

UNIVERSITY OF WEST HUNGARY

THESES OF DOCTORAL (PHD) DISSERTATION

**ADAPTATION OF THE RESULTS OF LOGISTICS FOR ENHANCING
THE EFFICIENCY OF DOMESTIC TREE UTILIZATIONS**

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1. IMPORTANCE OF THE RESEACH TOPIC

The profitability of silviculture can best be improved by the professional as well as economical conversion and processing of forest commodities (predominantly tree assortments) into basic materials which are suitable for the fabriaction of mostly valuable final products. That means that the efficiency of forest management can considerably be improved by the way of tree utilization. Nevertheless it is tree utilization that establishes connection bewteen forestry and wood products industry as well as timber trade.

Regarding these processes by a systems approach it can be established that cutting, transporting, converting and finally marketing of the timber make up basically one single system, even though the individual units of this system were realized and established by different divisions of the silvicultural and wood industrial organizations (or by even different sectors of the national economy) at certain historical periods.

For this reasons those changes have to be sought after and implemented at the level of manufacturing, which lead to the rationalization of the overall system. This task is undertaken nowadays by LOGISTICS.

Logistics works under the concept of complexity, treating each of the participants and their aims individually, by aspiring to a mutual optimum at the same time. Logistics contributes significantly to consumer satisfaction, as a good logistical performance provides the consumer to buy a certain product or service wherever and whenever he/she intends to. In the process of value creation logistics adds the place and time value to the use value of goods. To fulfil all expectations, each and every part of the material and information flow processes has to work integrated. It can generally be established that the introduction of an unified logistical system, involving forestry as a whole can not be realized, however using the partial results of different subbranches several verifiable and quantifiable economic results can be achieved.

Incomes and costs also arise to the greatest extent during the processes of tree utilization, that is, the most considerable revenues can also be realized here, by means of a so called „logistical management”. The actual data of the state-owned forestries also highlight these excellent possibilities:

	REVENUE	EXPENDITURE
<i>SYLVICULTURE</i>	1,7%	13,1%
<i>TREE UTILIZATION</i>	53,4%	29,2%
<i>GAME MANAGEMENT</i>	7,5%	6,5%
<i>CONVERSION OF TIMBER</i>	19,2%	20,7%
<i>OTHER (e.g. services)</i>	18,2%	30,5%
Σ :	100,0%	100,0%

These are the main respects why the dissertation investigates the possibilities of gaining additional savings and incomes in the processes of tree utilization which are owed to the use of logistics and logistical systems approach.

2. AIMS OF THE RESEARCH

Logistics can be approached and interpreted regarding several different aspects. It can be reckoned as a simple function, which has the mission to ensure the required flow of material and information at given levels of the economy; besides it can function as an integrator too.

Nowadays, the production of timber takes place in a more and more complex and cumbered economic environment loaded with increasing environmental and social expectations and demands while economic conditions are rapidly changing.

The major fields of the research work were as follows:

By demonstrating the development of systems approached timber conveyance the author enlightens the grounding of the introduction of tree utilization logistics.

The detailed syntheses of logistics and wood utilizational material flow systems justifies the necessity of tree utilization logistics.

Among the foreign tree utilization systems there are a good few which are already in a functional state, however extensive research has been being done in this field for decades by variuos groups parallelly. The research also focuses on the detailed review of these latest results.

The revealing of the results and the search for the possibilities could be realized within the framework of an international research project. The aim of the investigations was among others the testing of a newly-constructed forestry harvester crane, a forwarder and a special grapple log skidder as well as the assessment of their technical, economical and ecological efficiency at experimental logging sites (felling both hard- and softwoods) in nine Central European countries (ranging from England to Lithuania). The research project also provided a special possibility that the present doctoral research be extended towards the investigation of the effects of the aforementioned technological and technical developments on the rationalization of logistics. The aim of the domestic situational analysis was to reveal, to present and to assess the actually existing logistical attempts in Hungary.

As a result of the logistically-approached reseach work - which involved the four most significant fields of tree utilization - determination of the possibilities of increasing the incomes and reducing the costs could be potentiated. The investigation of the possibilities of logistical rationalizations have been carried out in the following fields:

- technological developments;
- rationalization of transport;
- organization of work;
- development of the infrastructure for tree utilization.

3. APPLIED METHODS

Because of the extensive character and novelty of the research subject and because its short Hungarian preliminaries, it requires the application of a unique research methodics and arrangement of the dissertation. It was highly necessary to get acquainted with the development of systems-approached wood conveyance in detail, which provides a justification and foundation for the applicability of logistics in tree utilization. Besides of that it was also important to study available results and possibilities and to introduce the flow of timber from a logistical point of view.

The analysis of the evolution of systems-approached timber conveyance has been achieved by the extensive study of the applying scientific fields, including:

- the developments and rationalizations of the 19th century,
- developments and scientific methods of the last century resulting in cost reduction,
- efforts of the present century which take aims to found material conveyance by a systems approach.

The basis of the research was given by the large number of Hungarian scientific publications from the fields of forest utilization, forest transportation and forest road engineering. By these works, which all represent the milestones of the past the outline of the history of the tree utilization conveyance can be drawn.

It's usually not characteristic to PhD dissertations that there are also subchapters discussing previous scientific results in the results' chapters after the introductory parts, the novelty and extensive nature of the research topic, however made this necessary.

The interpretation and historical review of logistics as well as the description of its fields and characterisation of the individual systems for materials transport, information and controlling has not only been achieved by the review of the scientific literature but also by the drawing of numerous comprehensive and illustrative charts and tables. The applicability of the general logistical rationalizations in tree utilization has been verified by concrete calculations.

In the development of logistical system schemes the examples of foreign structures (e.g. Göttingen, Germany) were good starting points, which were further developed respecting the features of domestic timber production and timber marketing.

Focusing on the results achieved in organizational and systems approach issues the research based emphasis on the investigation of the logistical developments in Central and Northern Europe (e.g. analyzing time and performance data of forwarding, and establishing time functions for the measurements at 28 experimental sites in 4 countries (pro cycle)).

According to the results achieved in the field of logistical developments the analysis of three forest management units has been carried out (NYÍRERDŐ Forestry Cco., Szombathely Forestry Cco. and EGER Forestry Cco.) based on field tours, consultations, measurements and on the units' official reports.

The research for realizable results in the field of technological and technical development has been attained by participating in the framework of the „forstINNO” international research project: the technological, economical and ecological effect of the materials transport developments has been researched throughoutly.

Because of the costs and the environmental implications of the delivering of the timber to the customers it is highly important to choose the most suitable transportation methods and tools. While determining the recommendable options using exact calculations it is to be investigated primarily, in which conditions it is economic to transport timber by road and when it is profitable to carry this out by rail by intermodal transport. By comparing the wages of common carriers and railway freighting rates and by carrying out mathematical optimization of cost equations the nomogram of the economic efficiency index of critical distances can be set up.

In order to demonstrate the advantages of the work organization a logistical system for wood chips utilization has been established which outlines clearly the classification of harvester systems, possibilities of transportation and information flow between the members of the system.

Using calculation examples the author has proven that the reduction of the idle time of transport vehicles and the reduction of the unloading/reception time of the timber as well as the reduction of the amount of stockpiled-timber (e.g. at felling sites) will result significant savings in loading and storage costs.

Applying the classical concepts of the opening-up of forests and using optimization methods complemented with the analysis of transportation cost, the dissertation provides strategic principles for the extension of the rate and the arrangement of the road network.

4. SUMMARY OF SCIENTIFIC RESULTS

By reviewing the comprehensive Hungarian scientific resources it could be established that the many decades of rationalizations and innovations of systems-approached material transportation have established the foundations of the introduction of tree utilization logistics.

The conveying of goods represents the major part of the material transportation tasks of logistics. Establishing a system for the modal split of the labour has been an important achievement, which was made using the last 40 years' scientific data from various resources. This system shows clearly how the transport by road increased taking the role of transport by rail to such an extent that the order of the two has even changed.

The solutions of transportation tasks are highly important and determinant in forestry material transport as they determine the costs of the overall production, thus have always been among the crucial questions of silviculture. The dissertation summarizes the different ways of transportation and investigates the importance of their applicability in tree utilization.

Throughout the research many ways and possibilities of transport have been ordered and classified. Besides of that various tools, equipment and installations have also been characterized hoping that this will provide help and basis for specialists during their machinery investments.

For the planning processes of the material and information flow of tree utilization, logistical system schemes have been set up. This has been completed with a graph showing the information and material flow in tree utilization and indicating the possible parallelism and succession of events.

The analysis of the logistical developments in North- and Central European countries has led to the following conclusions:

- Significant reduction of the costs and increase in productivity can be achieved by the introduction of complex logistical systems in forestry. This was shown by Prof. Dr. Dürstein and his co-workers (BOKU, Vienna, Austria) – who have been supporting the logistical research of our Institute for decades – on several concrete Austrian examples.
- The efficiency of transport vehicles and wood-mills can be improved, e.g.:
 - by the better planning of the shipping of timber,
 - by increasing the utilization of transport vehicles,
 - by shortening the time for trucking to the bunches which reduces fuel consumption and idle time even further,
 - by reduction of the waiting time of transport vehicles (by over 5,5%),
 - by increasing transport performance as a function of distance.

- The following ecological results can be realized:
 - the occurrence of pathogens, such as fungi and insects can be reduced,
 - the CO₂ emission (2,650 kg CO₂/liter diesel) of transport and hauling vehicles can be reduced,
 - the environmental load (noise, air pollution, disturbance) of the ecosystem can be reduced,
- Social and other benefits can be achieved:
 - creation of new jobs,
 - further education of the staff,
 - enhancing work safety.

In the same year as the measurements in Austria investigations were also carried out in Hungary for 7 months by JUNG. Evaluating these heat technical data the already-known fact was verified again, namely that the loss of water content and the exothermic capacity of stored-wood are reversely related. This means that considerable savings can be realized for the transport of wood chips, as the delivery price is significantly dependent on the water content, i.e. „not water should be delivered for hard-earned bucks, instead the production of quality and well dried wood chips has to be achieved and put to the front!”.

In the framework of the doctoral dissertation the author had the possibility to set up time norm functions and tables which are valid for the operations mechanized at the level of whole process machanization. These functions and tables can be applied for the whole Central European region as they can provide useful and reliable basic information for the modern organization and evaluation of the logging and transport of timber: both of these stages represent the beginning of the logistical system.

In the present days tree utilization logistics is still in its infancy in Hungary. Systems-approached material transport can only make excellent results nowadays by applying the achievements of logistics. The logistical centers of the NYÍRERDŐ Forestry Cco. represent the first successful steps in the application of this novel system in forestry and tree utilization practice. Their special surplus of results are realized in the logistical centers where the accomplishment of the processing and further processing actions are carried out. This also enhances the executing of the commissions of marketed (mostly exported) timber.

The logistical efforts at Szombathely began at the late 90's, but only at a strategic level – contrary to the operative developments at the Nyírség region and at Eger, where the the primary aim was the origination of the infrastructure – and unfortunately they got stuck there ever since.

To advance the finding of the most economic way of transport among the characteristic timber transporting systems (by rail and by road) a mathematical function and a corresponding nomogram has been set up.

By using the system established by the author for the possibilities of rationalizing the work organization (IMA), the organization of the transport of timber (wood chips) to the customer by a logistical approach can be assured. This results in the improvement of the efficiency of the transport, unloading and reception.

Competitive management also means high expectations and this is true in every sector of the economy. Forestry is not an exception either.

The introduction of logistics to tree utilization is a well-established and necessary objective due to which the working processes can be planned and executed more efficiently by a systems approach.

It's a naivety to think that a completely unified and general tree utilization system can ever be established. However, the rationalization of the single areas using a logistical approach will result in verifiable and necessary advantages.

5. THESES

- I. In her dissertation the author has summarized and characterized the different ways and possibilities of the transportation of goods grouping them into traditional and combined systems. She has investigated their role regarding wood conveyance. She has concluded that direct transport by lorry and intermodal transport by rail and by road have the most important role, the latter of which only above a distinct and well determinable distance. The reduction of the number of the stages of material transport, eliminating of loading and transferring or applying containers more extensively can also help to improve the economic efficiency of transports. The author has established that combined solutions, as for example „hucke-pack” in a narrow sense, bimodal bags or „Big Bags” are only imaginable nowadays at the present technical level for the transport of wood chips.
- II. The author has created system schemes for the design of the processes of material and information flow. Besides the traditional forestry basic logistical system it is also important to establish such structures which make it possible to involve 40% of the private forest owners too. It is also important to create such systems which promote the rationalization of the basic material supply of power plants and timber industry factories (e.g. wood-fibre and particle board factories) which use large volumes and amounts of timber. With all this in view it can be stated that a unified and general logistical solution can not be established only in its parts. The different logistical system schemes have been completed with a graph showing the information and material flow in tree utilization which indicates clearly the possible parallelism and succession of events.
- III. From the processing and evaluation of the time and performance data of the forwarder experiments carried out in four Central European countries a time function has been established. The participation within the framework of „forstInno” international project made the author possible to carry out measurements on the time and performance of loggings with a forestry harvester crane. The data was ordered, recalculated and the parameters of the time functions have been established using correlation and regression analysis. This resulted time norm tables and functions which can also be used in the future in the local regions for the operations mechanized at the level of whole process machanization. These tables and figures will provide reliable methods for the logging and material conveyance stages which represent the beginning of the logistical systems.

- IV. Within the scope of the dissertation a relationship has been established which is suitable for the determination of the critical distance to which it is more economical to transport directly by road, and after which it is better to apply intermodal rail transport. When choosing the proper transport system and vehicle it must be considered that the higher specific cost of the transport by road is compensated – up to a certain distance – by the advantage that the total cost of loading is lower and the route of the transport is also shorter as compared to that by rail. In the case of longer distances however, these advantages are surpassed by the significantly lower cost (Ft/performance km) of the transport by rail. The chart of the figure (nomogram) applied for the calculation of the critical distance of the transport casts light upon the distance to which it is more economical to ship directly by road (two loadings) and after which it is worthwhile to apply also transport by rail.
- V. The author has invented a system as an example for the possibilities of rationalization of work organization. By using this system the transport of timber (wood chips) and its delivery at the factories is more reliable and calculable. The economic efficiency of heating plants, power plants and large-scale consumers depends strongly on the logistic of timber production and transport. The efficiency of transport vehicles will be improved if there is up-to-date and accurate information available about the location of the load and the delivery and if the acceptance time of the timber can be reduced. The system could better be planned and executed when knowing the exact parameters of the freight. Using calculation examples it has been proven that significant savings can be realized concerning loading and storage costs by reducing the idle time of the transport vehicles and the unloading/reception time of the timber. In this regard the reduction of the amount of stockpiled timber (e.g. at the felling site) is also recommended.
- VI. The determinant element of tree utilization logistics is that large volumes of products must be moved using suitable systems of tracks with as low as possible environmental load, cost, and loss of revenue. Applying the classical concepts of opening-up of forests and using optimization methods complemented with the analysis of transportation cost, the dissertation provides strategic principles for the extension of the rate and the arrangement of the road network. The novel system model for opening-up of forests makes it feasible to investigate the tendency of all the material transport and road construction costs in general. With its application, concrete data for the optimal extension of existing road networks can be obtained and the sensitivity of the forwarders and skidders to the rule of mass-to-piece-ratio can also be investigated.

6. RECOMMENDATIONS

Due to the size limitations of the dissertation many questions have remained unanswered yet, which are intended for further investigation by the author in the future also with the possible participation of university students.

Further investigations should be in accordance with the development of tree utilization and should be carried out regarding economic expectations. Hence, the primary aim is to adapt such logistical applications to forestry (especially to tree utilization) which have already proven to be efficient in other sectors.

Selective cutting and the selection system which ensure constant forest coverage, set new tasks for the experts working in the field of forest cultivation and tree utilization too. This issue has come more and more to the front recently and what has become important by now is how to make loggings more tempered. This means that it has to be investigated also, how tempered tree utilization actually is nowadays (e.g. application of small machines, reintroducing of skidding with horses, which can only be realized with multiple coordination and organization, thus it is a logistical challenge).

Logging with harvesters and forwarders (whole process mechanization), which has been applied in developed countries for decades is spreading also in Hungary now (primarily at private enterprises). In order to use these high-cost machines knowingly and make the best of them it is important to coordinate production and hauling, conveyance. The planning, investigation, cost and time analysis of all this belongs to the urging logistical tasks of the future.

The tasks of tree utilization in our days also involve the proper employment of branchwood, piling up at the felling sites and landings. The economic issues of wood chipping, checking of the machines, development of working systems also belong to the logistical tasks, as complex and multiple processes have to be organized together, may the conveyance of materials involve wood chips or bundles of branchwood.

In behalf of efficient tree utilization the development of logistical system schemes is highly recommended at the level of forest management units, or better at the level of the overall forestry sector, connecting to the logistical systems of timber trade and wood products industry. It would be highly beneficial to organize a collaborating network, to develop a steadily available and improvable information and physical material flow network by creating the required infrastructure (roads, forest road networks) and device systems (digitized maps, satellite-based navigation and mobile mapping devices).

The logistically-approached management would best be achievable by the direct employment of engineers with specialization to logistics in the forestry sector.

7. THE AUTHOR'S OWN PUBLICATIONS CONCERNING THE DISSERTATION

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