

NEW SOFTWARE FOR TIMBER HARVESTING, LOGGING AND LANDING SITE PROCESSING COST ESTIMATION

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Abstract: *The technological design process afferent to timber harvesting activity pursues the obtaining of the best technological solutions. In finding of the reasonable optimum, the technological design activity deals with complex tasks and the results of a solution have to be valid from an economic point of view. Also, this activity involves a lot of time consuming work and personnel involvement especially due to its complexity, reflected by multiple tasks to be solved. In this context, the implementation of some software solutions for the above mentioned problems solving is welcomed. Thus, in the present paper we present both the use and tasks which can be solved by using the first version of the software product “Evaluator Procese Tehnologice”.*

Key words: *software, harvesting, logging, cost estimation.*

1. Introduction

In order to select the best harvesting strategy, it is necessary to realize a series of design tasks regarding the obtaining of an adequate setup for logging network as well as adopting the best strategy for harvesting and landing site organization.

Each of the three mentioned components is affected by specific costs, generated by the employed labour means as well as by the working force.

An exhaustive methodology for timber harvesting site organization as well as for the cost estimation has to consider all involved components, beginning with the labour force, harvesting, logging and landing site processes specific costs, and ending with overhead costs (indirect costs) generated by different logging networks setups [3], [4].

For certain local conditions, these costs can be greater or smaller, depending on the utilised harvesting-logging-processing means, stands conditions and adopted silvicultural system and logging network development.

2. “Evaluator Procese Tehnologice” - A Practical Solution for Cost Estimation

2.1. Software Design

“Evaluator Procese Tehnologice” (Figure 1) is a software product designed for technical and economic purposes in order to better estimate the timber logging processes associated costs. It is written in Visual Basic for Applications, extending the Microsoft Office (Excel) capabilities by implementing a graphical user interface which assists the user in realizing custom designs of the process. It is implemented

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by two program modules, the first one permitting to design a custom process and evaluate the associate costs, and the last one being used to compare the process costs for predefined processes.

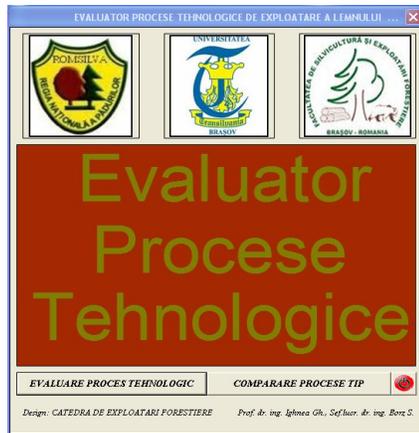


Fig. 1. *Evaluator Procese Tehnologice* greeting page of the software product

This software product was developed by paper authors, in order to provide a scientific based tool for timber harvesting processes, with application in production designs.

2.2. User Input Data and Modelling Results

In order to respond to practical necessities, the presented software product offers a large spectrum of allowable input data, grouped in the user interface windows. The two program modules allow a wide range of data input.

In case of “Evaluare Proces Tehnologic” module utilization, the initial data window (Figure 2) allows the user to input general data such as harvesting site area, harvested timber volume by considering the species groups (resinous and broadleaves), average tree volume (resinous and broadleaves), harvesting site name or the project name, forestry code for harvesting site identifying and operator’s name.

Fig. 2. *Initial data input window*

The process can be defined in the processing structure window. This window (Figure 3) allows the user to input harvesting means and percents, skidding means, percents and distances, as well as hauling means and distances. Also, in this window, the hourly wages for the labor force as well as the contribution percentage can be introduced.

The logging network characteristics as well as the associated costs can be designed in a dedicated window (Figure 4), in which the user can choose between tractors based or skyline based setups. Also, any combination between the above mentioned is possible.

In case of tractor based network, the user may choose the transversal profile characteristics of the tractor roads, the network length and the ground slope for particular tractor road portions. For the skyline case, the user may choose the machine type, the setup length and the number of successive setups.

The unitary costs regarding the logging network realization can be introduced from the same window.

The harvesting process costs are estimated after the hourly costs introduction for the used machines. This task is realized into a

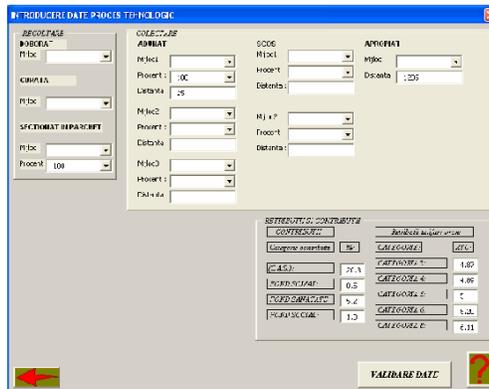


Fig. 3. *Process definition window*

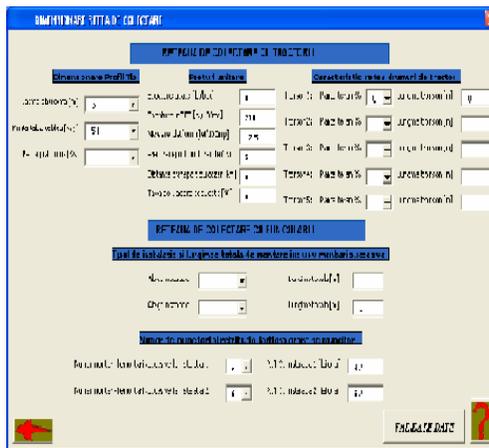


Fig. 4. *Logging network design*

dedicated window (Figure 5), which allows the hourly costs input for the most commonly used machines in Romania, including animal logging.

The obtained results are presented into a process results window, which describes the main process characteristics, referring at the same time to local conditions (Figure 6). In this window, the following data is presented: the harvesting site area, the harvested volume per hectare, felling area name, felling area code, operator's name, wages, process costs, network realization costs, overall technological process costs.

The second program's module allows the user to input the same initial data, and,

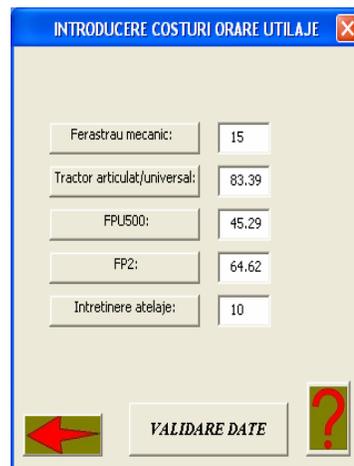


Fig. 5. *Hourly costs input window*

after completing this task, a wide range of technological systems (21 systems) can be selected from a dropdown list.

The screenshot shows a software window titled "AFISARE REZULTATE PROCES TEHNOLOGIC". It contains several input fields and a table of results. The input fields are: "SUPRAFATA PARCHETELUI [Ha]" with value 19.2, "VOLUM EXPLOATAT LA HECTAR:" with value 46.35, "Denumire parchet:" with "De completat", "Numar partida si anul exploatarei:" with "De completat", and "Intocnit:" with "De completat". The table below shows the following data:

SALARII [lei]	13346.88
SALARII [lei/mc exploatat]	15
CHELTUIELI DE INTRETINERE-FUNCTIONARE [lei]	68953.23
CHELTUIELI DE INTRETINERE-FUNCTIONARE [lei/mc]	77.48
CHELTUIELI IKA [lei]	6142.27
CHELTUIELI IKA [lei/mc]	6.9
TOTAL PROCES TEHNOLOGIC [lei]	8842.38
TOTAL PROCES TEHNOLOGIC [lei/mc]	99.37

Fig. 6. Results window

By selecting and validating a specific system, a supplementary window appears which asks for system related data. After the supplementary data input and validation, the user can select another system in order to compare the associated costs, as well as productive data. After these tasks' realization, the user can select the option to visualize the results, in which case the dedicated window is launched. If the results are satisfying, the user can use the print procedure in order to elaborate the necessary documentation. In case of the first program module, the printing procedure provides access to the default operating system printer, and a number of four pages are printed: wages, process costs, network realization costs and a process centralizer. If the printing procedure is selected from the second program module, a single page is printed, representing the technological and economic processes' comparison.

For all the specific windows and related tasks, a comprehensive user help was devised. The user help access can be

obtained from each window as well as form a dedicated user guide.

2.3. A scientific approach under the User Interface

A comprehensive approach regarding the timber harvesting site organization has to consider all the technical and economic related issues.

In order to determine the timber harvesting operations cost, the following cost categories must be considered [3]: personnel costs, harvesting and logging means functioning costs, logging network and landing site realization costs, diverse costs. The software product is realized on the basis of such scientific approaches.

Therefore the total cost function (1) can be written as follows:

$$C = C_p + C_{if} + C_{ip} + C_d, \quad (1)$$

where: C represents the process cost [currency/m³]; C_p - personnel costs, [currency/m³]; C_{if} - harvesting-logging means functioning costs (overheads, indirect costs), [currency/m³]; C_{ip} - logging network and landing site realization costs [currency/m³]; C_d - diverse costs, [currency/m³].

Personnel costs comprise salaries, contributions etc. and they are distributed on realized product unit. The calculus relation (2) can be written as follows:

$$C_p = \frac{p}{100} \left(1 + \frac{\sum S}{100} \right), \quad (2)$$

where: T_u - the unitary retribution tariff for a specific harvesting operation [currency/m³]; p - the percentage of the timber quantity processed in a specific operation; $\sum S$ - social contributions sum.

Harvesting-logging means functioning costs are estimated by applying the relation (3):

$$C_{if} = K_{if} N_{tu} \frac{p}{100}, \quad (3)$$

where: K_{if} - cumulated functioning costs (direct and variable costs), for a certain harvesting or logging mean [currency/machine-hour]; N_{tu} - time norm per machine, in given work conditions [machine-hour/m³]; p - the percentage of the timber quantity processed in a specific operation.

The unitary costs for timber logging network realization are estimated by the following relation:

$$C_{ip} = \frac{I}{Q}, \quad (4)$$

where: I - total estimated cost for timber logging network realization [currency]; Q - total quantity of harvested timber for a certain felling area.

The unitary retribution tariff is obtained by multiplying the hourly wage by the time norm [man-hour/m³], and the time norm per machine is obtained by dividing the time norm by number of workers in a formation group which require a machine.

2.4. Algorithms design

In order to calculate both the salaries and the operating costs, the program needs to search the corresponding norms according to the specific work conditions. For harvesting operations, the considered time norms were those presented in the national normative, whereas in case of logging operations, the time norms were obtained by reverse engineering of the time norms. This way, by using regression equations, the resulted program algorithms are more accurate and computing is time saving. Also, the resulted program procedures are compact, easy to understand and extend [2]. The applied conditions can be extended by

capacity extrapolation but we do not recommend working with conditions uncovered by the normative.

Hourly machine costs can vary from one situation to another, reason for which, a dedicated window was included, in order to input these costs. The methodology of hourly cost determination can be adopted from the scientific literature [3].

In case of logging network realization, the problems are quite different, according to the used logging machine. In case of tractor based logging network, the cost estimation considers the following variables: real network length, transversal profile of the tractor road characteristics, and associated costs for different operations in network realization.

Cut surface determination follows the methodology described in another paper [1], by implementing a calculus algorithm according to the design elements of the transversal profile.

Cut volumes' estimation is obtained by multiplying the network length by the cut surface. A supplementary cut volume is attributed in order to cover the situations in which the cut volume is moved on greater distances. All the cut volume is multiplied by a bulkage factor of 1.27 which covers the earth situations in case of tractor network development.

In case of skylines, the yarding network realization considers the amount of labour involved in skyline's setup. The amount of labour is determined by using a regression equation [4], for average terrain conditions, resulting the number of necessary labour hours according to the skyline type, number of setups and the total setup length. By multiplying the number of hours with the hourly wage, the program determines the network cost.

The same principia relations and algorithms are implemented in the second program module for different technological systems comparison.

3. Conclusions

Using the new software product “Evaluator Procece Tehnologice” is the premise for achieving high productivity in forest harvesting design activities. According to the Romanian public forest sector necessities, the software product was designed by incorporating the most used harvesting and logging machines. Also, in accordance with the national resort normative, cost estimation is realized by implementing norms for the mentioned machines.

There are three major problems which can be solved by a large scale utilization of the software product: time saving (a process design and cost evaluation takes no longer than two minutes), accuracy (software product eliminates all the design errors), and optimization possibilities (in the case in which the timber logging entrepreneur possesses more than one machine, the software can assist in decision making).

For now, the software product is limited by the necessity to manually determine the necessary design elements (by using an adequate technological map). Further versions will be developed by considering the necessity to automate downloading of field data and assisted processing-generating of design elements.

Also, next versions will be realized as stand-alone applications by transferring the code modules.

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