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Novel Efficiency-Based Model for Road-Transport Energy Evaluation Using Gravitational Benchmark and Route-Profile Characteristics

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GOAL OF THE STUDY

Based on the literature analysis, it can be concluded that so far the energy efficiency of road transport has been assessed by the total energy consumption without determining the efficiency coefficient of the processes. The consumed energy has never been divided into useful and non-useful part, and this does not allow sufficiently informative analysis and in-depth assessment of the operations and of the technological perfection of objects, systems and processes.

The goal of this study is to develop and justify a novel improved model for criterion evaluation of the energy efficiency of road transport processes, taking into account the gravitational potential energy of loads and using satellite technologies.

DEVELOPMENT OF A CRITERION MODEL FOR EVALUATION

The general concept of the criterion model can be expressed with the block diagram of Fig.1.

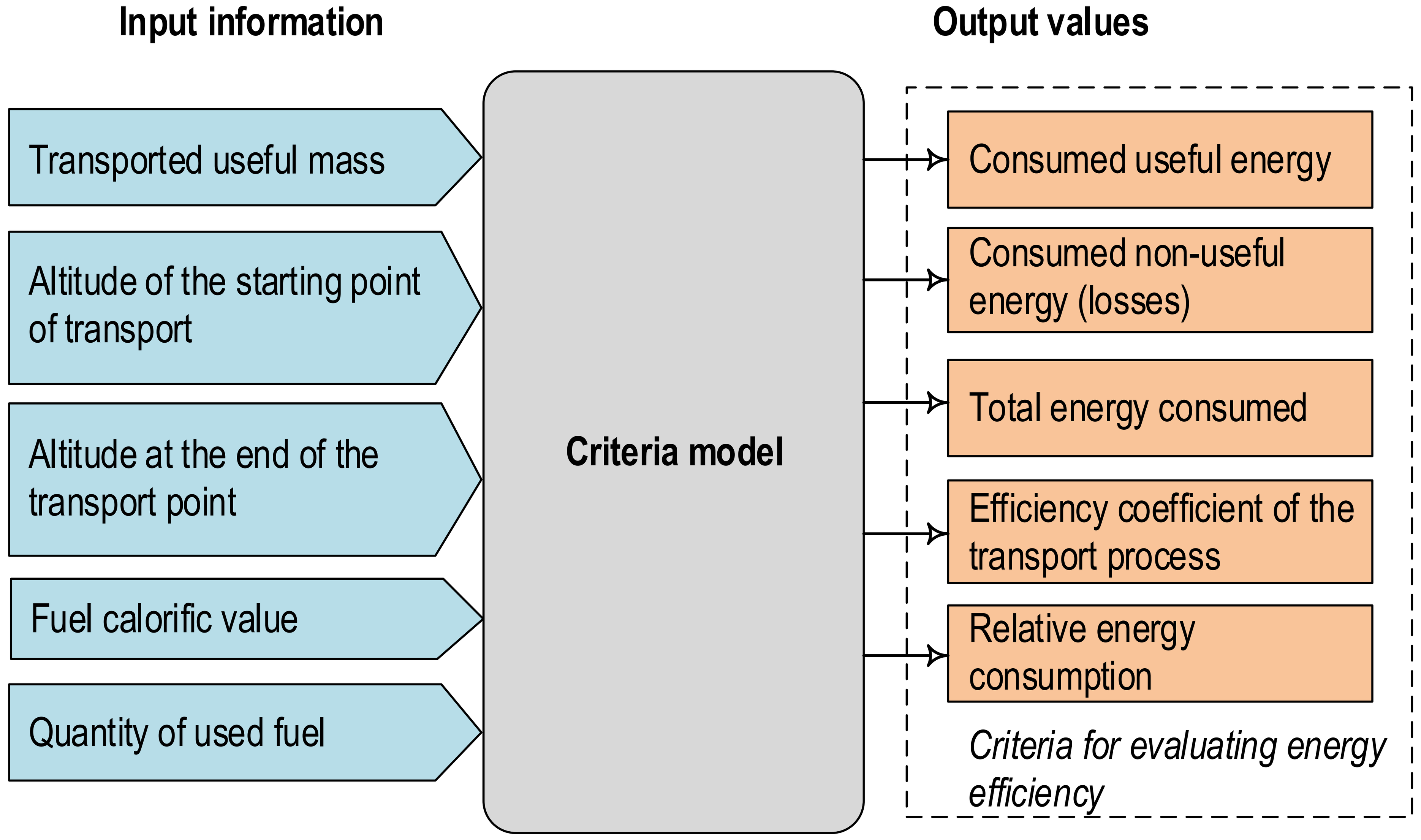

Fig. 1. General concept of the criterion model for energy efficiency evaluation

Energy efficiency research is greatly supported by the use of automated data processing with the help of software tools to obtain more reliable and user-friendly information. Using the developed algorithm, a software tool was created for the purposes of the elaborated model (Fig. 2).

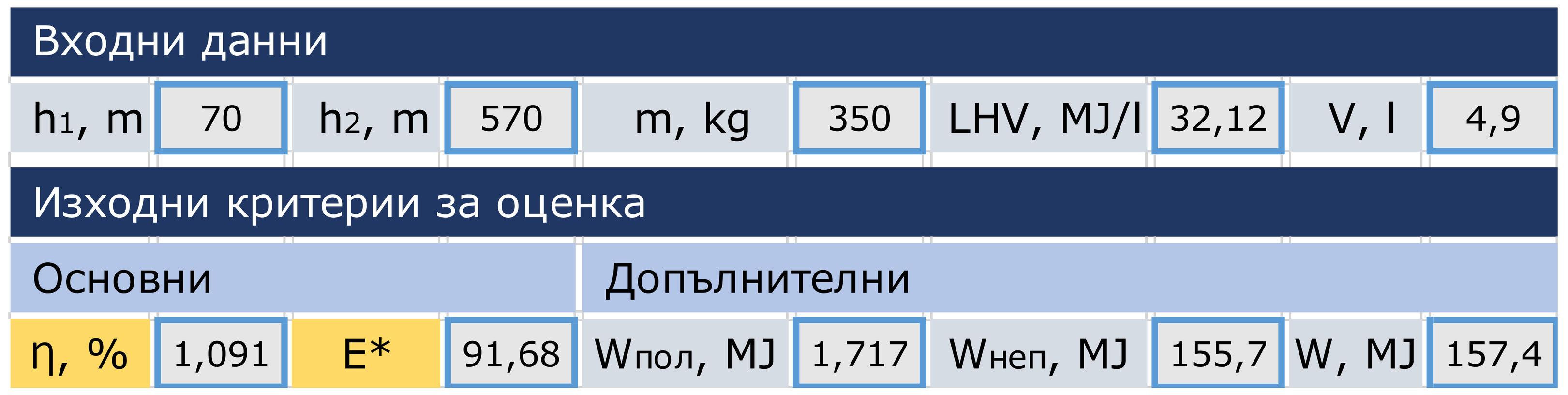

Fig. 2. Graphical interface of a software tool for determining criteria for assessing the energy efficiency of motor vehicles

EXAMPLE OF MODEL APPLICATION

Simulation studies of typical motor vehicles are performed. When selecting the objects, the condition for extensive use in practice is adopted. The technical characteristics of the studied objects are obtained using official information from manufacturers.

The results of the simulation studies are shown in Table 1.

Table 1. Some of the values of the efficiency coefficient η, % for different traveled distances d, km and route vertical displacements Δh, m

d, km	Object 1		Object 2	
	Δh =500 m	Δh =1000 m	Δh =500 m	Δh =1000 m
100	1.129	2.257	0.651	1.303
200	0.564	1.129	0.326	0.651
300	0.376	0.752	0.217	0.434
400	0.282	0.564	0.163	0.326
500	0.226	0.451	0.130	0.261
600	0.188	0.376	0.109	0.217
700	0.161	0.322	0.093	0.186
800	0.141	0.282	0.081	0.163
900	0.125	0.251	0.072	0.145
1000	0.113	0.226	0.065	0.130
1100	0.103	0.205	0.059	0.118
1200	0.094	0.188	0.054	0.109

CONCLUSIONS

The adoption of a gravity-based benchmark allows the development of a first-of-its-kind theoretical model for evaluating the energy efficiency in transportation processes using motor vehicles. The model allows comparison with the theoretical minimum and divides the consumption into useful and non-useful component.

The conducted simulation studies give grounds to assume the workability and applicability of the model for objects in the field.

New data are obtained for the efficiency coefficient when transporting with two typical motor vehicles that are widely used in practice. The average efficiency coefficient varies from 0.12 % to 0.41 %. The data show very low levels of energy efficiency and are indicative of the need to rethink the studied transport technologies.