KAKO ODABRATI NAČIN SUŠENJA ORAHA

HOW TO CHOSE WALNUT DRYING PROCESS

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Prilikom donošenja odluka uobičajeno je da se uradi analiza koja će u obzir uzeti različite kriterijume. Pošto postoji nekoliko poznatih načina za sušenje oraha, postavlja se pitanje koji od njih odabrati. U radu je obavljena analiza na osnovu kriterijuma različite vrste koji bi donosiocu odluke mogli da pomognu u donošenju odgovarajuće odluke. Analizirani su aspekti koji mogu da utiču na formiranje i odabir odgovarajućih kriterijuma, a analiza je sprovedena i na konkretnom primeru.

Ključne reči: *višekriterijalna analiza za donošenje odluka; kriterijumi; sušenje oraha*

During decision making process is common to make an analysis which will take into account different criteria. Since there are several known ways for walnut drying, it is a question which one to choose. In this paper is done an analysis of criteria of different kind which could help to a decision maker to make an appropriate decision. The aspects which can influence on forming and choice of appropriate criteria are analysed. The analysis is also done on a specific example.

Key words: *Multiple-criteria decision analysis; criteria; walnut drying*

1 Introduction

Drying is probably the oldest unit operation, since even the first men and women before the invention of any of the industries, had to dry themselves after the rain. During the centuries of drying applications in different fields, the drying process very much evolved. Speaking about walnut drying, the walnuts had to be somehow dried since the first days of their use. At the beginnings they were naturally dried (sun), and later different types of driers mainly using forced convection of heated air were developed. In this paper are analysed different ways for solving the dilemma about which drying process to choose.

2 Multiple-criteria decision analysis

Everybody is involved in some kind of decision making process which is done on a daily base. For making „the right decision“ relevant criteria have to be used. Multiple-criteria decision analysis (MCDA) is a mathematically formalized way of analysis used for decision making process.

Application of different approaches of multi-criteria analysis is frequent in the cases where, according to that analysis, formulation of some strategy or policy is expected [1]. In the cases where decisions are applied to much less number of stakeholders (or even to only one user), it is not common to make a formally structured such kind of analysis. In this paper, together with basic ideas and theoretical fundamentals related to some of the methods of multi-criteria analysis, are considered also possibilities of application of such kind of decision making during the choice of convenient walnut drying procedure.

There are several types of multi-criteria analysis for decision making [2].

As a foundation for most of them a pairwise comparison is taken. Although numerous references refer to [3] as the beginning of use of pairwise comparison which was also considered to be foundation for a specific MCDA tool (analytic hierarchy process – AHP), there are few authors stating in public scientific forums that pairwise comparison was not discovered by Saaty, but it was used much earlier by Ramon Llull who lived in XIII and XIV century, and that AHP is not the same as pairwise comparison [4].

Based on Saaty's work [3] the pairwise comparison scale from 1 to 9 became a widely accepted standard for such kind of analysis. Such approach was used in this paper for gathering data from interviewees to be used for weight coefficients formation.

Such initial structure used for pairwise comparison is used in several MCDA tools. Among AHP, it is also used ANP (analytic network process), etc.

There are a lot of different types of MCDA tools present today, which makes it hard to decide which of them to use. Some of them are listed below, divided by type of problem to be solved [2]:

- Choice problems – AHP, ANP, MAUT/UTA, MACBETH, PROMETHEE, ELECTRE I, TOPSIS, Goal Programming, DEA
- Ranking problems – AHP, ANP, MAUT/UTA, MACBETH, PROMETHEE, ELECTRE III, TOPSIS, DEA
- Sorting problems – AHPSort, UTADIS, FlowSort, ELECTRE-III
- Description problems – Gaia, FS-Gaia.

Taking into account such big number of available MCDA methods, it could be expected that the decision maker has to make a MCDA analysis just in order to decide which method to use, and yet to justify the method used for this, or to make another one before this process, etc. Without such kind of analysis is difficult to justify the choice, since none of them is neither perfect, nor universally accepted to all of the problems. Not dealing with these issues, the authors chose to do the analysis using AHP.

2.1 Analytic Hierarchy Process analysis

In this case, by the authors' opinions, because of the obvious advantages and disadvantages of walnut drying process, it was not necessary to make also a SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats). Instead of that kind of screening, based on own experience, as well as on known references from drying field, a list of criteria used for weight coefficients' formation was made. It was also taken into account a work done in the field of psychological experiments by Miller [5], where he proved that human mind cannot process more than 7 plus/minus two pieces of information. Applications of MCDA for choice of some drying type are not unknown [6].

In order to make weight coefficients, the criteria analysed during the process for choice the drying plant for walnuts are:

- Investment costs
- Exploitation and maintenance costs
- Plant's operation efficiency
- Plant's capacity
- Investment's security (in terms of product placement and profitability)
- Availability of existing infrastructure
- Stimulating measures (at local, regional, or national level).

For these criteria a questionnaire giving the pairwise comparisons among them was made and distributed among the experts in the field who were familiar with at least one of the drying methods. Their answers were used for making the matrices needed to make AHP analysis.

As it was explained in detail in [1], the pairwise comparisons among the criteria are presented in a matrix with their weights $w_1, w_2, ...w_n$. After this, matrix is multiplied by the column vector ($w_1, w_2, ...,w_n$) which gives the following vector *nw: An=nw*, where *n* is the eigenvalue of *A* if this equation has a non-zero solution.

After the matrix *A* is made (7×7 matrix in this case), the normalized matrix is made. After that, the priorities of each of the analysed matrix's component are calculated. The calculated priorities represent the relative impacts of the criteria.

This calculation was done in homemade spreadsheet software. The results are presented in Fig. 1.

It could be noticed, that the criteria of Exploitation and maintenance costs was among the most influential among the interviewed experts (0.360 accurate to third decimal point). Operation efficiency of the plant is also considered to be very important (0.190), as well as security of the investment (0.143), while the availability of existing infrastructure was considered to have minor impact (0.031) on decision making process about whether or not to invest in a walnut drying plant.

It is not enough to calculate the priorities of the chosen criteria, but it is also important to check the consistency of the sample used. In AHP method, it is usually done by calculation of so called Consistency Ratio (CR), although there are also some other opinions [7] The Consistency Ratio provides us an insight into the consistency of the answers of the examined experts. It was calculated by dividing so called Consistency Index (CI) and Random Consistency Index (RI). CI was calculated as a ratio of (λ_{max}-1) and (n-1), where λ_{max} is the maximum eigenvalue of the matrix and ***n*** is the number of criteria (7

in this case, since the matrix was 7×7). The Random Index represents the consistency of a randomly generated pairwise comparison matrix. Since the number of items compared in the matrix was 7, for RI was used value of 1.32.

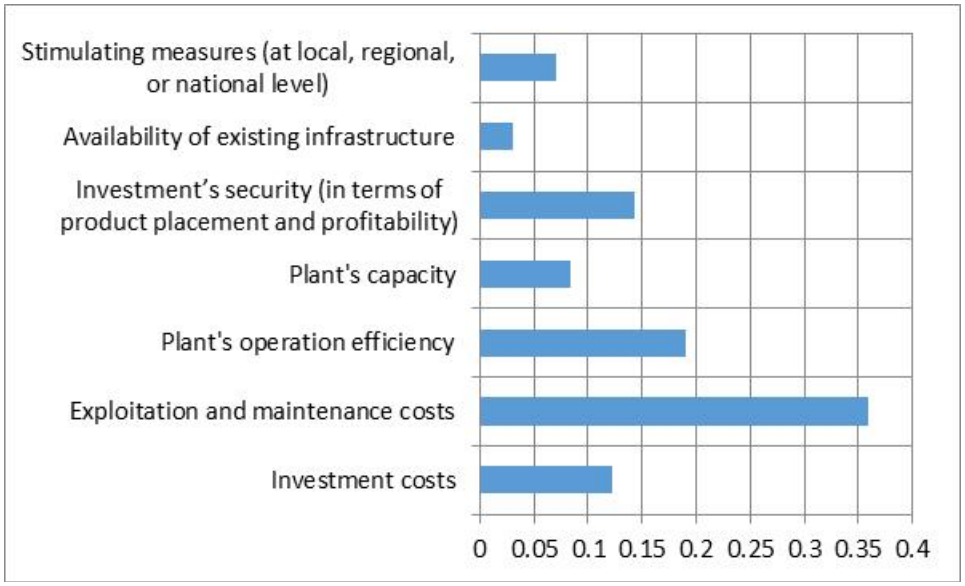

Figure 1. Calculated criteria priorities by AHP method

The consistency calculated in this way is better if lower number is obtained, which means higher consistency in the answers. For perfectly consistent judgments, CR will be zero [8]. It is generally considered that CRs equal or less to 0.10 are provided by acceptably consistent answers. There are also opinions that in some cases could be accepted CR less than 0.20 [9], or to apply the rule that for bigger problems less consistency, i.e. higher CR are allowed. The question of "how small is small" [10] stays the main issue if to apply such approach. For CR higher than 0.2, a re-evaluation should be considered.

In this case CR is 0.092, which is acceptable by all sources applying CR as a measure of consistency.

2.2 PROMETHEE

PROMETHEE stands for "the preference ranking organization methods for enrichment evaluation" [11]. It belongs to a class of outranking methods.

For PROMETHEE-GAIA analysis data from [12] were used.

The criteria used in this source were: Cost to purchase, Labour Requirements, Ability to handle small (less than 1-ton) lots of nuts, and Convenience for bulk deliveries to handler.

The types of walnut dryers analysed were:

Stationary bin, Pallet bin (including forklift), Trailer, and Grain trailer.

The authors qualitatively described the criteria used starting from Poor, through moderate, and good, to the best. These criteria were used as an input in Visual PROMETHEE software.

The results obtained from the analyses done by the software with these data are shown in the following figures.

Application of PROMETHEE I method takes into account incomparability, as well as difference among the alternatives which exert the strengths according to different criteria. In the case where exists such complication of their comparison, it is visualized by the intersections of the lines. If a line is completely above another one, it is clear that corresponding action is better relating both to Phi+ and Phi- flows. Hence, such action is preferred comparing to another one if PROMETHEE I Partial Ranking is used, as it is shown in Fig. 2. It is clearly that Grain Trailer dominates, while Trailer and Pallet Bin are incomparable by this method, although it is clear they are inferior comparing to other analysed alternatives.

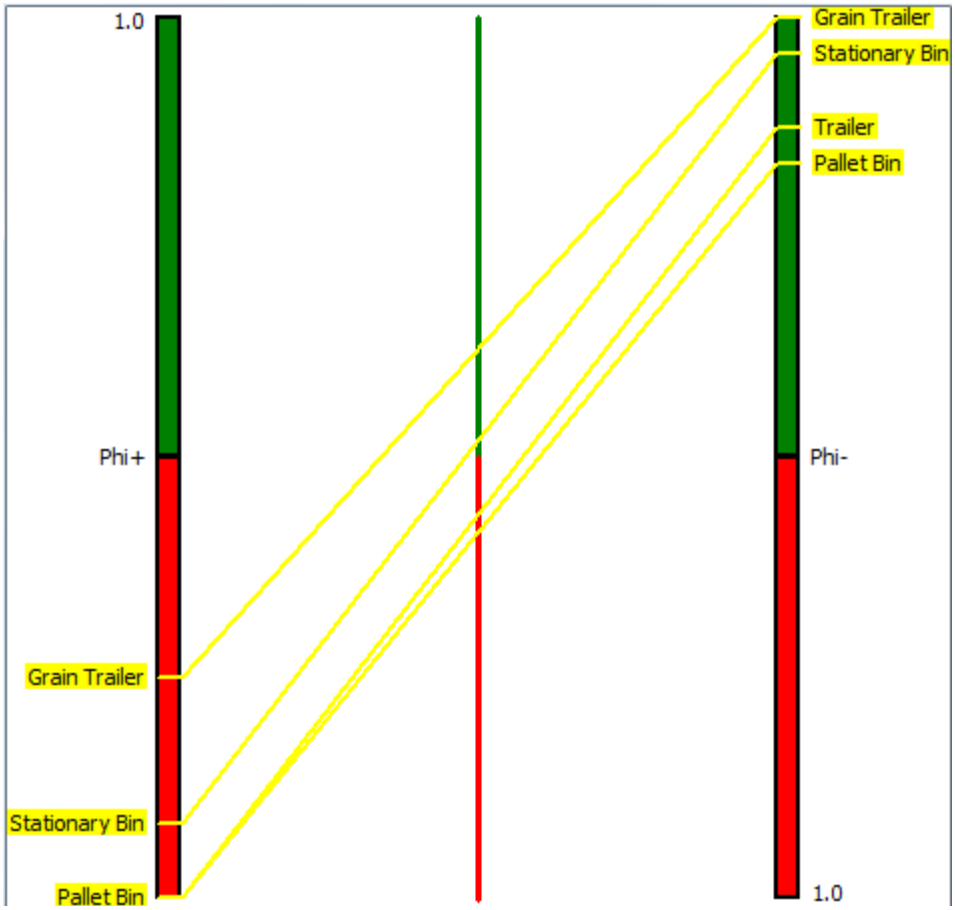

Figure 2. Comparison of different dryers by application of PROMETHEE I method

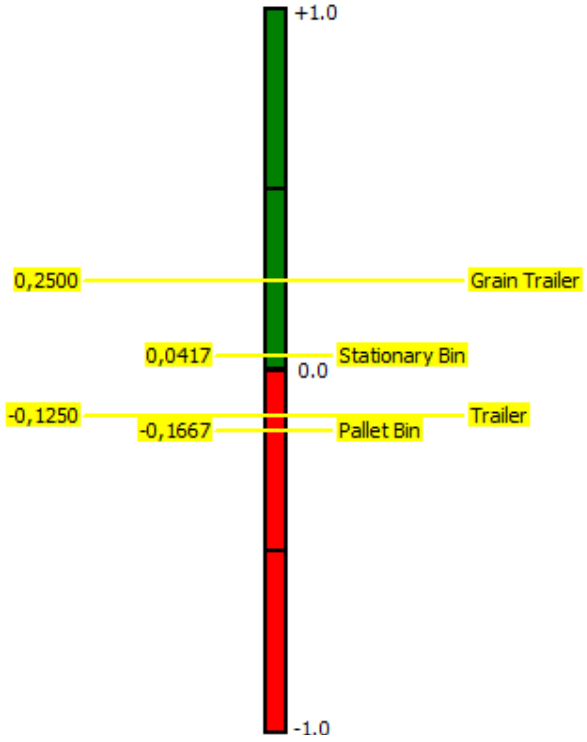

Figure 3. Comparison of different dryers by application of PROMETHEE II method

PROMETHEE II method disaffirms information about non-comparability. The main focus is the establishment of a ranking list for the most successful alternatives according to Phi flows which is sum of the flows of the strengths Ph+ and weaknesses Ph-. In Fig. 3. among the alternatives analyzed by this method also clearly dominates Grain Trailer with 0.2500, while the most inferior is Pallet Bin with -0.1667. The data shown in Table 1 present cumulated results of both PROMETHEE I and PROMETHEE II methods. The ranking is made according to PROMETHEE II ranking.

Table 1. Ranking of the alternatives according to preference flows

Rank	*Alternative*	*Phi*	*Phi+*	*Phi-*
1	Grain Trailer	0.2500	0.2500	0.0000
2	Stationary Bin	0.0417	0.0833	0.0417
3	Trailer	-0.1250	0.0000	0.1250
4	Pallet Bin	-0.1667	0.0000	0.1667

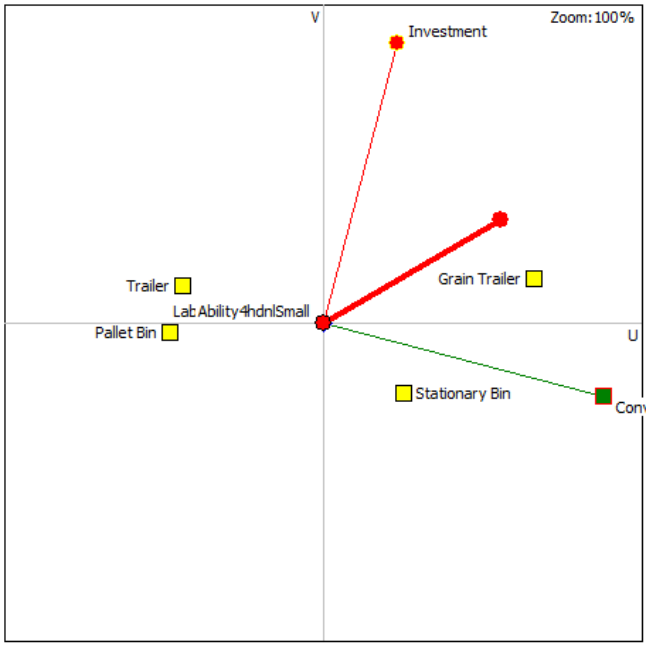

Figure 4. Comparison of different dryers by application of PROMETHEE II method

In Fig. 4 is presented GAIA visualization of the results obtained.

3 Conclusion

According to the results presented for walnut drying use of grain trailer is recommended over stationary bins, and pallet bins, and trailers. The analysis done is used according to the relative relations taken from the literature, since some of the alternative analysed are not applied at our market. Concerning the aspects which could be taken into account by a potential decision maker, knowledge of exploitation and maintenance costs, operation efficiency of the plant, and security of the investment are the most important criteria.

3.1 Acknowledgment

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3.2 Abbreviations

AHP – Analytic Hierarchy Process
ANP – Analytic Network Process

DEA – Data Envelopment Analysis

ELECTRE – ELimination and Choice Expressing REality (ELimination Et Choix Traduisant la REalité)

MACBETH – Measuring Attractiveness by a Categorical Based Evaluation Technique

MAUT/UTA – Multi-attribute utility theory/Additive Utility method (UTilitès Additives)

MCDA – Multiple-Criteria Decision Analysis

PROMETHEE – the Preference Ranking Organization Methods for Enrichment Evaluation

TOPSIS – Technique for Order of Preference by Similarity to Ideal Solution

UTADis – The Discriminating Additive Utility method (UTilitès Additives DIScriminantes – UTADIS)

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