Adjustment of Supplementary Worktimes in the Process of Logging and Timber Skidding

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Technical and technological progress necessitates updating of the worktime consumption standards. Proper adjustment to changing standards and realities of work has to take into account fluctuations in individual components of the overall worktime.

The aim of this dissertation was to create model shares for the categories of supplementary time and the time for preparation and completion of the major task depending on the selected factors of working environment observed in the workday structure of a harvester operator. The system of Supplementary Time Standards (STS) was the basis of adjustment. The components of the index were partial coefficients the significance of which for work shares is reflected in appropriate weighting assigned to them. The STS indices were developed for forest districts as the smallest administrative units undergoing adjustment. Grouping of forest districts characterized by similar logging and timber skidding conditions resulted in identifying the regions of work difficulties. The system of Supplementary Time Standards was constructed on the basis of similar management difficulties in forest districts of the State Forests. The differences consisted in a suitable selection of factors affecting the level of standard times and their proper ranking based on graph theory and replacement of quantitative and qualitative parameters of terrain features with a uniform system of numerical values. The model of impact of the working environment features on work of multi-operational machines was developed for forest districts belonging to the Regional Directorate of State Forests in Radom.

Management process control in forestry is part of the tasks of cybernetics, the science of automatic control of systems which is based on couplings (simple couplings and feedback loops) and system responsiveness. The forest ecosystem and the phenomena occurring there including technologies of machine logging have the features which enable a cybernetic analysis. Analysis of logging as the outcome of many variables resulting from the features of tree stands, terrain conditions and technique and technology as well as machine parameters and human psychomotor characteristics reveals a number of interrelationships which can be presented by means of discrete mathematics in the form of a graph and, at a later stage, in

the form of mathematical models. Methodological solutions presented in the dissertation outline a cybernetic model of couplings between work environment factors and worktime structure in the machine process of logging. A model of the working environment impact on work of multi-operational machines was developed for forest districts belonging to the Regional State Forest Directorate in Radom.

It was assumed that there are 13 elements of working environment which interact with the work of harvesters and forwarders. Numerical assessment of a given feature (working environment element) was carried out after its transformation enabling conversion of any distribution into a normal distribution with a mean of 10 and a standard deviation of 10/3. As a result of the conversion, the value of the index within the range from 0 to 20 was assigned to every value of feature X_i (observed feature). The impact strength of working environment factors was presented in the form of coefficients resulting from the number of relationships mapped in the form of a bipartite graph. The difficulty index (RN_i) for logging and timber skidding in the area of the forest district was obtained as a cumulative result of multiplication of the feature intensity strength and coefficients. On the basis of the obtained RN_i values the groups of forest districts in the Radom State Forest Directorate which are similar from the point of view of the logging process difficulty were identified. The extreme values of the index were assigned to the Pińczów Forest District ($RN_i = 9$) and Starachowice Forest District ($RN_i = 14$).

In order to define the shares of supplementary times and the time for the major task preparation and completion in the groups of forest districts revealing identical RN_i values, questionnaire surveys were carried out of the multi-operational machine workday structure. Compatibility of the workday structure estimated by means of questionnaire surveys and snapshot observations was very high. The coefficient of determination denoted R^2 stood at the level of 0.80 and the regression coefficient amounted to 0.6033. It was decided that the level of accuracy of estimates of the production and extra-production time shares determined by the questionnaire surveys is adequate for the processes of worktime standardization. Further analyses were focused on determination of the degree of dependence between the share of supplementary times and the time for the major task preparation and completion (Supplementary Time Standard), on the one hand, and the logging process difficulty index (RN_i), on the other.

The relationship between the value of the logging process difficulty index RN_i and the share of supplementary times and preparation and completion times during a shift were presented by means of a simple regression equation. Estimation of equation parameters was carried out on the basis of workday structures corresponding to RN_i values ranging from 9 to 14. With the use of the regression equation estimated in the dissertation we determined the workday structure of multi-operational machines (STS index) corresponding to the RN_i values ranging from 1 to 20. The *STS* value which is equal to 1 corresponds to the share of the examined time categories during a shift of multi-operational machines at the level of 72.3 %; when the STS value equals 20 - it is 9.5 %.

Key words: logging, work study, worktime structure, snapshot observations, harvester, questionnaire surveys,