Value creation in wood supply chains (WOODVALUE)

FINAL REPORT

Title of the research project	**Value creation is wood supply chains (WOODVALUE)**
Coordinator of the project	Jori Uusitalo

BASIC PROJECT DATA

Project period	[1.11.2007-31.12.2010]
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URL of the project	http://www.metla.fi

FUNDING

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<u>Finland</u>	
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Ministry of Agriculture and Forestry (MMM)	180 000 €
Academy of Finland (AKA)	-
<u>Denmark</u>	
Danish Forest and Nature Agency (DFNA)	121 000 €
Danish Research Council for Production and Technology Sciences (FTP)	-
<u>Germany</u>	
Federal Ministry of Education and Research (BMBF)/ Project Management Agency Jülich (PtJ)	395 000 €

Norway	
The Research Council of Norway (RCN)	-
Innovation Norway (INVANOR)	-
Sweden	
The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas)	-
Swedish Governmental Agency for Innovation Systems (VINNOVA)	95 000 €
France	
Ministry of Agriculture, General Direction for Forest and Rural Affairs (DGPAAT)	-
Technical Centre for Wood and Furniture (CTBA)	-
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James Jones & Sons	12 000 €

PROJECT TEAM (main participants)

Name, degree, job title	Sex	Organisation	Funder organisation
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David Leslie	M	James Jones and Sons Ltd.	Forestry Commission (FC)

DEGREES
Degrees earned or to be earned within this project.

Year	Degree	Sex	Name, year of birth and year of earning M.Sc., D.Sc., etc. Degree	University	Supervisor of thesis, supervisor's organization
2009	D. Sc.	M	Matthias Holzmann	University of Freiburg	Gero Becker, co-supervision U. Sauter, FVA
2009	Diplom-Forstwirt	M	Lorenz Breinig	University of Freiburg	Gero Becker, co-supervision F. Brüchert, FVA
2012	D. Sc.		Heikki Korpunen	University of Helsinki	Jori Uusitalo, Margetta Sipi

ABSTRACT

In the modern wood value chain the trees should be cut, transported, processed into final products and delivered to customers in such a manner that the total aggregated value of the products is maximized. Each action within the woodvalue chain cause costs. However, it does not mean that the costs of the logistics should always be minimized. Pure focus on lean management of wood supply chain may cause substantial losses of revenues if the potential value of the wood raw material is not utilized properly. Wood value chain optimization is thus a paradigm of finding the optimal balance between aggregated costs and revenues also considering environmental load.

The WOODVALUE project has aimed to settle a strong basement for future development of wood value chain optimizations. In the project structures, dynamics and costs of several wood supply chains in the partner countries business environment have been defined and modelled. This has given us a good background to define a standardized structure of the logistics for modern wood supply chains.

The project has taken important steps in defining the processing costs of the most important end products of wood. During this project we have managed to develop models for sawmilling and chemical pulping. We have based our cost analyses on so called “greenfield”, virtual mills that include all technical data, resources and costs needed to establish and run a mill. Sawmilling is a good example of the possibilities of the ABC method where a log is converted to various end products (boards, battens, bark, sawdust and wood chips). Technical data, resources needed and costs are acquired from manufactures of sawmill appliances, construction industry and sawmilling companies. Main production processes in sawing are universal and are found in every commercial mill which helps the economical comparison between mills.

In the WOODVALUE project new trials to measure and predict the quality and the value of the end products has also been carried out and/or validated. In a joined effort, the accuracy of models predicting the most important characteristics of wood (basic density, modulus of elasticity, modulus of rupture, knot sizes, knot types (sound/loose), heartwood diameter and bark thickness of sawlogs) from standing trees have been validated. Potential value of modern acoustic tools has also been tested in these trials. The project has taken full benefit from the new computer tomography laboratory established at the FVA in Freiburg.

In order to provide insight into how the forest resource can be better utilised at the enterprise level, the models and predictions provided by researchers have to some extent been tested and validated in experimental tests. The outcome of these trials proves that great potential exists in enhancement of the current wood supply chains but more research efforts are still needed to better define the right places and right moments that could make actors of the wood supply chain to make better predictions and decisions to achieve additional value.

1.1 Introduction

1.1.1 Background

Efficient manufacturing of both existing and new wood and fibre based products of defined quality can be considerably facilitated by efficient selection, processing and destination of fitting blanks (adapted raw material) from the harvesting and haulage procedures. To make production systems more efficient the physical manufacturing of each product should preferably start in the forest, not at the industry. The potential economic gain in doing right from the beginning may well be 10 % of the value of the end products before retailing. With better fitness and integration of the forestry procedures into the industrial production chains higher process efficiency and lower degree of downgraded products could be gained. Consequently considerably lower emissions and lower energy consumption could be gained as well.

Forestry operations, the wood processing industry and other actors involved in the process chain have organized their activities according to their own, usually functional criteria and spheres of responsibility (e.g. buying, logistics, marketing). Moreover, the fragmented structure of the timber supply chain makes it extremely difficult to persistently optimize timber value added from supply in the forest through processing in a factory. For instance, no suitable procedures or tools exist to forecast the revenue from the sale of intermediate and finished products of the processed lumber (veneer wood, sawn and barked wood, lumber, industrial lumber, wood chips, etc.) based on the quality of the timber so that the appropriate trunk assortments can already be converted during the timber harvest, i.e. at the head of the value added chain,. There is also no procedure available to project the costs of transportation logistics, influenced by a multitude of parameters (timber assortment, lot sizes, transport distance, truck utilization, etc.), along the entire supply chain and beyond. Such projection methods are an important prerequisite to optimizing timber utilization geared toward maximized value added.

1.1.2 Objectives

The aim of the WOODVALUE project was to develop a standardized methodology at European level to define, measure and value the efficiency and profitability of key wood supply chains - from standing trees to end consumer products. The WOODVALUE project aims to settle a strong basement for future development of wood supply chain optimizations.

The four workpackages (WP) of the project has been:

- WP1) Definition and quantification of the most important wood characteristics and methods to convert wood information on wood properties to log grades or value indices (later referred as "Wood properties")
- WP2) Methodology to calculate process costs and revenues of the most important wood industry branches ("Industrial processes")
- WP3) Identification of costs and cost modeling of logistic processes in key wood supply chains ("Logistic costs")
- WP4) Development of allocation models and value creation analyses through demonstrating case studies in participating countries ("Case studies/customization")

1.2 Results and discussion

Logistics structures and costs
The WOODVALUE project has succeeded to define a standardized way to describe the structure of the upstream of the wood value chain i.e. from forest to mill. The outcome of this work is recapped in table 1. The wood supply chain is divided into four different levels, namely strategic, operative, execution and acceptance and settlement levels. Strategic planning is long-term orientation of future activities (1-3 years) toward all of an actor's organizational units, executed by top management and/or management. Operative planning is medium to short-term orientation of future activities (1 week – 3 months) toward all of an actor's pending measures. Execution is detailed planning, control and execution of an actor's actions. Acceptance and settlement is acceptance and invoicing of an actor's action(s).

Actors within the chain are divided into four categories also as follows:

- Forestry (FOR) - actors, which are forest owner or forest owner representatives

- Forest Service Providers (FSP) - actors, which can realize or offer services for harvesting, short distance transport
- Logistics Service Providers (LSP) – actors, which can realize or offer services for long distance transport (road transport)
- Contractors (CON) – actors, which buys the raw material (wood processing industries, timber trade companies/timber dealer, energy plants)

The costs are categorized into direct and indirect costs. Direct costs are costs that are directly allocable to a production unit while indirect costs are not directly allocable to a production unit. Production unit is the quantity based on the individual actors' costing basis (e.g. solid cubic meter, bulk cubic meter, ton, truckload, etc.).

Table 1. General structure of the wood supply chain.

Scope	**Processes** (to be grouped)	**Definition**	**Actors**	**Costs** Indirect	**Costs** Direct
Strategic level	Production planning	• Allocation of areas due to be cut according to annual forest inventory plan	FOR FSP CON	X	
		• Predefinition of quantity • Allocation of wood	FOR FSP CON	X	
	Pre-Selection of service provider	• Invitation for bids to ensure compliance with (in Germany, largely public) forest owners' technical, quality, ecological and social requirements. • Listing of compliant companies in a pool of potential contractors • Preparation and administration of invitations to bid (harvesting, forwarding, transportation) based on the working capacity plan (see above) • Award of the quantities to be cut or forwarded by the individual bidder ➔ frame contracts	FOR FSP LSP	X	
	Capacity planning and budgeting	• Long-term planning of internal capacities (labor, equipment, volumes, etc.) • Specification of lacking capacity to be absorbed by service providers • Annual budget • Breakdown into costing basis and organizational unit	FOR FSP LSP	X	
	Sales, acquisition and contracting	• Planning of quantities, assortments and wood species groups • Market analysis to define price expectations • Frame contracts with important buyers	FOR FSP LSP CON	X	
Operative Level	Plan coordination	• Clarification of working site conditions and technical requirements and restrictions • Coordination of external capacities (subcontractors, etc.)	FOR FSP LSP CON	X	
	Contracting	• Specific contracting (cutting, short-distance transport/moving, hauling, etc.) by the individual	FOR FSP	X	

Scope	Processes (to be grouped)	Definition	Actors	Costs Indirect	Costs Direct
		contractors with frame contracts and other contractors without frame contracts	LSP CON		
	Application planning	• Planning of external (in case of subcontractors) and internal capacities (labor, equipment, volumes, etc.)	FOR FSP LSP CON	X	
Execution level	Detail application planning	• On the stand level • Preparation of work orders • Briefing of workers and/or service providers involved	FOR FSP LSP CON	X	
	Cutting	• Cutting including preparation, post processing and measurement/counting/data collection • Assortment formation	FOR FSP CON		X
	Short distance transportation /moving	• Short distance transport including preparation, post processing and measurement/counting/data collection • Assortment formation	FOR FSP CON		X
	Long distance transportation	• Long-distance transport (arrival, loading, securing, transport to factory) including preparation, post processing and measurement/counting/data collection • External support, e.g. guidance to decks by service orderer, subcontractors, etc. • Unloading	FOR FSP LSP CON		X
	Execution control	• Data exchange • Measurement • Quality control • Execution control	FOR FSP LSP CON	X	
Acceptance and settlement level	Delivery and quality control	• Volume, quantity and quality • Determination of basis of calculation (delivered unit) • Comparison and validation of planning with actual delivery status (such as execution control at wood processing industry)	FOR FSP LSP CON	X	
	Settlement	• Accounting and billing • Payment	FOR FSP LSP CON	X	

Direct costs of the most important processes; namely cutting, forest transport (i.e. forwarding), and long-distance transportation (i.e. trucking) can be estimated with an activity-based management (ABC) system further developed within the project. Within this management system, logistics costs are assigned to timber assortments and timber lots. A costing system is formulated separately for each of the main processes. Costs are traced to individual stands and the lots of timber assortments from that stand; the system's cost object is therefore a lot of timber from a specific assortment that is cut, forwarded, and trucked to a mill.

The ABC management system may be used either to estimate future costs or to assign true costs after production. In either case the user may utilise advanced time consumption models like the recently published models for CTL harvesting (Nurminen et al. 2006) and timber truck transportation (Nurminen and Heinonen 2008) to predict the time consumption of each work element. The costing system is thoroughly described in recently published paper by Nurminen, Korpunen and Uusitalo (2009).

Industrial process costs

The project has taken big steps in defining the processing costs of the most important end products of wood. During this project we have managed to develop models for sawmilling and chemical pulping. We have based our cost analyses on so called "greenfield", virtual mills that include all technical data, resources and costs needed to establish and run a mill.

Main production processes in sawing are universal and are found in every commercial mill which helps the economical comparison between mills. Sawing was divided into seven processes: receive, unload and sorting of logs; debarking; sawing and edging of sawn lumber; green sorting and stickering; drying; quality sorting and packing; storing and shipping (Korpunen et al. 2010a). Woodchip and sawdust production is considered as a side process which is also included in modeling. Processes and the general cost allocation are described in figure 1.

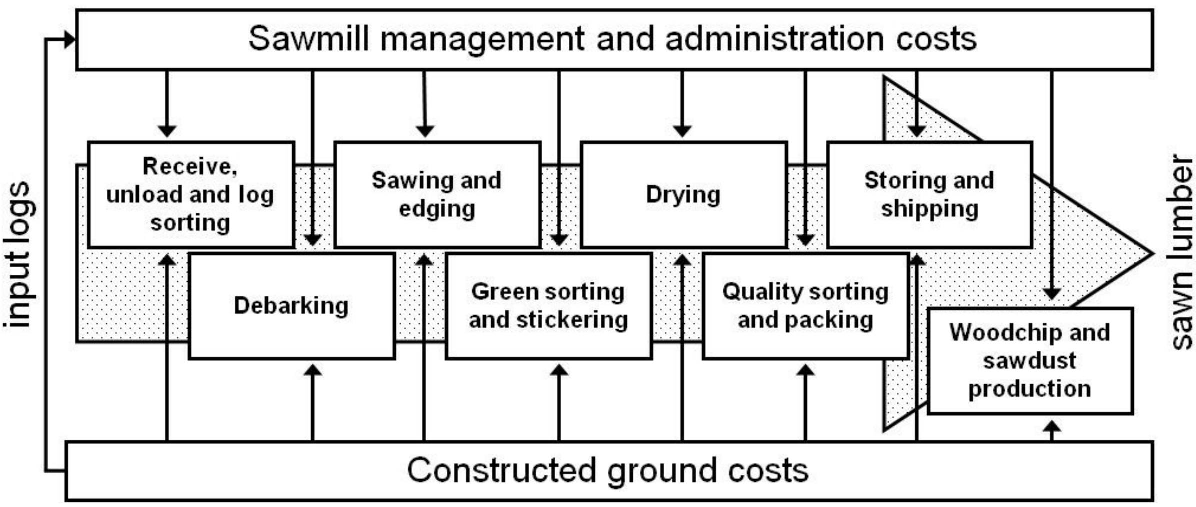

Figure 1. – Description of ground construction, mill management and administration cost allocation to production processes (according to Korpunen et al. 2010a).

The resources of the seven processes were identified and combined with the production information for detailed analysis. As result, we produced a cost model, which enables calculations for different case studies, where different scenarios can be tested. Preliminary tests proved the model to be functional and applicable for forest industry, wood industry, and also for researchers, when determining the costs and the key factors (sawing pattern, log distribution, price level, etc.) affecting on the costs. Figure 2 presents a case study, where the applicability of the model was tested at a greenfield Scots pine sawmill. The ABC proves to be an efficient method for calculating different end product groups manufactured from one raw material. With the more accurate costing information, the production can be adapted according to the market situation and thus the company can improve its economic result.

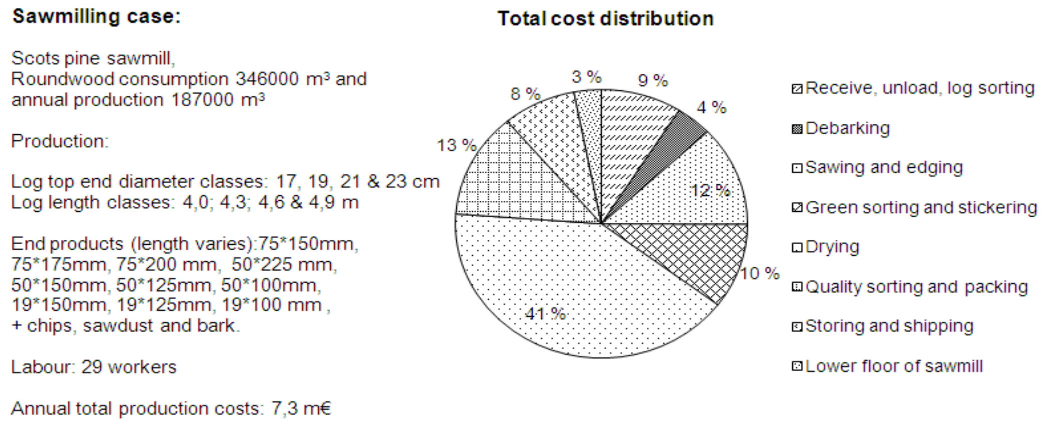

Figure 2. A sample calculation of sawmilling cost distribution with a certain input variables.

Pulp manufacturing requires highly automated large-scale technology, special expertise in chemistry, major capital investments and reliable infrastructure around mills. The production is divided into three main processes, wood handling, pulping and drying. The chemical recovery is handled as a separate supporting process (Korpunen et al. 2010b). Wood handling consists of seven sub-processes: receive, storing, debarking, chipping, chip screening and chip storing. Pulping is divided into pulp cooking, washing, screening, oxygen delignification and bleaching. The cost driver is the pulp flow (tons per hour) through processes. The processes and general cost allocations are presented in figure 3.

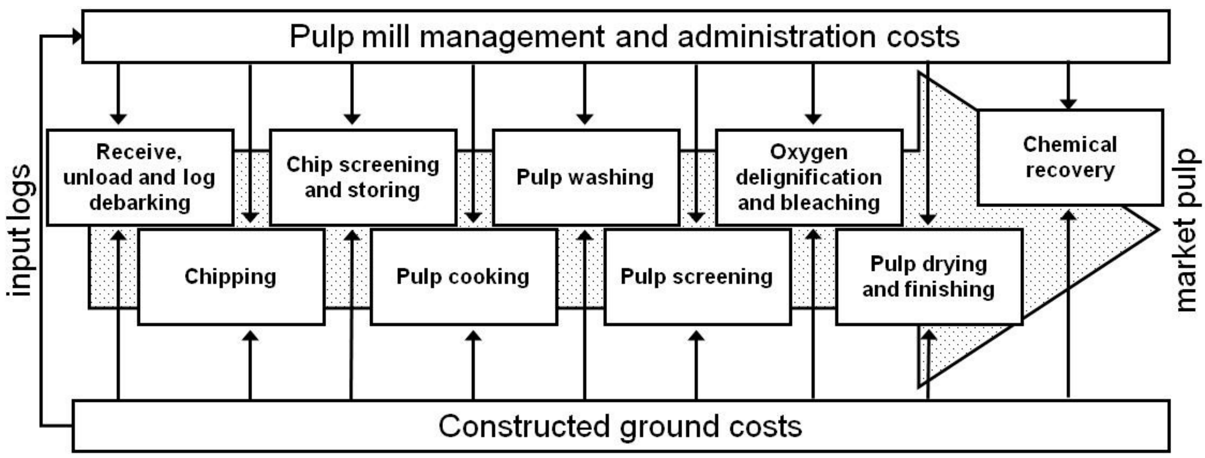

Figure 3. Description of ground construction, mill management and administration cost allocation to production processes.

As the sawmilling produces many different products (various sawn lumber classes) from various raw materials (log classes), the pulping produces one main bulk product from one raw material. The ABC method fits well also to this situation; the process-specific costs are useful for estimating the accumulation of costs as the production proceeds (Korpunen et al. 2010b). For example, the high cost of drying as a separate process (figure 4) indicates why many pulp mills are combined directly with paper mills, the expensive drying of pulp is avoided as the pulp slurry can be pumped to papermaking in liquid form.

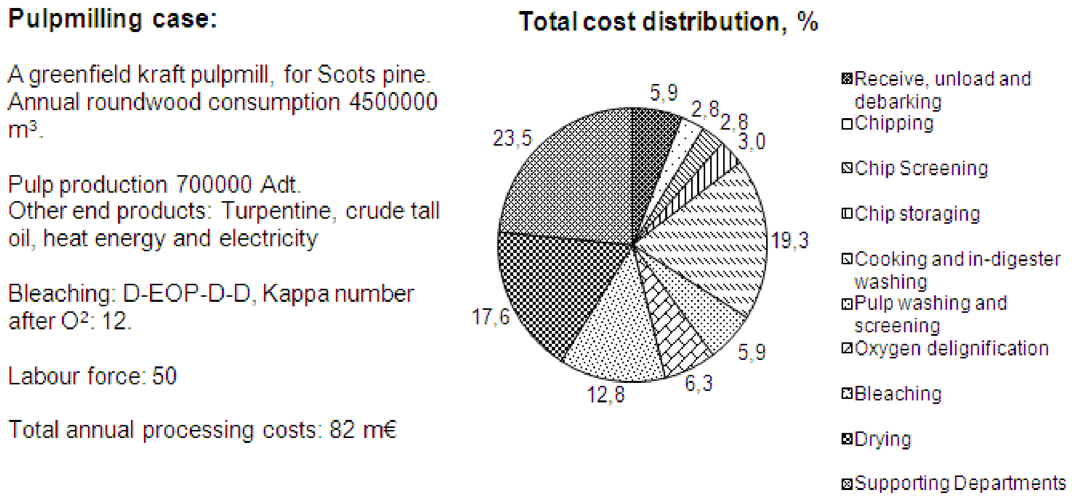

Figure 4. A case of cost distribution in a kraft Scots pine pulpmill (Korpunen et al 2010b).

Wood quality predictions

New trials to measure and predict the quality and the value of the end products has been carried out. In a joined effort, the accuracy of models predicting the most important characteristics of wood (basic density, modulus of elasticity, modulus of rupture, knot sizes, knot types (sound/loose), heartwood diameter and bark thickness of sawlogs) from standing trees have been validated. Potential value of modern acoustic tools has also been tested in these trials. The project has taken full benefit from the new computer tomography laboratory established at the FVA in Freiburg.

Measurements and predictions of selected wood properties

The approach applied in this project focussed on predictions of wood density, knot properties and the mechanical wood characteristic MOEdyn for mechanical strength of sawn timber as required for construction purposes. At several stages along the forest wood chain from standing tree to sawn board the same technology was applied or the characteristic measured with a different methodology. Objective was to identify methodologies suitable to predict quality features for construction purpose as early as possible along the forestry wood chain in order to optimise raw timber allocation. Methodology applicable at the following four stages were determined: standing tree (Director ST 300; MOEdyn by ultrasound), during harvesting (pri-simulation of density and knot characteristics), at mill gate on roundwood (Director HM 200, MOEdyn by ultrasound; ViScan, MOEdyn by Eigenfrequency; CT density, knots) (additionally for part of the material top discs were sampled for density measurement from the logs) and sawn boards (ViScan, MOEdyn; density). Test material was sampled on three sites in Sweden and one site in Germany and considered both Scots pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*).

For Nordic conditions, the results show that, model predictions based on ordinary harvester diameter measurements, average tree age (site level) and site location (latitude and altitude) commonly provide useful results for characterisation of basic density, modulus of elasticity (MOE), heartwood and knot properties of both pine and spruce at a pile level (mean values and standard deviations). Individual log MOE may however have considerable errors as the R^2 of the model is in the range of 0.5 (based on predicted basic density and height in stem). Models for predicting heartwood and sound knots showed comparatively small errors and provided results useful for fair predictions at the individual log level as well. Inaccurate tree ages will however increase predictions errors of heartwood.

The dominating part of the results from harvester predictions were in accordance with expectations (both lower and higher than the estimated prediction errors). However in one of the three stands, logs from spruce were poorly predicted. The director measurements on standing trees showed a similar pattern, however not exceeding accuracy of MOE predicted by harvester information. Director measurements on cut logs were closer to the Viscan measurements.

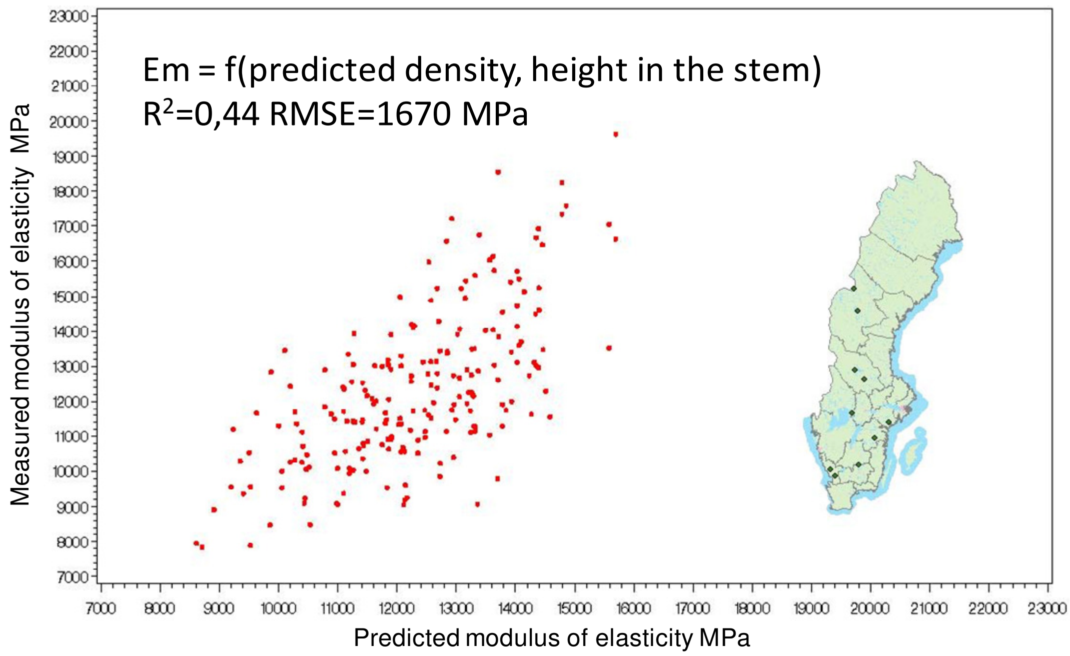

Figure 5. Predicted vs. measured modulus of elasticity (MOE) of spruce boards based on the new model developed with contribution from Woodvalue (Hannrup & Wilhelmsson, manuscript). Model developed from sample trees of the Swedish spruce stem bank (Luleå Tech University, Chalmers and SLU). Experiments located according to map.

X-ray based computer tomography is a methodology suitable for detection of internal wood structures on the basis of density contrasts. Thus features like knots or growth rings can be detected and measured given a density contrast exists between the feature and the surrounding wood. For fresh roundwood the density of sapwood is similar of even higher as knot wood due to the high water content. Therefore detection of features in the sapwood area of fresh roundwood is restricted. The detection of ringwidth additionally is restricted to the geometrical capability of the CT scanner given by the size of the individual detectors. Narrow ring width below 2mm usually can not be detected. Hence ring width detection was not further developed, in the project, but the focus was laid on wood density and knots in the heartwood area.

On a log level, wood density prediction by pri-simulation and wood density of the top disc were compared to log density derived from the CT measurements (Fig. 6, Fig. 7). The relation between measured density at CT level and predicted wood density (R^2=0.25) is weaker than between CT measurement and the density at top disc of log (R^2= 0.89) considering both spruce and pine.

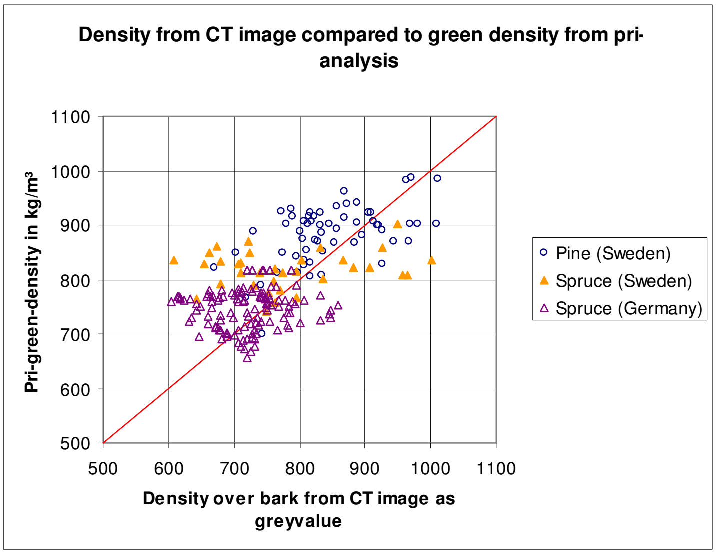

Figure 6. Variation of mean log wood density measured by CT scanning and predicted by pri-simulation.

Knot detection algorithms showed good results to detect the knot in the correct position (azimuth) of the cross ection (deviation$_{max,\ absolute}$ = ±6° for pine). The dimension of the knots was derived from CT slices with a divergent precision. For spruce the R^2 of the model is in the range of 0. 68, largest absolute deviation of knot width was 22mm, the largest relative deviation was (138 %). For pine the equivalent measures read: R^2=0.82, largest absolute deviation equals to 10 mm, largest relative deviation equals to 75%.

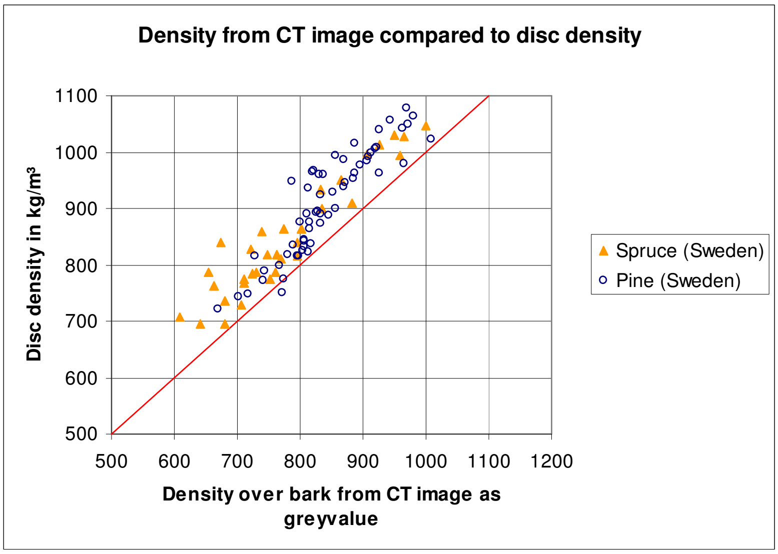

Figure 7. Variation of mean log wood density measured by CT scanning and on top disc of logs

The results show that tools are available which allow to measure or predict quality relevant wood characteristics for sawn timber with regards to construction purposes at an early stage of the forest-wood value chain. However, depending on the individual feature the tools need further development to increase the precision of the forcast, even though the direct measurement of MOEdyn at different stages of the chain showed good agreement. This study however is based on a restricted sample size of only altogether approximately 150 trees for the complete value chain, therefore for industrial application larger samples will be required to derive stable relations.

Case studies

In order to provide insight into how the forest resource can be better utilised at the enterprise level, the models and predictions provided by researchers have been tested and validated in some experimental tests. By utilising sample tree data from the National Forest Inventory of Sweden (SLU) we have been able to simulate Cut To Length harvesting by Skogforsks tools for bucking simulations. By functions estimating the costs for harvesting, sorting and haulage operations and attempts to value different wood properties we have been able to make cost benefit analyses of different alternatives. The outcome of these trials indicate that great potential exists in enhancement of the current wood supply chains. However more research and development efforts are still needed to further develop tools for analyses of value chain reactions when combining pre-harvest information, integrated production control (forestry – industry), harvester production reports, improved knowledge concerning the raw material properties.

1.3 Conclusions

The WOODVALUE project has shown that it is possible to estimate costs and incomes within woodvalue chain that further gives possibilities to compare, enhance or even optimize the key wood supply chains. The future projects should concentrate on developing measurement systems that predict the characteristics of the wood resources already in the early phase of the supply chain and estimate both costs and revenues of different alternatives from a strategic/tactic level as well as operational from each current position in the value chain and ahead.

1.4a Capabilities generated by the project

- The logistic structures of modern wood supply chain has been defined along with the basic principles how the cost should be calculated. That gives strong basement for future development of wood value chain optimizations
- Cost calculation models of sawing process and chemical pulping has been constructed in the project
- Usability of acoustic tools in predicting wood quality within the wood supply chain has been tested and analyzed

1.4b Utilisation of results

The group will finalize a scientific report that will synthesise the main outcomes of the project. In addition roughly 15-20 scientific reports has been or will be published based on the work carried out in the project. The ABC costing system of sawing developed in the project will be demonstrated for the sawmills that are interested in applying the system in their production planning.

1.5 Publications and communication

1. Articles in international scientific journals with peer review

Ehrhardt I, Seidel H & Doden N (2010). Potentials for Savings by Implementing RFID and Telematic Technologies in the Biomass Supply Chain. Biosystems Engineering, Volume 8. pp 47-59.

Korpunen H, Mochan S & Uusitalo J (2010). An activity-based costing method for sawmilling. Forest Products Journal Vol. 60. No. 5. pp 420-431.

Nurminen T, Korpunen H & Uusitalo J (2009). Applying the Activity-Based Costing to Cut-to Length Timber Harvesting and Trucking. Silva Fennica 43(5): 847-870.

Wäsche M & Ehrhardt I (2009). Services for Sustainable Forest Timber Supply Chain Planning and Control: Development, Implementation and Usage. Management and Sustainable Development. pp. 28-33.

2. Articles in international scientific compilation works and international scientific conference proceedings with peer review

Kotzab, H, Troelsen, T, Suadicani K (2010). The use of activity based costing and value stream mapping and Supply Chain Management in Forestry. Nofoma Proceedings, 22nd conference. Syddansk Universitetsforlaget. pp. 825-840.

Wilhelmsson, L. Arlinger, J. Nordström, M. Westlund, K. 2009. Economic and environmental improvements to wood supply - operative predictions of costs and benefits in monetary, environmental and working-hour units. In: Rosén, K. (ed) Shape your sustainability tools - and let your tools shape you. Eforwood final conference. 23-24 september 2009, Uppsala, Sweden, Poster presentation.

Wilhelmsson, L. Arlinger, J. 2010. Models and simulation tools for characterizing yield and log properties. Presentation at the Final seminar. Indisputable key. Paris, 22-23 Mars. 22 pp.

Wilhelmsson, L. Arlinger, J. Hannrup, B. Möller, J. Nordström, M. 2010. Wood properties. In: Lämås, T. The Heureka research programme. Final report for Phase 2, October 2005 - September 2009, SLU (Umeå), pp 57-63.

Wilhelmsson, L. Arlinger, J. Hannrup, B. Nordström, M. Øvrum, A. Gjerdrum, P. 2010. Methods and models for relating wood properties and storage conditions to process efficiency and product quality. D3.5. Indisputable Key. Sixth Framwork Programme. EC Project no: 34732. 65 pp.

4. Articles in national scientific compilation works and national scientific conference proceedings with peer review

Andersson, G. Frisk, M. Furness-LIndén A. Lidén, B. Lundström, H. Löfroth, C. Svenson, G. Westlund, K. Wilhelmsson, L. 2010. Effektivare virkesförsörjning. I: Ukonf10 Tillbaka till framtiden. Skogforsk (Uppsala), pp 50-54. (Conference documentation, four occasions Feb-Mars 2010)

Arlinger, J. Barth, A. Frisk, M. Möller, J. Sonesson, J. Wikström , P. Wilhelmsson, L. 2010. Värdeskapande planering. I: Ukonf10 Tillbaka till framtiden. Skogforsk (Uppsala), pp 20-31. (Conference documentation, four occasions Feb-Mars 2010)

Ehrhardt I, Wäsche M, & v. Garrel J, (2009). Der Wert des Holzes – Logistik als Erfolgsfaktor zur Kostensenkung. Tagungsband zum 3. Rostocker Bioenergieforum. pp. 287 - 290.

Sauter U H (2010). Logistics cost factors of a round wood supply chain in Germany. IUFRO-Conference Seoul, Korea and IRG-Sweden. August 2010.

Wilhelmsson, L. Arlinger, J. Möller, J. 2009. Trädpris – värdering av intäkter från virke och biomassa. I: Heureka Road show. 48 pp. Three occasions spring 2009.

5. Scientific monographs

Holzmann M (2009). Die Auswirkungen des Einsatzes der RFID-Technologie zur Rundholzkennzeichnung auf die Prozessabläufe der Logistikkette Wald-Werk Fallstudie am Beispiel zweier Rundholz-Bereitstellungsvarianten eines mittelständischen Sägewerks. Doctoral dissertation. University of Freiburg. 225 p.

6. Other scientific publications, such as articles in scientific non-refereed journals and publications in university and institute series

Anon. 2010. Getting More Out of the Wood. In: Short Cuts 2. Skogforsk (Uppsala), pp 2-2 .

Baumgartner R., Brüchert F., Sauter U. H. (2010): Knots in CT scans of Scots pine logs. Conference Proceedings: The Final Conference of COST Action E53 - The Future of Quality Control for Wood & Wood Products', 4-7th May 2010, Edinburgh. (paper und presentation)

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1.6 National and international cooperation

Coordination of the project has worked well. The partners of the consortium have are well-experienced and have been willing to work together. Some partners have temporarily lacked resources (=time) to work on the common issue according to original plans. The consortium has had two-three plenary workshops (all workpackage meetings) every year and numerous WP meetings that have formed the main forum for collaboration. In addition, video conferences has also been utilized for bilateral conversions on certain subjects.

The consortium itself has had no effort to work with other projects. The main reason is that the group itself is rather big and includes know-how on the main areas of the subject. Each partner had continued to work with their own industrial partners in their own countries. In all, collaboration within the group has been very fruitful since the group has comprised a rich variety of expertise from the key areas of the research theme.