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Y. S. Biks
O. G. Ratushnyak

THE SUSTAINABILITY OF THE BEST ALTERNATIVE WHEN CHANGING THE CRITERIA WEIGHTS IN MCDA ASSESSMENT OF ENVELOPES ENERGY EFFICIENCY POTENTIAL

Vinnytsia National Technical University

Abstract
The assessment of energy efficient potential of multilayered envelopes was performed by Multi Criteria Decision Analysis (MCDA) techniques. There were compared eight types of wall assemblies from natural materials: hempcrete, adobe, strawbale panel, earthbag, cordwood, SIP (plywood+ecofiber), hempcrete+straw and energy efficient block. Validation of the best alternative sustainability was calculated by DECERNS MCDA software. Conducted research revealed that the most sensible criteria in weight range of [0.1-0.3] are «cost», «mass» and «u-value». Further analysis of the increasing/decreasing trends in wall assemblies should be conducted to discover the key role of specific criteria weight changing on the priority arrangement of the best wall alternative.

Keywords: TOPSIS, MCDA methods, weighting method, wall assemblies

Introduction

The huge amount of building materials in modern construction practice forces to make a choice using multi-criteria decision analysis (MCDA) methods [1, 2]. The problem of choice from variety of energy efficient envelope's alternatives is still the challenge [3, 4]. From the other hand, in case of uncertain input model data situation, the decision maker has to take into consideration opportunity to change own judgements about criteria weights that affects on the final decision of best alternative choice. Therefore, in this thesis is proposed the attempt of general influence evaluation of criteria weights on the goal function.

Such influence criteria have been taken into consideration as ISO 13786:2017 [5] decrement factor *f*, the internal area heat capacity (kJ/m^{2}K), the thermal transmittance (u-value), mass and the cost of materials of the wall assembly.

Results of the research

As multilayered envelopes such types of walls were considered into comparison assessment: hempcrete, adobe, strawbale panel, earthbag, cordwood, SIP (plywood+ecofiber), hempcrete+straw and energy efficient block. The MCDA assessment of envelopes energy efficiency potential was conducted by TOPSIS [2] method with predefined weights of criteria by Analytic Hierarchy Process (AHP) [7] and by Entropy method [2]. The cross sectional compositions of wall types shown below in Fig. 1.

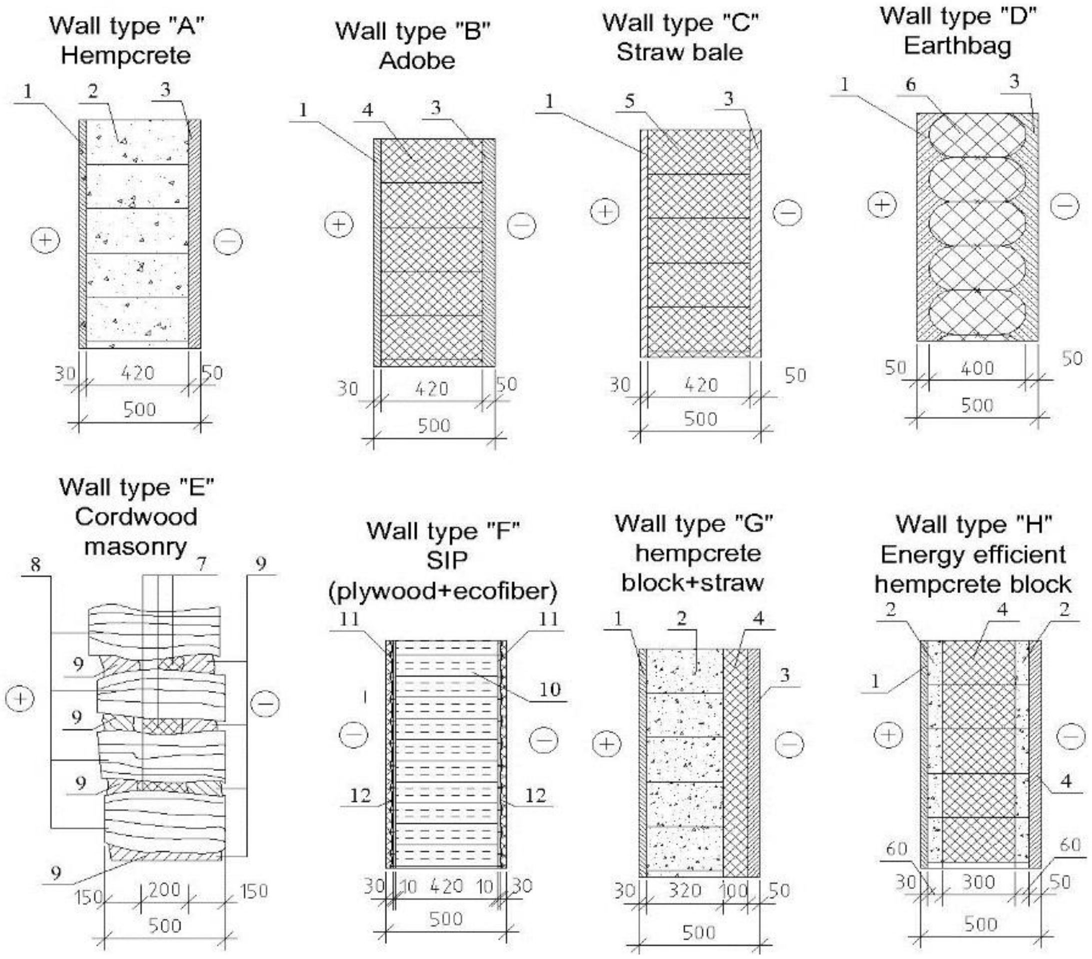

Fig. 1. Cross sectional scheme of considered wall types (1 – internal lime-sand plaster, 2 – hemcrete, 3 – external lime-sand plaster, 4 – adobe, 5 – strawbale panel, 6 – earthbag, 7 – chopped straw as insulator, 8 – cordwood, 9 – lime-sand plaster, 10 – ecofiber, 11 – lime-sand plaster, 12 – plywood)

The model for energy potential assessment by TOPSIS method was performed in DECERNS MSDA [8] software which is presented below (Fig. 2). The weights of criteria calculated according to Entropy method is presented in Fig. 3.

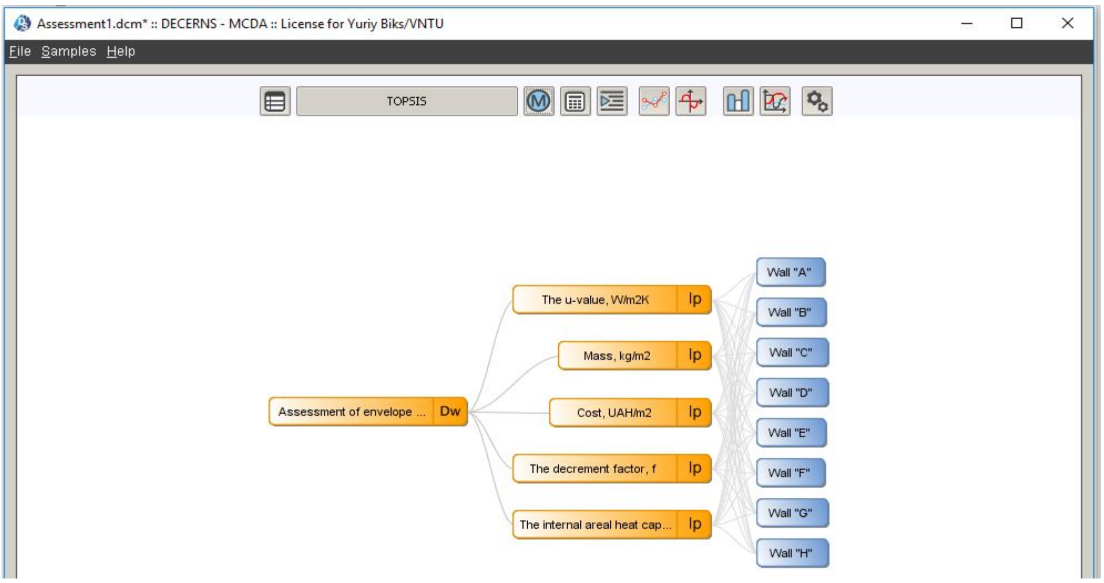

Fig. 2 Model for energy efficiency assessment of multilayered walls

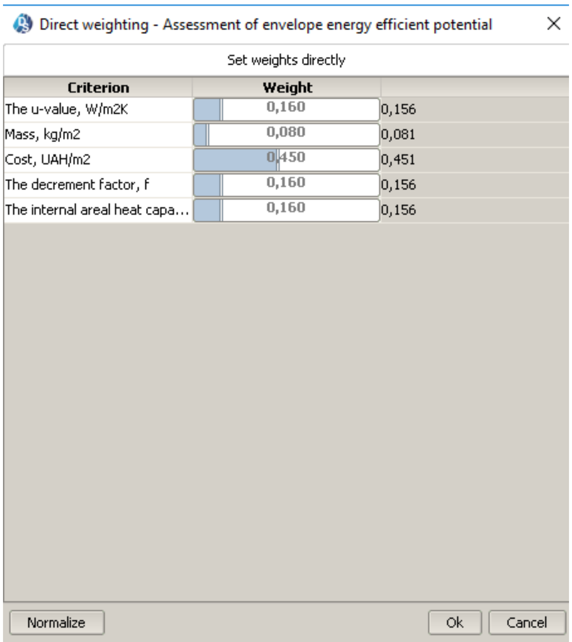

Fig. 3 Initial criteria weights calculated by Entropy method in the proposed model of energy efficiency assessment in DECERNS MCDA window [8]

After the all data been inputted the arrangement of alternatives were as follows in Fig. 4.

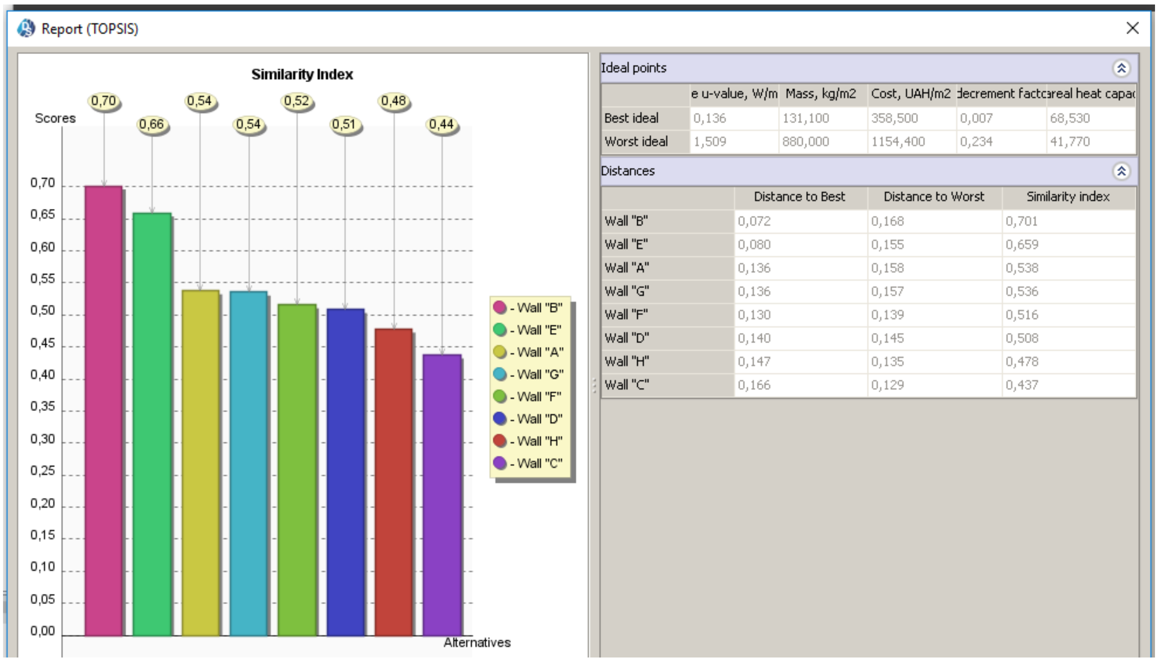

Fig. 3 Energy efficient potential assessment which was calculated by TOPSIS method in DECERNS MCDA [8]

The value of criteria weight can be changed by moving the button on the Weigh Sensitivity window of the program [8]. In the Fig. 4-6 are presented wall assemblies arrangement influenced by the «mass» criteria weights change.

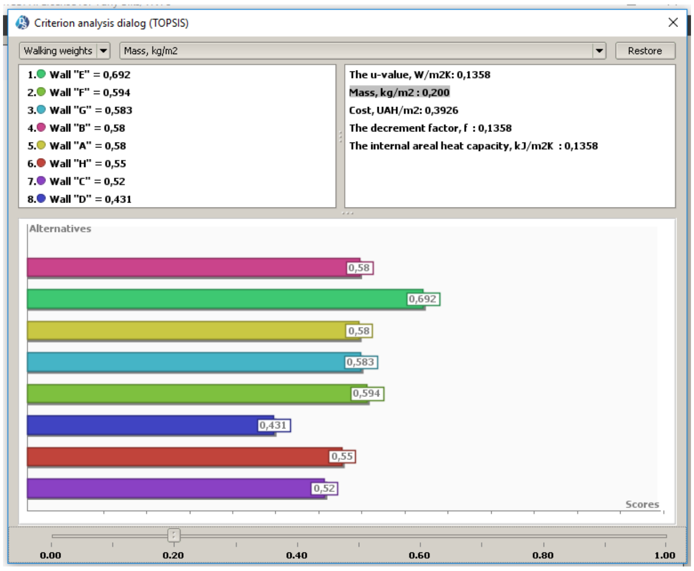

Fig. 4 Difference in priority order of walls due to «mass» criteria weight changed to 0.2 [8]

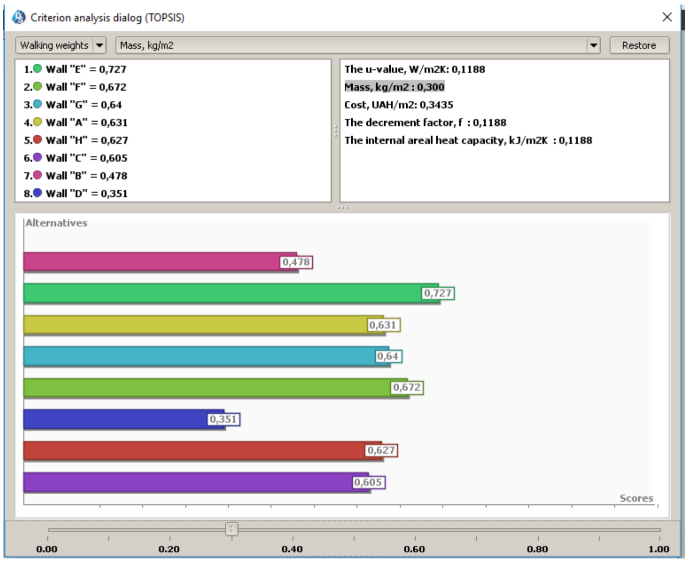

Fig. 5 Difference in priority order of walls due to «mass» criteria weight changed to 0.3 [8]

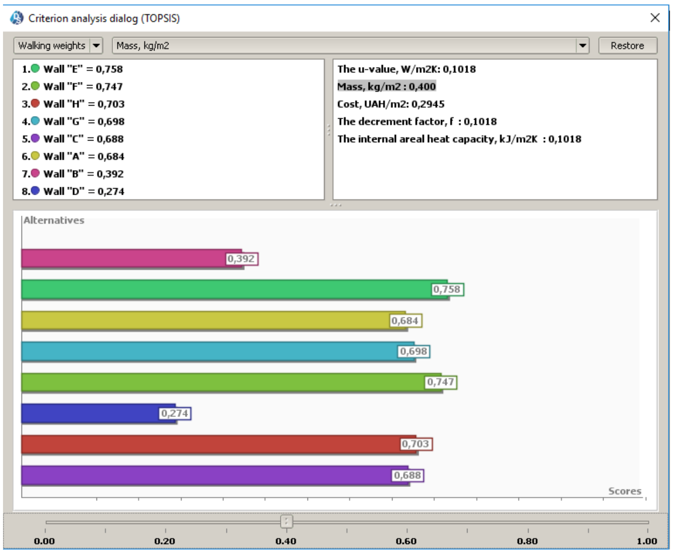

Fig. 6 Difference in priority order of walls due to «mass» criteria weight changed to 0.4 [8]

Conducted research has shown, that the most sensible criteria in range of [0.1-0.3] are «cost», «mass» and «u-value». Further analysis of the increasing/decreasing trends in wall assemblies should be conducted to reveal the key role of specific criteria weight changing on the priority arrangement of the best wall alternative.

Conclusions

It can be noted that criteria weights play important role in the decision making by MCDA methods such as TOPSIS, AHP and others that use additive goal function. Numerical modelling analysis has shown that massive walls such as Adobe («B» type) and Earthbag («D» type) are strongly sensitive to the «mass» criteria changing.

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Biks Yuriy S. — PhD, Assosiate Professor, Department of Construction, Urban Economy and Architecture, Vinnytsia National Technical University, Vinnytsia, email: biksyuriy@gmail.com

Ratushnyak Olga G. – PhD, Assosiate Professor, Department Of Enterprise Economics and Production Management, Vinnytsia National Technical University, Vinnytsia.