

A Framework for the Selection of a Packaging Design Based on the SWARA Method

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Well-designed packaging is intended to present a product in the best possible way, which would have a significant impact on sales improvement. Creating and finding the ideal design solution for packaging is an extremely complex process. Many characteristics of a packaging design can affect the level of customer satisfaction, where the different characteristics of the packaging tend to have a different significance. To make the problem more complex, the significance of characteristics of a packaging design is not the same for all customers. Therefore, creating and finding the ideal design solution for packaging often involves an evaluation of a number of variants, typically evaluated on the basis of multiple criteria, often with different significance. To provide an efficient approach for the selection of appropriate packaging, a framework for selecting the appropriate packaging design which meets customer preferences, based on the SWARA method and group decision making, is proposed. The usability and efficiency of the proposed framework is considered in the case of the selecting the appropriate packaging design for the wine of the autochthonous grape variety called Black Tamjanika. On the basis the considered examples, it can be concluded that SWARA method can be successfully used to solve many similar problems, and that in some cases may have some advantages over similar methods, such as AHP method or Conjoint Analysis. As an advantage of the proposed procedure can be mentioned a much smaller number of comparisons in pairs, compared with the AHP method, and much more comprehensible procedure for selecting the most acceptable alternative, compared with Conjoint Analysis. The proposed framework can also be easily adjusted to solve a significant number of MCDM problems.

Keywords: *Step-wise Weight Assessment Ratio Analysis (SWARA), packaging selection, packaging design, MCDM, pairwise comparison.*

Introduction

The importance and role of packaging has changed over the years, from its basic purpose to preserve and protect a product from external influences to the present requirements that well-designed packaging facilitates selling and the very act of buying with the best way to establish a relationship between producers, on the one hand, and buyers, on the other.

Well-designed packaging is intended to present a product in the best possible way, which would have a significant impact on sales improvement.

Creating and finding the ideal design solution for packaging is an extremely complex process. In a sea of similar products, a design has a specific function and reflects the creation of a product different from others and likely to attract the favor of consumers. Today, contemporary design in companies plays a very important role; with a good design and an innovative approach, a company's offer and its products are differentiated from the competition; a design can be said to be one of the ways for gaining a competitive advantage on the market.

The identification, prioritization and determining of the significance of customer requirements are very important. Therefore, numerous studies have been dedicated to this problem, a significant number of which have been based on the Conjoint Analysis (Anderson & Bettencourt, 1993; Ares & Deliza, 2010; Lihra *et al.*, 2012; Pentus *et al.*, 2014; Garver *et al.*, 2014) and AHP method, proposed by Saaty (1977; 1980), such as (Armocost *et al.*, 1994; Kwong & Bai, 2003; Lin *et al.*, 2008; Chan *et al.*, 2012; Desai *et al.*, 2012; Chan *et al.*, 2013; Aghdaie *et al.*, 2013a; Muerza, *et al.*, 2014; Wang *et al.*, 2014).

Over the last decade scientists and researchers have developed a set of new MCDM methods (Kaplinski & Tupenaite, 2011; Zavadskas & Turskis, 2011; Zavadskas *et al.*, 2014). The new Step-wise Weight Assessment Ratio Analysis (SWARA) technique was proposed by (Kersuliene *et al.*, 2010). Although it is a newly proposed method, it was used to solve many problems such as a rational dispute resolution (Kersuliene *et al.*, 2010), an architect selection (Kersuliene & Turskis, 2011), the design of products (Hashemkhani Zolfani *et al.*, 2013), a machine tool selection (Aghdaie *et al.*, 2013b), the prioritizing of the sustainability assessment indicators of

the energy system (Hashemkhani Zolfani & Saporauskas, 2013), supplier selection (Alimardani *et al.*, 2013), evaluation of external wall insulation (Ruzgys, 2014).

Compared to the AHP method, the SWARA method has some similarities but also its own specificities. Therefore, the use of the SWARA method for choosing the most appropriate design solution to packaging is being considered in this paper.

Because all the above-mentioned reasons, the rest of this paper is organized as follows: in Section 1, the computational procedure of the SWARA method is shown. Section 2 provides a comparison between the SWARA and the AHP methods. In Section 3, a framework for selecting an appropriate packaging design is proposed. In Section 4, a case study is discussed, with the aim to explain in detail the proposed methodology, to point out its efficiency as well as to identify its possible weaknesses. Finally, the conclusions are presented.

The Computational Procedure of the SWARA Method

The process of determining the relative weights of criteria using SWARA method can accurately be shown by using the following steps:

Step 1. The criteria are sorted in descending order based on their expected significances.

Step 2. Starting from the second criterion, the respondent expresses the relative importance of criterion j in relation to the previous ($j-1$) criterion, for each particular criterion. According to Kersuliene *et al.* (2010), this ratio is called the Comparative importance of average value, s_j .

Step 3. Determine the coefficient k_j as follows:

$$k_j = \begin{cases} 1 & j = 1 \\ s_j + 1 & j > 1 \end{cases} \quad (1)$$

Step 4. Determine the recalculated weight q_j as follows:

$$q_j = \begin{cases} 1 & j = 1 \\ \frac{k_{j-1}}{k_j} & j > 1 \end{cases} \quad (2)$$

Step 5. The relative weights of the evaluation criteria are determined as follows:

$$w_j = \frac{q_j}{\sum_{k=1}^n q_k}, \quad (3)$$

where w_j denotes the relative weight of criterion j .

A Comparison of the SWARA and the AHP Methods

The SWARA and the AHP methods have significant similarities with each other, but they also have their own respective specificities.

Both methods use pairwise comparisons to express the relative significance of the elements in a hierarchy, which is called the Comparative importance of average value in the SWARA method; which is usually suitable for decision makers, i.e. respondents involved in evaluation. However, for the same number n of criteria, the AHP method requires a significantly greater number of pairwise comparisons, which is $\sum_{i=2}^n \sum_{j=2}^i j$ comparisons, compared with the SWARA method, where the required number of pairwise comparisons is significantly lower, i.e. $n-1$ comparisons.

In the case of solving decision-making problems involving a larger number of criteria using the AHP method, the number of comparisons significantly increases, which can have a negative impact on the consistency of performed comparisons.

However, the AHP method includes the procedure for checking the consistency of performed comparisons, which allows an easy identification of the inadequate respondent, i.e. a useless questionnaire.

SWARA method does not have such, or similar, procedure. However, the number of required comparisons in the SWARA method is significantly lower in comparison with the AHP method, which makes it more attractive to use in cases of gathering responses from ordinary respondents, i.e. those respondents who were previously not significantly prepared for the use of the SWARA method.

The next difference between these methods is related to the use of predefined scales for expressing preferences. For pairwise comparisons in the AHP method, commonly is used the nine-point scale proposed by Saaty (1980). In contrast, in the SWARA method, respondents have a greater freedom to express their attitudes. However, there are some advantages, as well as disadvantages, to each of these approaches that can be highlighted.

A Framework for Selecting an Appropriate Packaging Design

The framework for selecting appropriate packaging design, which respects customer preferences, based on SWARA method and group decision making, can be shown using the following steps:

Step 1. As stated in (Kersuliene *et al.*, 2010), the first step in solving a problem using the SWARA method begins with defining a set of evaluation criteria, after which the criteria are sorted in descending order on the basis of their expected significance.

Step 2. Define the domain for each criterion, i.e. a set of available instances. Similar to the criteria, the available instances for each criterion are sorted in descending order, based on their expected significance.

Step 3. Determine weights of criteria. In this step, respondents express their preferences about the importance of the criteria by giving numerical values to the variable s_j .

In order to obtain the results that more accurately reflect respondents' opinions, it is necessary to inform respondents that the relationship between s_j and w_j is not linear. This deviation is not so significant for the low values of s_j , but it cannot be fully ignored when higher values are concerned.

Therefore, in Table 1 are given some pre-selected value for s_j . In addition, in this table are given significances of criterions j and $j-1$, as well as the relative distance between them, for each s_j .

Table 1

The pre-selected values of s_j and their impact on the relative weights of criteria

s_j	w_j	w_{j-1}	$(w_{j-1}-w_j)/w_{j-1}$ (%)
0	0,500	0,500	0,00
0,05	0,512	0,488	4,76
0,1	0,524	0,476	9,09
0,15	0,535	0,465	13,04
0,2	0,545	0,455	16,67
0,25	0,556	0,444	20,00
0,3	0,565	0,435	23,08
0,35	0,574	0,426	25,93
0,4	0,583	0,417	28,57
0,45	0,592	0,408	31,03
0,5	0,600	0,400	33,33
1	0,667	0,333	50,00
1,5	0,714	0,286	60,00
2	0,750	0,250	66,67
2,5	0,778	0,222	71,43

It is important to note that the values shown in Table 1 were obtained on the basis of the comparison of only two criteria. In the case of solving problems that involve a few criteria, the comparison procedure is much more complex and therefore it may be useful for respondents to gain an insight into the achieved results, and to be allowed, if necessary, to correct their own responses.

For this purpose, using a certain form of “interactive questionnaires” made in a spreadsheet program can provide significant advantages in comparison with using the ordinary paper form of questionnaires.

Step 4. Determine the significance of instances, for each particular criterion. This step is carried out for each of the evaluation criteria, wherein for each instance of a criterion, relative importance is determined through the procedure described in Step 3.

Step 5. Establish a set of acceptable variants and determine their priorities. In the case of using a greater number of criteria, as well as a greater number of instances for each criterion, the number of possible variants rapidly grows. A large number of variants may further make it more difficult for respondents to evaluate alternatives; so, it is desirable that a set of potentially acceptable variants should be formed and their evaluation be performed.

Step 6. Determine the significance of potentially acceptable variants. Determining the significance of each variant can be done as follows

$$S_i^k = \sum_j^n w_j w_{lj}, \tag{4}$$

where: S_i^k denotes the overall significance of variant i on the basis of the responses obtained from respondent k , w_j denotes the relative weight of criterion j , w_{lj} denotes the relative weight of variant l from domain of criterion j .

Step 7. Determine the overall significance of each variant based on a group approach. For a group containing the K decision makers, the overall group significance of each variant S_i can be calculated using the geometric mean,

as follows: $S_i = \left(\prod_{k=1}^K S_i^k \right)^{1/K}$. (5)

Case Study

Tamjanika is an old type of grapes, a variety of Muscat Blanc a Petite Grains, grown in Serbia and Macedonia. Tamjanika is used to produce white wines of an intense fruit aroma and taste.

However, there is a less known fact that there is Crna Tamjanika (Black Tamjanika), probably a Serbian indigenous variety grown in the vicinity of Negotin. Even there, this species of grapes was nearly weeded out. Fortunately, some wine producers recognized this species of grapes as a business opportunity and started growing it.

Knowing that product packaging and a packaging design may have a significant effect on its placement on the market, it was necessary to make a selection of an appropriate packaging design (Westerman *et al.*, 2013; Luo *et al.*, 2012; Xie, 2012), i.e. to select an appropriate bottle design, as well as the shape, the orientation, and the alignment of the graphical forms on consumers’ assessments. In the initial study, in order to reduce the number of possible variations, a number of respondents were asked to perform the ranking of possible packaging.

For the reason of simplicity in this paper, the steps used in the evaluation of alternative packaging designs are presented on the basis of the responses obtained from three selected respondents.

In accordance with the framework proposed in Section 3, at the beginning of the evaluation process, the respondents specified the set of the criteria according to which the further evaluation will be performed; also, they determined the appropriate set of really usable instances for each one of the criteria.

In the next step, the respondents determined the significance of the selected evaluation criteria. The responses of the first of the three respondents as well as the obtained weights of the criteria are shown in Table 2.

Table 2

The responses obtained from the first of the three respondents and the relative weights of the criteria

Criteria	Designation	s_j	k_j	q_j	w_j	
C_1	Bottle shape	Sh	1	1	0,395	
C_2	Bottle color	Co	0,5	1,5	0,667	0,263
C_3	Label	La	0,2	1,2	0,556	0,220
C_4	PVC shrink capsule	Sc	0,8	1,8	0,309	0,122
				2,531	1,000	

After that, the respondents carried out the evaluation of the instances of each criterion.

Table 3 shows the results obtained from the first respondent during the evaluation of the bottle shapes.

Tables 4, 5 and 6 show the results obtained for the following criteria: the color, the label and the PVC shrink capsule of the bottle, respectively, the ones also obtained from the first of the three respondents.

Table 3

The relative weights of the bottle shapes obtained on the basis of the first of the three respondents

	Bottle shape	Designation	s_j	k_j	q_j	w_j	Rank
C_1	Bordeaux	Bo		1	1	0,288	1
C_2	Rhine	R	0,05	1,05	0,952	0,274	2
C_3	Burgundy	Bu	0,15	1,15	0,828	0,239	3
C_4	Mosel/Alsace	M/A	0,2	1,2	0,690	0,199	4
						3,471	1,000

Table 4

The relative weights of the bottle color obtained on the basis of the first of the three respondents

	Criteria	Designation	s_j	k_j	q_j	w_j	Rank
1	French green	Fg		1	1	0,524	1
2	Antique green	Ag	0,1	1,1	0,909	0,476	2
						1,909	1,000

Table 5

The relative weights of the labels obtained on the basis of the first of the three respondents

	Criteria	Designation	s_j	k_j	q_j	w_j	Rank	
1	Rectangular, dark red colored background label with gold colored characters	Rr			1	1	0,375	1
2	Rectangular, white colored background with black colored characters	Rw		0	1	1,000	0,375	1
3	Oval, white colored background with black colored characters	Ow		0,5	1,5	0,667	0,250	3
						2,667	1,000	

Table 6

The relative weights of the color of the PVC shrink capsules obtained on the basis of the first of the three respondents

	Criteria	Designation	s_j	k_j	q_j	w_j	Rank
1	Matte Black	Mb		1	1	0,368	1
2	Burgundy	B	0	1	1,000	0,368	1
3	Matte white	Mw	0,4	1,4	0,714	0,263	3
						2,714	1,000

The summary of the ranking results obtained on the basis of the responses of the first of the three respondents are presented in Table 7. The values in Columns XII, XIII, XIV and XV were obtained by multiplying the relative weights of the criteria and the relative weights of the instances. The values in Column XVI were obtained as the sum of the values in Columns XII, XIII, XIV and XV, i.e. using Eq. (4).

Finally, Column XVII shows the ranks of the considered variants. As it can be seen, there are several variants which are the candidates for the best placed alternative. It can also be seen that the top ranked form of the bottle (Rd) in relation to the most important criterion (C_1) may have a low position, e.g. Variant 8.

The overall ranking order of the variants obtained on the basis of the responses of the three respondents is shown in Table 7.

As it can be concluded from Table 8 above, the inclusion of a larger number of respondents in the process of the selection of the most suitable packaging design has an impact on the ranking order of variants, i.e. alternatives. By having a larger number of respondents included in the selection process, the obtained results will to a greater extent reflect the real attitudes of customers.

Table 7

The relative weights of the variants obtained on the basis of the first of the three respondents

I	II	III	IV	V	VI	VII	VIII	IX	X	XII	XIII	XIV	XV	XVI	XVII						
Variants	C ₁	C ₂	C ₃	C ₄	w _j	C ₁	C ₂	C ₃	C ₄												
	Bottle					0,395	0,263	0,220	0,122												
	Shape	Color	Label	Shrink		Sh	Co	La	Sc	Sh	Co	La	Sc	S _j	Rank						
1	Bo	Fg	Rr	Mb	0,288	0,524	0,375	0,368	0,114	0,138	0,082	0,045	0,379	1							
2				B					0,368	0,114	0,138	0,082	0,045	0,379	1						
3				Mw					0,263	0,114	0,138	0,082	0,032	0,366	4						
4				Mb					0,368	0,114	0,138	0,082	0,045	0,379	1						
5				Mw					0,263	0,114	0,138	0,082	0,032	0,366	4						
6				Ow					Mb	0,25	0,368	0,114	0,138	0,055	0,045	0,352	12				
7									Mw		0,263	0,114	0,138	0,055	0,032	0,339	20				
8				R					Ag	Rr	Mb	0,274	0,476	0,375	0,368	0,108	0,125	0,082	0,045	0,361	6
9											B				0,368	0,108	0,125	0,082	0,045	0,361	6
10											Mw				0,263	0,108	0,125	0,082	0,032	0,348	13
11											Mb				0,368	0,108	0,125	0,082	0,045	0,361	6
12											Mw				0,263	0,108	0,125	0,082	0,032	0,348	13
13	Bu	Fg	Rr		Mb	0,239	0,524	0,375			0,368				0,094	0,138	0,082	0,045	0,360	9	
14				B	0,368				0,094	0,138	0,082	0,045	0,360	9							
15				Mw	0,263				0,094	0,138	0,082	0,032	0,347	15							
16				Mb	0,368				0,094	0,138	0,082	0,045	0,360	9							
17				Mw	0,263				0,094	0,138	0,082	0,032	0,347	15							
18				Ow	Mb				0,25	0,368	0,094	0,138	0,055	0,045	0,332	21					
19					Mw					0,263	0,094	0,138	0,055	0,032	0,319	24					
20				M/A	Fg				Rr	Mb	0,199	0,524	0,375	0,368	0,079	0,138	0,082	0,045	0,344	17	
21										B				0,368	0,079	0,138	0,082	0,045	0,344	17	
22										Mw				0,263	0,079	0,138	0,082	0,032	0,331	22	
23										Mb				0,368	0,079	0,138	0,082	0,045	0,344	17	
24										Mw				0,263	0,079	0,138	0,082	0,032	0,331	22	

Table 8

The overall ranking order of the variants obtained on the basis of the responses of the three respondents

Variant	I	II	II	S _j	Rank
1	0,380	0,393	0,406	0,393	1
2	0,380	0,393	0,397	0,390	2
3	0,365	0,371	0,385	0,373	4
4	0,380	0,389	0,398	0,389	3
5	0,365	0,367	0,377	0,370	5
6	0,352	0,368	0,378	0,366	7
7	0,337	0,347	0,357	0,347	15
8	0,362	0,363	0,366	0,363	10
9	0,362	0,363	0,357	0,360	11
10	0,347	0,341	0,344	0,344	19
11	0,362	0,359	0,358	0,359	12
12	0,347	0,337	0,337	0,340	21
13	0,360	0,367	0,378	0,368	6
14	0,360	0,367	0,369	0,366	8
15	0,345	0,346	0,356	0,349	13
16	0,360	0,364	0,370	0,365	9
17	0,345	0,342	0,349	0,345	18
18	0,333	0,343	0,349	0,342	20
19	0,318	0,322	0,328	0,323	24
20	0,345	0,346	0,357	0,349	14
21	0,345	0,346	0,348	0,346	16
22	0,329	0,324	0,336	0,330	22
23	0,345	0,342	0,349	0,345	17
24	0,329	0,320	0,328	0,326	23

Conclusions

Based on the results discussed in the considered case study, the SWARA method can successfully be used when selecting the most desirable packaging design.

A significantly smaller number of pairwise comparisons can be mentioned as an advantage of the proposed procedure in relation to similar procedures,

especially those based on the pairwise comparisons proposed in the AHP method..

Except for the choice of a packaging design solution, the proposed framework can also easily be adapted to the solution of similar decision-making problems, especially those concerning the ranking of a larger number of available variants or the selecting of the most appropriate one.

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