beräkning och geografisk visualisering av avverkade kvantiteter skogsbränsle baserat på skördardata. 36 s.
Nr 678	Enström, J. & Winberg, P. 2009. Systemtransporter av skogsbränsle på järnväg. 27 s.
Nr 679	Iwarsson Wide, M. & Belbo, H. 2009. Jämförande studie av olika tekniker för skogsbränsle-uttag. – Skogsbränseluttag med Naarva-Gripen 1500-40E, Bracke C16.A och LogMax 4000, Mellanskog, Färila. 43 s.
Nr 680	Iwarsson Wide, M. 2009. Jämförande studie av olika metoder för skogsbränsleuttag. Metodstudie – uttag av massaved, helträd, kombinerat uttag samt knäckkvistning i talldominerat bestånd, Sveaskog, Askersund. 25 s.
Nr 681	Iwarsson Wide, M. 2009. Teknik och metod Ponsse EH25. – Trädbränsleuttag med Ponsse EH25 i kraftledningsgata. 14.
Nr 682	Iwarsson Wide, M. 2009. Skogsbränsleuttag med Bracke C16. – Bränsleuttag med Bracke C16 i tall respektive barrblandskog. 14 s.
Nr 683	Thorsén, Å. & Tosterud, A. 2009. Mer effektiv implementering av FoU-resultat. – En intervjuundersökning bland Skogforsks intresenter. 58 s.
Nr 684	Rytter, L., Hannerz, M., Ring, E., Högbom, L. & Weslien, J.-O. 2009 Ökad produktion i Svenska kyrkans skogar – Med hänsyn till miljö och sociala värden. 94 s.
Nr 685	Bergkvist, I. 2009. Skördarstorlek och metod i förstagallring av tall och gran – studier av prestation och kvalitet i förstagallring. 29 s.
Nr 686	Englund, M. 2009. Röststyrning av aggregatet på en engreppsskördare – En Wizard of Oz-studie. 32 s.
Nr 687	Lindgren, D. 2009. Polymix breedning with selection forwards. 14 s.
Nr 688	Eliasson, L., Nordén, B. 2009. Fyra olika studier med A-gripen. 31 s.
Nr 689	Larsson, F. 2009. Skogsmaskinföretagarnas kundrelationer, lönsamhet och produktivitet. Under bearbetning. 44 s.
Nr 690	Jönsson, P., Löfroth, C. & Englund, M. 2009. Förarstol för stående arbetsställning – en pilotstudie. 12 s.
Nr 691	Brunberg, T., Lundström, H. & Thor, M. 2009. Gallringsstudier hos SCA vintern och sommaren 2009. 26 s.
Nr 692	Eliasson, L. & Johannesson, T. 2009. Underväxtens påverkan på bränsleanpassad slutavverkning – Studie från avverkning hos Sca Skog AB. 11 s.
Nr 693	Nordén, B. & Eliasson, L. 2009. En jämförelse av ett Hugglinksystem med en traktormonterad flishugg vid flisning på avlägg. 9 s.
Nr 694	Hannrup, B. et al., 2009. Utvärdering av ett system för beräkning och geografisk visuali-sering av avverkade kvantiteter skogsbränsle. 42 s.
Nr 695	Iwarsson Wide, M. 2009. Skogsbränsleuttag i vägkanter. Prestationsstudie – uttag av Skogsbränsle i vägkant med BRACKE C16. 14 s.
Nr 696	Iwarsson Wide, M. 2009. Skogsbränsleuttag i vägkanter. Prestationsstudie – uttag av Skogsbränsle i vägkant med ponsse dual med EH 25. 15 s.

Nr 697	Almqvist, C. & Wennström, U. 2009. Granfröplantageskötselresa 2009-08-31–200-09-03. Noter från besök i respektive plantage. 22 s.
Nr 698	Wilhelmsson, L. m.fl. 2009. D3.1 Initial analysis of drivers and barriers. 41 s.
Nr 699	Wilhelmsson, L. m.fl. 2009. D3.2 Existing models and model gap analyses for wood properties. 54 s.
År 2010	
Nr 700	Hannerz, M. & Cedergren, J. 2010. Attityder och kunskapsbehov – förädlat skogsodlingsmaterial. 56 s.
Nr 701	Rytter, R.M. 2010. Detektion av röta i bokved – resultat av mäthöjd, riktning och tidpunkt. 10 s.
Nr 702	Rosvall, O. & Lundström, A. 2010. Förädlingseffekter i Sveriges skogar - kompletterande scenarier till SKA-VB 08. 31 s.
Nr 703	von Hofsten, H. 2010. Skörd av stubbar – nuläge och utvecklingsbehov. 18 s.
Nr 704	Karlsson, O. & Nisserud, F. 2010. Utveckling av en dynamisk helfordonsmodell för skotare. 73 s.
Nr 705	Eliasson, L. & Johannesson, T. 2010. Förröjningens påverkan på grotskotning – En studie av produktivitet, ekonomi, grotkvalitet hos SCA skog. 9 s.
Nr 706	Rytter, L. & Stener L.G. 2010. Uthållig produktion av hybridasp efter skörd – Slutrapport 2010 för Energimyndighetens projekt 30346. 23 s.
Nr 707	Bergkvist, I. 2010. Utvärdering av radförbandsförsök anlagda mellan 1982-1984. 16 s.
Nr 708	Hannrup, B. & Jönsson, P. 2010. Utvärdering av sågmotorn F11-iP med avseende på uppkomsten av kapsprickor – en jämförande studie. 28 s.
Nr 709	Iwarsson Wide, M., Belbo, H. 2010. Jämförande studie av olika tekniker för skogsbränsleuttag i mycket klen skog Skogsbränsleuttag med Naarva-Gripen 1500-40E och Log Max 4000, Mellanskog, Simeå 28 s.
Nr 710	Englund, M., Löfroth, C. & Jönsson, P. 2010. Inblandning av rött ljus i LED-lampor – Laboratoriestudier av hur människor uppfattar tre olika ljusblandningar. 7 s.
Nr 711	Mullin, T.J., Hallander, J., Rosvall, O. & Andersson, B. 2010. Using simulation to optimise tree breeding programmes in Europe: an introduction to POPSIM™. 28 s.
Nr 712	Jönsson, P. 2010. Hydrauliskt dämpad hytt – ett lyft för arbetsmiljön? 14 s.
Nr 713	Eriksson, B. & Sonesson, J. 2010. Tredje generationen skogsbruksplaner – Slutrapport DElproj 4 – Arbetsgång vid planläggning. 23 s.
Nr 714	Sonesson, J. 2010. Nya arbetssätt i skogsbruksplanläggning. 20 s.
Nr 715	Eliasson, L. 2010. Huggbilar med lastväxlarsystem. 13 s.
Nr 716	Eliasson, L. & Granlund P. 2010. Krossning av skogsbränsle med en stor kross – En studie av CBI 8400 hos Skellefteå Kraft. 6 s.
Nr 717	Stener, L.G. 2010. Tillväxt, vitalitet och densitet för kloner av hybridasp och poppel i sydsvenska försök. 46 s.
Nr 718	Palmquist, C. & Sandberg, J. & Vibrationskomfort och ergonomi på förarstolar i skotare. 100 s.
Nr 719	Andersson, G., Thor, M., barth, A., Björheden, R., Brunberg, T. Frisk, M. & Weslien, J.O. 2010. Avverkning och hantering av virke och avverkningsrester vid angrepp av tallvedsnematoder i svensk skog. 42 s.
Nr 720	Fogdestam, N. 2010. Studier av Biotassu Griptilt S35 i gallring. 11 s.
Nr 721	Brunberg, T. 2010. Bränsleförbrukningen i skogsbruket. 12 s.
Nr 722	Brunberg, T. 2010. Rätt begrepp. 25 s.
Nr 723	Löfroth, C. & Svenson, G. 2010. ETT – modulsystem för skogstransporter – Delrapport för de två första åren. 130 s.
Nr 724	Rytter, L. & Lundmark, T. 2010. Slutrapport för Energimyndighetens projekt 30658. Trädslagsförsök med inriktning på massaproduktion. – Tree species trial with emphasis on biomass production. 24 s.

Nr 725	Rytter, R.M. & Högbom, L. 2010. Slutrapport för Energimyndighetens Projekt 30659. Markkemi och fastläggning av C och N i produktionsinriktade bestånd med snabbväxande trädslag – Soil chemistry and C and N sequestration in plantations with fast-growing tree species. 64 s.
Nr 726	Brunberg, T., Eliasson, L. & Lundström, H. 2010. Skotning av färsk och hyggestorkad grot. 15 s.
Nr 727	Enström, J. 2010. Inlandsbanans potential i Sveriges skogsbränsleförsörjning. 34 s.
Nr 728	Häggström, C. & Thor, M. 2010. Human factors in forest harvester operation. 26 s.
Nr 729	Audy, J.-F., Westlund, K., Furness-Lindén, A., D'Amours, S., Rönnqvist, M., LeBel, L. & Gaudreault, J. 2010. WP-5100 Alternative logistics concepts fitting different wood supply situations and markets. 50 s.
Nr 730	von Hofsten, H. Jämförelse mellan CeDe stubbrytare och Pallari 140. 9 s.
Nr 731	Berg, R., Bergkvist, I., Lindén, M., Lomander, A., Ring, E. & Simonsson, P. Förslag till en gemensam policy angående körskador på skogsmark för svenskt skogsbruk 18 s.
Nr 732	Jönsson, P. 2010. Stolar och armstöd – Ergonomisk granskning enligt European ergonomic and safety guidelines for forest machines. 37 s.