Inzinerine Ekonomika-Engineering Economics, 2012, 23(5), 471-484

Decision Making on Advertisement Strategy Selection Based on Life Cycle of Products by Applying FAHP and TOPSIS GREY: Growth Stage Perspective; a Case about Food Industry in IRAN

Sarfaraz Hashemkhani Zolfani[1, 2], Nahid Rezaeiniya[3], Morteza Pourhossein[4], Edmundas Kazimieras Zavadskas[2]

[1]*Amirkabir University of Technology*
P.O. Box 1585-4413, Tehran, Iran
e-mail: sa.hashemkhani@gmail.com

[1, 2]*Vilnius Gediminas Technical University*
Sauletekio al. 11, LT-10223, Vilnius, Lithuania
e-mail: edmundas.zavadskas@vgtu.lt

[3]*Alghadir Institute of higher Education*
P. O. Box 5166898691, Tabriz, Azarbaijan Sharghi, Iran
e-mail: nah.rezaeiniya@gmail.com

[4]*Shomal University*
P. O. Box 731, Amol, Mazandaran, Iran
e-mails: poorhosseinm@yahoo.com

crossref http://dx.doi.org/10.5755/j01.ee.23.5.3134

In recent decades, Marketing management and Advertising have been major concepts in business field. The main reason that attracts attention to them is growth of competition among companies. There are different ways to increase the competition in organizations such as improving productivity by acquiring information technology. In this paper hybrid MCDM methods applied for selecting Advertising strategy by considering product life cycle of products. Growth stage is one of the critical situations for companies and advertising has an important role in this step. Hence Growth stage selected as a case study for this research and the proposed model is implemented for most famous Iranian's factory in food industry, Kalleh.

Five criteria are selected as important criteria by studying in literature and experts decision include: Audience fit, Content, Impression rate, Monthly cost and Look and feel. In this article Fuzzy Analytic Hierarchy Process (FAHP) applied for calculating weight of each criterion and finally TOPSIS grey applied for selecting the best Advertising strategy among Television, Radio, Newspaper, Internet & SMS and Environmental advertising.

The results of this research illustrated that monthly cost, content and educational level, are three important criteria in advertising strategy and also newspaper is the best way for advertising and after that television is next and radio, environmental advertising and internet & SMS are after those in this case in Growth step of Product Life Cycle. This research can be useful as a valuable framework for companies and different industries. Each company in different industry can apply this methodology and develop that due to their needs and priority.

Keywords: *Advertising; Fuzzy Analytic Hierarchy Process (FAHP); Multiple Criteria Decision Making (MCDM), TOPSIS Grey, Product Life Cycle (PLC).*

Introduction

Whether we turn on TV or pass by billboards along freeways, casual observation suggests the omnipresence of advertising in modern cultures. There is a widespread perception of advertising as powerful economic and social force. Advertising description or presentation of a product, idea or organization, in order to induce individuals to buy, support or approve of it. The advertising essentially represents information which helps consumers to decide and choose their needs. Due to global intensive competition, many companies prioritize quick and specific responses to customers' various demands and improve their advertising. Nowadays many people now improve their business, one of the steps that they need to do is to select the right media where they will advertise and promote their business. Industry proponents argue that advertising does not influence consumer choice (Hoek & Gendall, 2006).

However, if they really believe such a proposition, how could they justify the large sums they invest in advertising (Story & French, 2004)? Advertising actually has a major role in reinforcing and normalizing behavior (Hoek & Gendall, 2006). One of the industries that advertising have a big and impressive influence on it is food industries. Prior research shows that advertising influences food preferences, food purchases, consumption behavior, and brand and category sales (Caraher & Landon, 2007). Three main categories of attributes affect consumer demand for (food) products, Price, narrow use value for the consumer, and performance for issues like its impact on the commons or on nature, on future generations, and on distant people which the consumer does not expect to ever meet (Michalopoulos *et al.,* 2008). Determining the communication and promotion budget and allocating that budget across different promotional tools are important marketing decisions, particularly for manufacturers, who spend considerable money on promoting their brands. From a retailer's viewpoint, manufacturer spending decisions on consumer and trade promotions are critical as they affect their pricing and promotional policies (Shankar, 2008).

The brand manager further allocates the brand's promotional budget within each promotional tool. For example, within advertising, the manufacturer allocates spending between traditional media (e.g., TV, print, radio) and new media (e.g., the Web, email, blog, social media, mobile media). Manufacturers allocate marketing budgets to different promotional tools on the basis of relative competitive elasticity (Shankar, 2008). We know that Food industry almost is more important for the consumer packaged goods (CPG) industry. For most CPG firms, the bulk of the marketing budget goes to advertising and sales promotion (consumer and trade promotion). Over the past two decades, the allocation for CPG firms has shifted from advertising toward sales promotion due to three key reasons: increasing consumer decision-making at the point of purchase, the rise of retailer power, and the fragmentation of mass media communication vehicles (Shankar, 2008).

MCDM can give managers many dimensions to consider related elements, and evaluate all possible options under variable degrees. Group decision-making is a process where experts make decisions and consolidate an optimal strategy (Chu *et al.,* 2007). Decision-making or "problem solving", as a broader term, is the process of selecting one or a few alternatives that should be the most favorable (Ulubeyli & Kazaz, 2009; Zavadskas *et al.,* 2009; Saparauskas *et al.,* 2011; Medineckiene *et al.,* 2011; Yazdani *et al.,* 2011). An important step to developing your sales and marketing plan is to select the right media to send out your message. There are no hard-and-fast rules as to which media is better. The right media for one business may be wrong for another. Therefore selecting the right media for advertising is a decision under a variety of factors and can be evaluated according to different aspects, Therefore it can be viewed as a multiple criteria decision making (MCDM) problem (Zavadskas & Turskis, 2011).

The food industry includes the restaurant, beverage, confectionery, and processed food industries (Story *et al.,* 2002). Prior research shows that advertising influences food preferences, food purchases, consumption behavior, and brand and category sales (Caraher & Landon, 2007). After reviewing the evidence, Royne & Levy (2008) conclude that the food industry's marketing is undermining public health. Food industry marketing appears to have a substantial influence on obesity. Research using children found that children choose the brands they have seen in advertisements (Story & French, 2004). The food industry spends billions each year to reach children and youth. Advertising increases food purchase requests by children to parents, and influences their product and brand preferences (Institute of Medicine, 2004). Advertising may also influence adults although not to the same extent as children.

There is a lot of research in literature that focused on selection the best advertising, they introduce several criteria and consider them for advertising selection, these criteria are: Educational Level (Hyun *et al.,* 2011;Rojas-Méndez *et al.,* 2009), age (Capella *et al*., 2011; Farris & Buzzell, 1979; McKay-Nesbitt *et al.,* 2011; Luyt, 2011; Rojas-Mendez *et al.,* 2009), Content (Wu *et al.* 2008; Song, *et al.*, 2011), Impression Rate (Alpert & Maltz, 2005; Vann *et al.,* 1987), Monthly cost (Joshi & Hanssens, 2009; Walters *et al.,* 2008), User- Friendliness (Brown *et al*., 1998; Lee *et al.,* 2006; Krishnamurthy, 2001), Design (Feasely *et al.,* 1987; Lecknby & Kim, 2002; Aaker *et al.,* 1990), and in this study we use literature and expert's idea for evaluation criteria.

The aim of this research is developing a framework for advertising strategy selection based on new hybrid MCDM methods. Accuracy of this issue is so important. Advertising has a key role in business and companies all around the world have different plans for their advertising strategies. Authors do believe in importance of Product Life Cycle (PLC) in process of advertising. Due to industries importance of PLC is different. Authors propose that each stage of PLC about products needs different strategy. Previously there wasn't enough attention to PLC in advertising strategies and this research tries to show importance of that in advertising and business.

Case study of this research is in food industry and also Growth stage of PLC selected as a case of stages. At the end authors believe that Growth step is critical stage of PLC.

Process of this research at first is identifying important criteria that should be considered in the process of selecting alternatives of advertising. In second step Fuzzy AHP will be applied for calculating weights and importance of each criterion and in third step TOPSIS Grey will be applied to illustrate importance of each alternative and finally rank them.

Fuzzy AHP is evaluating criteria in more details and it seems suitable for applying in research because accuracy is very important for this research. Grey analysis in evaluating alternatives is very useful hence TOPSIS Grey applied in this research for evaluating alternatives and prioritizing them.

In the rest of this paper there are described product life cycle, methodology, case study and the conclusion summarized in the last section.

Product life cycle

Levitt defined a PLC as the life of a product to that of a living organism (Levitt, 1965; Dickson, 1997). The concept of PLC explains the general tendency of products' development process or a depiction of a product's sales history from its "birth" or marketing beginning, to its "death," or withdrawal from the market (Zikmund & d'Amico, 1999). Schnaars (1991) defined the concept of PLC to be a pattern-based approach which tracks trends in product sales histories from their inception to their demise.

Sakai *et al.,* (2003) and Chen *et al.,* (2006) mentioned that PLC could describe the possible product policies in different stages of PLC as well as helps the enterprise to compare its product with the former similar product to estimate the performance of the products that would be introduced to the market. Assael (1993) thought PLC to be a useful tool for suggesting strategies over the life of a brand and in indicating when changes in strategies should take place. It is even more useful for helping marketers to develop successful, profitable product strategies as the market for a product changes over time (Solomon & Stuart, 1997). Based on the definitions being provided by Kotler and Keller (2006), a PLC has four distinct stages: introduction, growth, maturity and decline:

1. Introduction: Introduction is a period of slow sales growth as the product is introduced in the market. Profits are nonexistent in this stage because of the heavy expenses of product introduction. (Product development begins when the firm finds and develops a new product idea. During the product development stage, sales are zero and the firm's investment costs mount.
2. Growth: Growth is a period of rapid market acceptance and increasing profits.
3. Maturity: Maturity is a period of the slowdown in sales growth because the product has achieved acceptance by most potential buyers. Profits level off or decline because of increased marketing outlays to defend the product against competition.
4. Decline: Decline is the period when sales fall off and profits drop. The slow introduction phase reflects the difficulty of overcoming buyer inertia and stimulating trial of a new product. Rapid growth then occurs as many new buyers are attracted once the product is perceived as successful. Maturity of the product's potential buyers is eventually reached, causing the rapid growth to level out to the underlying rate of growth of the relevant target market. Finally, the decline will set in as new substitute products appear (Doyle & Stern, 2006).

During a product's life time, a firm will normally reformulate its marketing strategies several times. Not only do economic conditions and competitive situations change. However, in addition, the product also passes through new stages of buyer interest and requirements.

Product Life Cycle (PLC) has different roles in many areas of science and can be considered in different sciences. In previous section we described briefly the aim of this research and after described each section of PLC. We want to focus on growth stage in developing products with materials of media advertising. In fact PLC is applied in this research as a powerful tool for advertising in more details. Products of food industry have expiring dates and coordinating between processes is so critical and hard. Authors believe that selecting growth stage as a case study in this industry is more critical than other section of PLC and for this mean growth stage is selected for this research.

Methodology

Over the past decades the complexity of economic decisions has increased rapidly, thus highlighting the importance of developing and implementing sophisticated and efficient quantitative analysis techniques for supporting and aiding economic decision-making (Zavadskas & Turskis, 2011). Multiple criteria decision making (MCDM) is an advanced field of operations research, provides decision makers and analysts a wide range of methodologies, which are overviewed and well suited to the complexity of economical decision problems (Hwang & Yoon, 1981; Figueira *et al.,* 2005). Multiple criteria analysis (MCA) provides a framework for breaking a problem into its constituent parts. MCA provides the means to investigate a number of alternatives in light of conflicting priorities. Over the last decade scientists and researchers have developed a set of new MCDM methods (Kaplinski & Tupenaite, 2011; Antucheviciene *et al.,* 2011; Kaplinski & Tamosaitiene, 2010;Tamosaitiene *et al.,* 2010). They modified methods and applied them to solve practical and scientific problems (Kalibatas *et al.,* 2011; Ginevicius *et al.,* 2008a; Zavadskas *et al.,* 2011). Solving of modern decision making problems in most cases is based on integrated model of different approaches. There is a wide range of methods based on multi-criteria utility theory: SAW (MacCrimon, 1968); TOPSIS (Hwang & Yoon, 1981); VIKOR – compromise ranking method (Opricovic and Tzeng, 2004); COPRAS-G (Zavadskas *et al*., 2008); and other methods (Turskis *et al.,* 2010 a,b). Decision-makers in their activities deal with uncertain future. The multi criteria decision-making could be applied to assess different alternatives of future activities. Hui *et al.* (2009) incorporated the fuzzy concept in linear programming to obtain the best possible outcome in portfolios, when direct real estate investment is included.

The best strategy could be selected from available scenarios, and information. In strategic decisions, dealing with uncertainty, the values of criteria could be determined at intervals – from pessimistic value to optimistic value.

The limits of criterion value could also be determined by expert and determination of limits depends on the qualification and experience of expert. Therefore it is better to collect the objective data (Zavadskas *et al.,* 2010a).

Deng (1982) developed the Grey system theory and described operations with grey numbers. Grey relational analysis possesses advantages (Deng, 1989):

– involves simple calculations,
– requires smaller samples,
– a typical distribution of samples is not needed,
– the quantified outcomes from the Grey relational grade do not result in contradictory conclusions to qualitative analysis,
– the Grey relational grade model is a transfer functional model that is effective in dealing with discrete data.

This paper presents the application of Fuzzy AHP and TOPSIS grey methods for the case study of selection the best advertising strategy in growth stage of product life cycle. The framework of research is shown in figure 1.

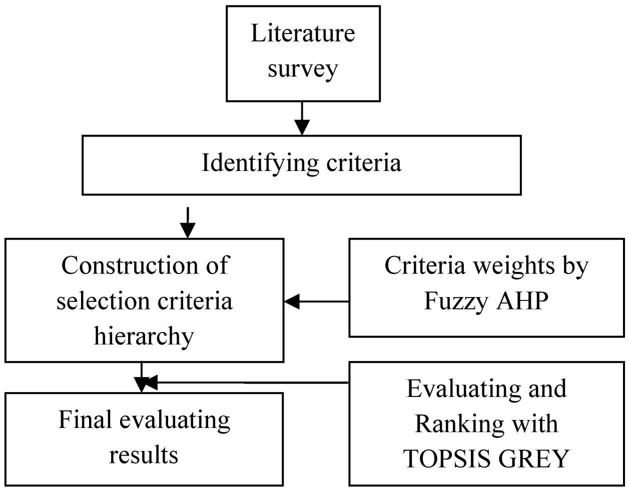

Figure 1. Framework of research

Analytic Hierarchy Process

Analytic hierarchy process (AHP), proposed by Thomas L. Saaty in 1971 (Saaty, 1980), is able to solve the multiple criteria decision making problems. AHP utilize three principles to solve problems (Aydogan, 2011; Podvezko, 2009; Sivilevicius, 2011):

1) Structure of the hierarchy,
2) The matrix of pair wise comparison ratios, and
3) The method for calculating weights.

AHP can decompose any complex problem into several sub-problems in terms of hierarchical levels where each level represents a set of criteria or attributes relative to each sub-problem. During the past, there were 13 major conditions that have discovered to well fit the utilization of AHP such as setting priorities, generating a set of alternatives, choosing a best policy alternatives, determining requirements, allocating resources, predicting outcomes, measuring performance, designing system, ensuring system stability, optimization, planning, resolving conflict, and risk assessment (Saaty, 1980). Besides, recent conditions encompass to reduce the influence of global climate change (Berrittella *et al.,* 2007), to choose university faculty (Grandzol, 2005), to decide the location of offshore manufacturing plants (Walailak and McCarthy, 2002), to evaluate risk in conducting cross-country petroleum pipelines (Dey, 2003) and so on.

With this method, a complicated system is converted to a hierarchical system of elements. In each hierarchical level, pair-wise comparisons of n elements are made by using a nominal scale and the value m_{ij} is assigned to represent the judgment concerning the relative importance of decision element e_i over e_j.

These comparisons compose a pair-wise comparison matrix $M = \{m_{ij}\}$. In order to find the weight of each element, or the score of each alternative, the priority vector (or eigenvector) $W= (w_1,w_2,...,w_n)^T$ of this comparison matrix is calculated based on solving the equation (1):

$$MW = \lambda_{max} \quad W, \quad \lambda_{max} n \tag{1}$$

It indicates that the eigenvector corresponding to the largest eigenvalue (λ_{max}) of the pair-wise comparisons matrix reflects the relative importance of the decision elements. This conventional AHP approach gives reasonably good approximation only when the decision-maker's preferences are consistent. However, the descriptions of linguistic variable (such as 'judgment' or 'preference') are usually vague and the verbal attitudes of decision-maker's requirements on evaluation process always contain ambiguity and multiplicity of meaning. AHP is ineffective when applied to ambiguous problem. Thus, fuzzy sets could be incorporated with the pair-wise comparison, as an extension of AHP, to solve this kind of uncertainty (Lee, 2010).

Fuzzy AHP method

Zadeh (1965) first introduced the fuzzy set theory to deal with the uncertainty due to imprecision or vagueness. Let the universe of discourse X be the subset of real numbers R. A fuzzy set $\tilde{A} = \{(x, \mu_{\tilde{A}}(x) | x \in X)\}$ is a set of ordered pairs, where it is called the membership function which assigns to each object x a grade of membership ranging between zero and one. Triangular fuzzy number is the most widely used membership function in many application fields because of its intuitive appeal and computational efficiency. A triangular fuzzy number, defined to be a normal and convex fuzzy subset of X and denoted as $\tilde{A} = (a, b, c)$, has the following membership function (Kaufmann & Gupta, 1991) The parameter "b" gives the maximal grade of , the parameters "c" and "a" are the upper and lower bounds which limit the field of possible evaluation (Lee, 2010). In this research, triangular fuzzy numbers are used to represent subjective pair-wise comparisons of experts' judgments among the options such as just equal, equal importance, weak importance, strong importance, very strong importance, and extremely preferred. The triangular fuzzy conversion scale used to convert such linguistic values into fuzzy scales in the evaluation model of this paper is shown in Table 1.

The recent applications of AHP method in shortly are listed below:

- Hashemkhani Zolfani *et al.,* (2012a) applied fuzzy AHP for performance evaluating rural ICT centers (Telecenters)
- Aghdaie *et al.,* (2012) applied fuzzy AHP in market segment evaluation and selection.
- Basirat Bayggi *et al*., (2011) applied fuzzy AHP to Develop intellectual capital evaluation model in Hotel Industry;
- Aghdaie *el al.,* (2011) used fuzzy AHP and fuzzy TOPSIS for market segment evaluation and selection;
- Kersuliene, Turskis (2011) fuzzy AHP and ARAS for architect selection;
- Gungor *et al.,* (2009) used fuzzy AHP approach to personnel selection problem (quality1);
- Onut *et al.,* (2008) applied fuzzy AHP and fuzzy TOPSIS for machine tool selection.

This paper applies Chang's extent analysis method (Chang, 1996). According to Chang's extent analysis method, the value of fuzzy synthetic extent is defined, using the standard fuzzy arithmetic, as below:

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]^{-1} \quad (2)$$

Where M_i^j is a triangular fuzzy number representing the extent analysis value for decision element i with respect to goal j.$M_i^j$is the generic element of a fuzzy pair-wise comparison matrix like the one used in the AHP method.

The degree of possibility of $M_1 \geq M_2$ is defined as:

$$V(M_1 \geq M_2) = \sup_{x \geq y} [\min (,)] \quad (3)$$

And can be equivalently expressed as follo: $V(M_1 M_2) hgt(M_2 M_1) \begin{cases} 1, & if\ b_1 \geq b_2 \\ 0, & if\ a_2 \geq c_1 \\ & \frac{c_1 - a_2}{(c_1 - a_2) - (b_2 - b_1)}, otherwise \end{cases}$ (4)

The degree of possibility for a convex fuzzy number to be greater than k convex fuzzy number:

$M_i\ (i = 1, 2, \ldots, k)$ can be defined by $V\ (M \geq M_1, M_2, \ldots, M_k) = V\ [(M \geq M_1)\ \ and\ (M \geq M2)\ and \ldots and\ (M \geq M_K)]\ \ \min V\ (M\ M_i),\ \ i\ 1, 2, 3, \ldots, k.$ (5)

Assume that:

$$d'(A_i)\ min\ V(S_i\ \ S_k) \quad (6)$$

For $k = 1, 2, \ldots, n;\ k \neq i.$ then the weight vector is given by:

$$W' = (d'(A_1)\ \ d'(A_2), \ldots, d'(A_n))^T \quad (7)$$

Where $A_i\ (i = 1, 2, \ldots, n)$ are n decision elements. Via normalization, the normalized weight vectors are:

$$W = (d(A_1)\ \ d(A_2), \ldots, d(A_n))^T \quad (8)$$

Where W is a non-fuzzy number, compared to conventional AHP, The fuzzy AHP approach allows a more accurate description of the decision making process.

Table 1

Linguistic variables describing weights of the criteria and values of ratings (Onüt *et al.*, 2008)

Linguistic scale for importance	***Triangular fuzzy scale (a,b,c)***
Just equal	(1.0,1.0,1.0)
Equal importance	(1.0,1.0,3.0)
Weak importance of one over another	(1.0,3.0,5.0)
Essential or strong importance	(3.0,5.0,7.0)
Very strong importance	(5.0,7.0,9.0)
Extremely preferred	(7.0,9.0,9.0)
If factor i has one of the above numbers assigned to it when compared to factor j, then j has the reciprocal value when compared whit i Reciprocals of above $M_1^{-1} \approx \left(\frac{1}{c_1}, \frac{1}{b_1}, \frac{1}{a_1}\right)$.	

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

The TOPSIS method was developed by Hwang and Yoon (1981). TOPSIS method belongs to MCDM (Multi-criteria decision-making method) group and identifies solutions from a finite set of alternatives based upon simultaneous minimization of distance from an ideal point and maximization of distance from a negative ideal point. TOPSIS can incorporate relative weights of criteria. The only subjective input needed is weights. Lin *et al.,* (2008) developed TOPSIS method with grey number operations to the problem solution with uncertain information.

TOPSIS method was applied in many fields:

- For evaluating rural ICT telecenters (Hashemkhani Zolfani *et al.,* 2012a);
- About Multi-role artist of rock bands in Iran (Hashemkhani Zolfani *et al.,* 2012b);
- For team member selecting (Hashemkhani Zolfani & Antucheviciene, 2012);
- Risk assessment of construction projects (Zavadskas *et al.,* 2010b);
- For selection of the strategic alliance partner (Buyukozkan *et al.,* 2008);
- For supplier selection with TOPSIS method (Boran *et al.,* 2009);
- To risk evaluation in workplaces (Grassi *et al.* 2009);
- To customer evaluation using fuzzy methods based on TOPSIS in safety management (Yang *et al.,* 2009).

TOPSIS method with criteria values determined at intervals

The TOPSIS method is one of the best described mathematically and not simple for practical using. Lin *et* *al.,* (2008) proposed the model of TOPSIS method with attributes values determined at intervals that includes the following steps:

Step 1: Selecting the set of the most important attributes, describing the alternatives;

Step 2: Constructing the decision-making matrix $\otimes X$. Grey number matrix $\otimes X$ can be defined as:

$$\otimes X = \begin{bmatrix} \otimes x_{11} & \otimes x_{12} & \cdots & \otimes x_{1m} \\ \otimes x_{21} & \otimes x_{22} & \cdots & \otimes x_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ \otimes x_{n1} & \otimes x_{n2} & \cdots & \otimes x_{nm} \end{bmatrix}, i = \overline{1,n},\ j = \overline{1,m} \quad (9)$$

Where $\otimes x_{ij}$ denotes the grey evaluations of the *i*-th alternative with respect to the *j*-th attribute; $[\otimes x_{i1}, \otimes x_{i2}, \cdots, \otimes x_{im}]$ is the grey number evaluation series of the *i*-th alternative.

Step 3: Construct the normalized grey decision matrices. The normalized values of maximizing attributes are calculated as:

$$\overline{\otimes x}_{ij,b} = \frac{\otimes x_{ij}}{\max\limits_i (b_{ij})} = \left(\frac{w_{ij}}{\max\limits_i (b_{ij})}, \frac{b_{ij}}{\max\limits_i (b_{ij})} \right). \quad (10)$$

The normalized values of minimizing attributes are calculated by Lin et al. (2008):

$$\overline{\otimes x}_{ij,w} = 1 - \frac{\otimes x_{ij}}{\max\limits_i (b_{ij})} = \left(1 - \frac{b_{ij}}{\max\limits_i (b_{ij})}, 1 - \frac{w_{ij}}{\max\limits_i (b_{ij})} \right). \quad (11)$$

Step 4: Determining weights of the criteriaq_j.

Step 5: Construct the grey weighted normalized decision-making matrix.

Step 6: Determine the positive and negative ideal alternatives for each decision-maker. The positive ideal alternative A^+, and the negative ideal alternative A^- can be defined as:

$$A^+ = \{(\max_i b_{ij} | j \in J), (\min_i w_{ij} | j \in J') | i \in n\} = [x_1^+, x_2^+, \ldots x_m^+] \quad (12)$$

$$A^- = \{(\min_i w_{ij} | j \in J), (\max_i b_{ij} | j \in J') | i \in n\} = [x_1^-, x_2^-, \ldots x_m^-] \quad (13)$$

Step 7: Calculate the separation measure from the positive and negative ideal alternatives, d_i^+ and d_i^-, for the group. There are two sub-steps to be considered: the first one concerns the separation measure for individuals; the second one aggregates their measures for the group.

Calculate the measures from the positive and negative ideal alternatives individually. For decision-maker k, the separation measures from the positive ideal alternative d_i^+ and negative ideal alternative d_i^- are computed through weighted grey number as:

$$d_i^+ = \left\{ \frac{1}{2} \sum_{j=1}^{m} q_j \left[\left| x_j^+ - \overline{w}_{ij} \right|^p + \left| x_j^+ - \overline{b}_{ij} \right|^p \right] \right\}^{\frac{1}{p}} \quad (14)$$

$$d_i^- = \left\{ \frac{1}{2} \sum_{j=1}^{m} q_j \left[\left| x_j^- - \overline{w}_{ij} \right|^p + \left| x_j^- - \overline{b}_{ij} \right|^p \right] \right\}^{\frac{1}{p}} \quad (15)$$

In equations (14) and (15), for p≥1 and integer, q_j is the weight for the attribute j, which can be determined by attribute weight determination methods. If p = 2, then the metric is a weighted grey number Euclidean distance function. Equations (14) and (15) will be as follows:

$$d_i^+ = \sqrt{\frac{1}{2} \sum_{j=1}^{m} q_i \left[\left| x_j^{k^+} - \overline{w}_{ij}^k \right|^2 + \left| x_j^{k^+} - \overline{b}_{ij}^k \right|^2 \right]}, \quad (16)$$

$$d_i^- = \sqrt{\frac{1}{2} \sum_{j=1}^{m} q_j \left[\left| x_j^{k^-} - \overline{w}_{ij}^k \right|^2 + \left| x_j^{k^-} - \overline{b}_{ij}^k \right|^2 \right]} \quad (17)$$

Step 8: Calculate the relative closeness C_i^+, to the positive ideal alternative for the group. The aggregation of relative closeness for the *i*-th alternative with respect to the positive ideal alternative for the group can be expressed as:

$$C_i^+ = \frac{d_i^-}{d_i^+ + d_i^-} \quad (18)$$

Where $0 \le C_i^+ \le 1$. The larger the index value is, the better the evaluation of alternative will be.

Step 9: Rank the preference order. A set of alternatives now can be ranked by the descending order of the value of C_i^+.

Case study: selection Advertising strategy in growth of product life cycle based on Fuzzy AHP and TOPSIS grey method

Criteria selection and data survey

The aim of this study is to utilize a new hybrid model of MCDM methods in selection Advertising strategy in growth of product life cycle. A case company is Kalleh Company, the oldest and the most famous company in food industrials, in Iran. Kalleh Company tends to select best advertising strategy in growth of product life cycle, because sale of the products in growth stage of the cycle have the rising growth and the company want to focus on the product's advertising so the structure of this decision are shown in figure 1.This figure shows that there are five alternatives, Television Ad (A_1), Radio Ad (A_2), Newspaper Ad (A_3), Internet & SMS Ad (A_4), Environmental Ad (A_5) and five group criteria that are shown in table 2.

Table 2

Criteria for selection advertising strategy in growth of product life cycle

Criteria	Sub criteria
Audience fit $\otimes x_1$	Educational level $\otimes x_{1-1}$ Age $\otimes x_{1-2}$
Content $\otimes x_2$	
Impression rate $\otimes x_3$	
Monthly cost $\otimes x_4$	
Look & feel $\otimes x_5$	User-friendliness $\otimes x_{5-1}$ Design $\otimes x_{5-2}$

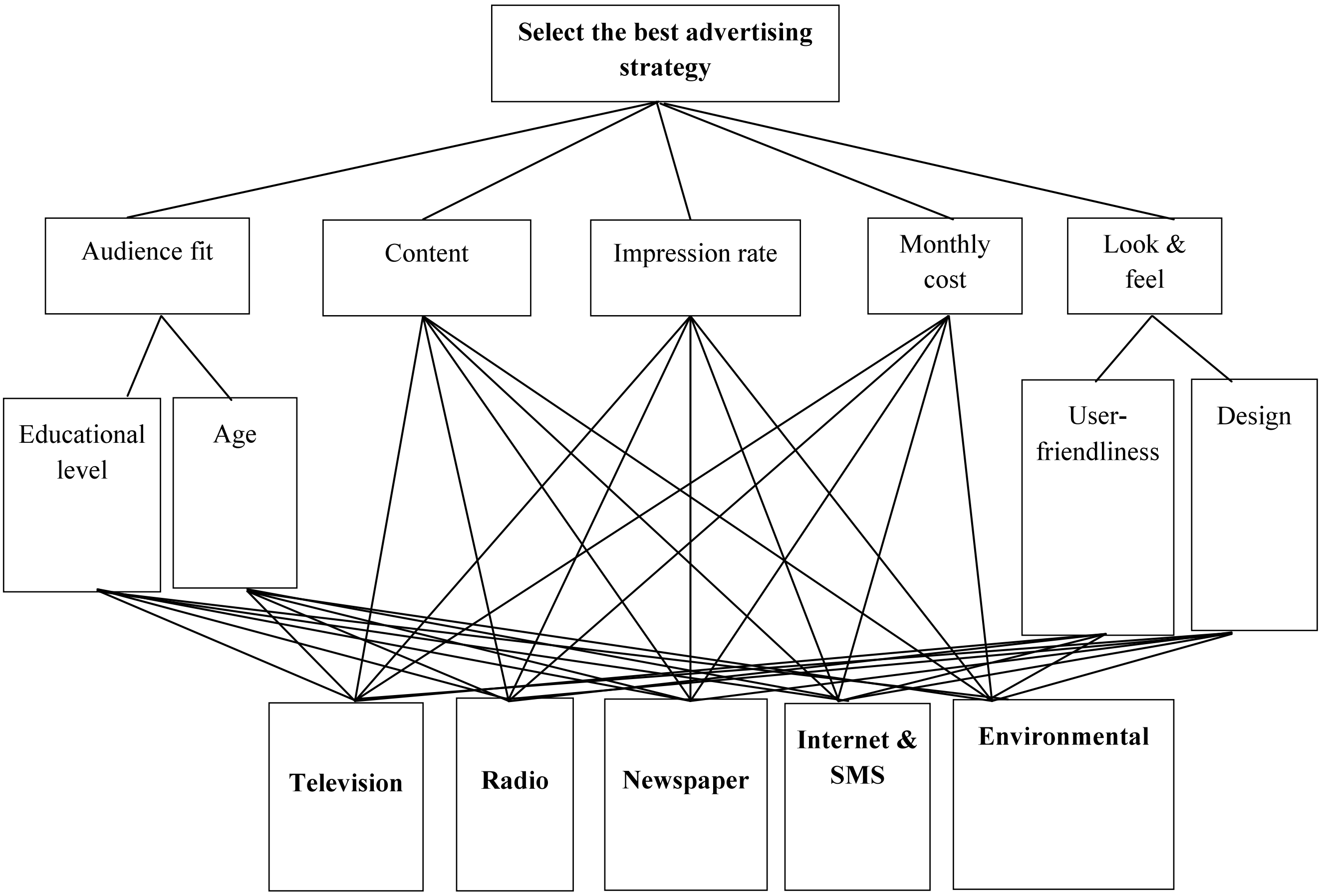

Figure 2. The hierarchy structure of selection advertising strategy in product life cycle

Based on the nature of seven evaluation criteria, optimization directions for each evaluation criterion is determined as follows:

x_{1-1},x_{1-2},x_2, x_3,x_{5-1}, x_{5-2} *Max* ⟶

x_4 *Min* ⟶

Using FAHP method for Prioritization criteria

For pair wise comparison decision making in FAHP, a questionnaire was sent to a group of 8 experts that are the senior managers of company and are responsible for production sales. Information about experts is shown in Table 3:

Table 3

Background Information of Experts

Variable	Items	NO	Variable	Items	NO
1)Education background	Bachelor Master PhD	3 3 2	3)Sex	Male Female	5 3
2)Groups	Labani Goshti	4 4	4)Age	31-40 41-50	6 2

Paired comparison matrix criteria is one of the matrices which were completed with information of experts is shown in Table 4. FAHP method is then used for prioritizing.

Table 4

Criteria paired comparison matrix

	X_1			X_2			X_3			X_4			X_5		
X_1	1.000	1.000	1.000	1.000	3.000	5.000	3.000	5.000	7.000	0.200	0.333	1.000	1.000	5.000	7.000
X_2	0.200	0.333	1.000	1.000	1.000	1.000	5.000	7.000	9.000	0.111	0.143	0.200	0.200	0.333	1.000
X_3	0.143	0.200	0.333	0.111	0.143	0.200	1.000	1.000	1.000	0.200	0.333	1.000	0.200	0.333	1.000
X_4	1.000	3.000	5.000	5.000	7.000	9.000	1.000	3.000	5.000	1.000	1.000	1.000	1.000	3.000	5.000
X_5	0.143	0.200	1.000	1.000	3.000	5.000	1.000	3.000	5.000	0.200	0.333	1.000	1.000	1.000	1.000

Chang's extension method is then used to synthesize the data. The values of fuzzy synthetic extents are calculated. As an example, the values of fuzzy synthetic extents for audience fit's sub criteria are calculated as below: $S_{x_{1-1}} = (0.153,0.212,0.301) \otimes (2.043, 3.265, 4.562) = (0.313, 0.694, 1.373)$

The minimum of the degrees of possibility are calculated as below: $Min\ V(S_{x_{1-1}} \geq S_{x_{1-2}}) = 1$

Same calculations are performed for the other criteria and sub-criteria and these yield the following weights vector: $W' = (1.000, 0.416)^T$

Then every weight is divided into this total to become normalized:

$W = (0.706, 0.294)$

After all comparisons and weighing processes are done, we obtain the overall priority weight of each criteria and sub-criteria that is shown in table 5.

Table 5

Priority weights of criteria and sub criteria

	x_1 0.281	x_2 0.204	x_3 0.011	x_4 0.304	x_5 0.2	weights
x_{1-1}	0.706					0.198
x_{1-2}	0.293					0.082
x_2		1.000				0.204
x_3			1.000			0.011
x_4				1.000		0.304
x_{5-1}					0.643	0.129
x_{5-2}					0.357	0.071

According the weights in table 5, $x_4, x_2, and\ x_{1-1}$ were three of the most important considering criteria.

Selection of the best advertising strategy:

Ranking of alternatives by applying TOPSIS grey technique and the weights that are calculated in last stage, is performed. The initial decision-making matrix with values determined at intervals is presented in Table 6. In Table 6 given notations $q_j$are the criteria weights and $A_1, \cdots, A_5$are alternatives. In this table the group of experts evaluated each candidate according to each criterion. The evaluation was done on a scale from 1 to 9, where 9 meant "very important" and 1 "not important at all".

Table 6

Initial decision-making matrix with values (TOPSIS grey method)

Alternatives	***Criteria***						
	$\otimes x_1$		$\otimes x_2$	$\otimes x_3$	$\otimes x_4$	$\otimes x_5$	
	$\otimes x_{1-1}$	$\otimes x_{1-2}$	$\otimes x_2$	$\otimes x_3$	$\otimes x_4$	$\otimes x_{5-1}$	$\otimes x_{5-2}$
Optimum	max	max	max	max	min	max	max
A_1	6 7	7 8	7.5 8	7 8	7 8	8 9	7.5 8
A_2	4.5 5	5 5.5	5 6	6 7	6.5 7.5	6.5 7.5	5 6
A_3	6.5 7.5	6 6.5	6.5 7.5	6.5 7.5	6 7	7 8	6.5 7.5
A_4	7 8	6 7	7 8	6.5 7.5	6.5 7.5	6.5 7.5	6.5 7.5
A_5	5 6	6 6.5	6 7	6 7	6 7	7.5 8	7 7.5
Optimal value	8	8	8	8	8	9	8

In Table 7 the normalized decision-making matrix with value of each criterion expressed at intervals is presented.

Table 7

Normalized decision-making matrix (TOPSIS grey method)

Alternatives	*Normalized values of criteria*													
	$\otimes x_1$				$\otimes x_2$		$\otimes x_3$		$\otimes x_4$		$\otimes x_5$			
	$\otimes x_{1-1}$		$\otimes x_{1-2}$		$\otimes x_2$		$\otimes x_3$		$\otimes x_4$		$\otimes x_{5-1}$		$\otimes x_{5-2}$	
	$\bar{w}_{1-1}$	$\bar{b}_{1-1}$	$\bar{w}_{1-2}$	$\bar{b}_{1-2}$	$\bar{w}_2$	$\bar{b}_2$	$\bar{w}_3$	$\bar{b}_3$	$\bar{w}_4$	$\bar{b}_4$	$\bar{w}_{5-1}$	$\bar{b}_{5-1}$	$\bar{w}_{5-2}$	$\bar{b}_{5-2}$
Weights q_j	0.198	0.198	0.082	0.082	0.204	0.204	0.011	0.011	0.304	0.304	0.179	0.179	0.071	0.071
A_1	0.75	0.875	0.875	1	0.937	1	0.937	1	0.875	1	0.888	1	0.937	1
A_2	0.562	0.625	0.665	0.687	0.625	0.75	0.75	0.875	0.812	0.937	0.722	0.835	0.625	0.75
A_3	0.812	0.937	0.75	0.812	0.812	0.937	0.812	0.937	0.75	0.875	0.777	0.888	0.812	0.937
A_4	0.875	1	0.75	0.875	0.875	1	0.812	0.937	0.812	0.937	0.722	0.835	0.812	0.937
A_5	0.625	0.75	0.75	0.812	0.75	0.812	0.75	0.875	0.75	0.875	0.835	0.888	0.817	0.937

The results of the calculation for each alternative are presented in Table 8.

Table 8

Weighted-normalized decision-making matrix (TOPSIS grey method)

Alternatives	*Weighted-normalized values of criteria*																	
	$\otimes x_1$				$\otimes x_2$		$\otimes x_3$		$\otimes x_4$		$\otimes x_5$				d^+	d^-		
	$\otimes x_{1-1}$		$\otimes x_{1-2}$		$\otimes x_2$		$\otimes x_3$		$\otimes x_4$		$\otimes x_{5-1}$		$\otimes x_{5-2}$				c^+	*Rank*
	$\bar{w}_{1-1}$	$\bar{b}_{1-1}$	$\bar{w}_{1-2}$	$\bar{b}_{1-2}$	$\bar{w}_2$	$\bar{b}_2$	$\bar{w}_3$	$\bar{b}_3$	$\bar{w}_4$	$\bar{b}_4$	$\bar{w}_{5-1}$	$\bar{b}_{5-1}$	$\bar{w}_{5-2}$	$\bar{b}_{5-2}$				
A_1	0.148	0.173	0.071	0.082	0.191	0.204	0.010	0.011	0.266	0.304	0.158	0.179	0.066	0.071	0.3482	0.4089	0.54	2
A_2	0.111	0.123	0.051	0.056	0.127	0.153	0.008	0.009	0.247	0.285	0.129	0.149	0.044	0.053	0.3826	0.4326	0.530	3
A_3	0.160	0.185	0.061	0.066	0.165	0.191	0.008	0.010	0.228	0.266	0.139	0.158	0.057	0.066	0.3322	0.4063	0.550	1
A_4	0.173	0.198	0.061	0.071	0.178	0.204	0.008	0.010	0.247	0.285	0.129	0.149	0.057	0.066	0.3567	0.3726	0.510	5
A_5	0.123	0.148	0.061	0.066	0.153	0.165	0.008	0.009	0.228	0.266	0.149	0.158	0.058	0.066	0.3653	0.4060	0.526	4
A^+	0.198	0.111	0.082	0.051	0.204	0.127	0.011	0.010	0.304	0.228	0.179	0.129	0.071	0.044				
A^-	0.111	0.198	0.051	0.082	0.127	0.204	0.010	0.011	0.228	0.304	0.129	0.179	0.044	0.071				

According to the TOPSIS grey and the weight that calculated with FAHP methods the order of alternatives ranks is:$A_3 \succ A_1 \succ A_2 \succ A_5 \succ A_4$. The first alternative newspaper Ad must be selected as best advertising media.

Conclusions

In this age of dynamic and increased competitive markets, advertising is an important tool for condensing cross-domain integration energy and a source of core competency. The industries spends billions each year to reach children and youth, therefore selecting the right media for advertising is a very important decision and it and can be evaluated according to different aspects. The main aim of this study is to consider Product Life Cycle (PLC) in process of advertising. In our case of Iran, Kalleh Company is one of the oldest and the most famous company in food industry that is working internationally and have a suitable strategy of advertising is very important for it. This problem is critical for Kalleh Company to acquire competitive advantages. In food industry strategies, growth stage in product life cycle of products has a critical position. This research tried to show the importance of this stage as a case study.

In this research a hybrid model of MCDM method utilized. At first FAHP applied to weight the seven evaluation criteria include: and TOPSIS Grey method for evaluating the performance of advertisings Medias. The results of the study showed that monthly cost, content and educational level, are three important criteria in advertising strategy. FAHP applied in this section because authors believe that fuzzy information can help to identify importance of criteria more carefully. Results of TOPSIS Grey illustrated that newspaper is the best way for advertising and after that television is next and radio, environmental advertising and internet & SMS are after those. The newly developed methods TOPSIS grey could be successfully applied for the assessment of alternatives described by multiple criteria with values expressed at intervals. TOPSIS Grey help experts to describe their ideas more carefully and in this research applied for this mean. Product Life Cycle is a critical issue in many industries and this research can be helpful for other industries as a framework and can be developed in other situations.

References

Aaker, D. A., & Stayman Douglas, M. (1990). Measuring Audience Perceptions of Commercials and Relating them to ad Impact. *Journal of Advertising Research. New York,* 30(4), 7-11.

Aghdaie, M. H., Hashemkhani Zolfani, S., Rezaeiniya, N., & Mehri-Tekmeh, J. (2011). A Hybrid Fuzzy MCDM Approach for Market Segments Evaluation and Selection. *International Conference on Industrial Engineering and Management, IEEE,* Pp. 1-4.

Aghdaie, M. H., Hashemkhani Zolfani, S., & Zavadskas, E. K. (2012). Market Segment Evaluation and Selection Based On Application of Fuzzy Ahp and Copras-G Methods. *Journal of Business Economics and Management*, http://dx.Doi.Org/10.3846/16111699.2012.721392

Alpert, J. I., & Maltz, E. N. (2005). Purchase Occasion Influence on the Role of Music in Advertising. *Journal of Business Research Special Section: Marketing Communications and Consumer Behavior,* 58(3), 369-376.

Antucheviciene, J., Zakarevicius, A., & Zavadskas, E. K. (2011). Measuring Congruence of Ranking Results Applying Particular MCDM Methods. *Informatica,* 22(3), 319-338.

Assael, H. (1993). Marketing: Principles & Strategy (2nd Edition). Forth Worth: *Dryden Press.*

Aydogan, E. K. (2011). Performance Measurement Model for Turkish Aviation Firms Using the Rough-AHP and TOPSIS Methods under Fuzzy Environment. *Expert Systems with Applications*, 38(4), 3992-3998. http://dx.Doi.Org/10.1016/J.Eswa.2010.09.060

Basirat Baygi, M., Hashemkhani Zolfani, S., Rezaeiniya, N., & Aghdaie, M. H. (2011). Using Fuzzy AHP to Develop Intellectual Capital Evaluation Model in Hotel Industry. *European Journal of Scientific Research,* 59(2), 170-178.

Berrittella, M., Certa, A., Enea, M., & Zito, P. (2007). An Analytic Hierarchy Process For The Evaluation of Transport Policies To Reduce Climate Change Impacts, Retrieved April 08, 2011 from http://www.Feem.It/Userfiles/Attach/ Publication/NDL2007/NDL2007-012.Pdf.

Boran, F. E., Genc, S., Kurt, M., & Akay, D. (2009). A Multi-Criteria Intuitionistic Fuzzy Group Decision Making for Supplier Selection with TOPSIS Method. *Expert Systems with Applications,* 36(8), 11363-11368. http://Dx.Doi.Org/10.1016/J.Eswa.2009.03.039

Brown, S. P, Homer, P. M., & Inman, J. J. (1998). A Meta-Analysis of Relationships between ad-Evoked Feelings and Advertising Responses. *Journal of Marketing Research*, 35, 114-126. http://Dx.Doi.Org/10.2307/3151934

Buyukozkan, G., Feyzioglu, O., & Nebol, E. (2008). Selection of the Strategic Alliance Partner in Logistics Value Chain. *International Journal of Production Economics,* 113(1), 148-158. http://Dx.Doi.Org/10.1016/J.Ijpe.2007.01.016

Capella, M. L., Webster, C., & Kinard, B. R. (2011). A Review of the Effect of Cigarette Advertising. *International Journal of Research in Marketing, 28,* 269-279. http://Dx.Doi.Org/10.1016/J.Ijresmar.2011.05.002

Caraher, M., & Landon, J. (2007). The Impact of Advertising on Foodchoice: The Social Context of Advertising. *The Psychology of Food Choice. Oxford Shire, England: CABI Publisherspp,* 227-246.

Chang, D. Y. (1996). Applications of Extent Analysis Method on Fuzzy AHP. *European Journal of Operational Research,* 95, 649-655. http://dx.Doi.Org/10.1016/0377-2217(95)00300-2

Chen, C. K., Liao, C., & Weng, T. C. (2006). Optimal Replenishment Policies for the Case of a Demand Function with Product-Life-Cycle Shape in a Finite Planning Horizon. *Expert Systems with Application,* 32(1), 65-76. http://dx.Doi.Org/10.1016/J.Eswa.2005.11.019

Chu, M. T., Shyu, J., Tzeng, G. H., & Khosla, R. (2007). Comparison among Three Analytical Methods for Knowledge Communities Group-Decision Analysis. *Expert Systems with Applications,* 33, 1011-1024. Http://Dx.Doi.Org/10.1016/J.Eswa.2006.08.026

Deng, J. L. (1982). Control Problems of Grey System. *Systems and Control Letters,* 1(5), 288-294. http://Dx.Doi.Org/10.1016/S0167-6911(82)80025-X

Deng, J. L. (1989). Properties of Relational Space for Grey Systems, *In Essential Topics on Grey System – Theory and Applications.* China Ocean, 1-13.

Dey, P. K. (2003). Analytic Hierarchy Process Analyzes Risk Of Operating Cross-Country Petroleum Pipelines In India. *Natural Hazards Review*, 4(4), 213-221. http://Dx.Doi.Org/10.1061/(ASCE)1527-6988(2003)4:4(213)

Dickson, P. R. (1997). Marketing Management (2nd Edition). Fort Worth: *Dryden Press.*

Doyle, P., & Stern, P. (2006). Marketing Management and Strategy. *New York: Financial Times Prentice Hall.*

Farris, P. W., & Buzzell, R. D. (1979). Why Advertising And Promotional Costs Vary: Some Cross-Sectional Analyses. *Journal of Marketing*, 43, 112-122. http://dx.Doi.Org/10.2307/1250277

Feasely, F., Stuart, G., & Elnora, W. (1987). Magazine Advertising Layout and Design: 1932-1982. *Journal of Advertising*, 16, 20-25.

Figueira, J., Greco, S., & Ehrgott, M. (2005). Multiple Criteria Decision Analysis: *State of The Art Surveys. Springer.*

Ginevicius, R., Podvezko, V., & Raslanas, S. (2008b). Evaluating the Alternative Solutions of Wall Insulation by Multicriteria Methods. *Journal of Civil Engineering and Management*, 14(4), 217-226. http://dx.Doi.Org/10.3846/1392-3730.2008.14.20

Gungor, Z., Serhadlıoglu, G., & Kesen, S. E. (2009). A Fuzzy AHP Approach to Personnel Selection Problem. *Applied Soft Computing*, 9, 641-646. http://Dx.Doi.Org/10.1016/J.Asoc.2008.09.003

Grandzol, J. R. (2005). Improving The Faculty Selection Process In Higher Education: a Case For the Analytic Hierarchy Process.*IR Applications,* 6(24), 1-13.

Grassi, A., Gamberini, R., Mora, C., & Rimini, B. (2009). A Fuzzy Multi-Attribute Model for Risk Evaluation in Workplaces. *Safety Science,* 47(5), 707-716. http://Dx.Doi.Org/10.1016/J.Ssci.2008.10.002

Hashemkhani Zolfani, S., & Antucheviciene, J. (2012). Team Member Selecting Based on AHP and TOPSIS Grey, *Inzinerine Ekonomika-Engineering Economics*, 23(4), 425-434.

Hashemkhani Zolfani, S., Sedaghat, M., & Zavadskas, E. K. (2012a). Performance Evaluating of Rural ICT Centers (Telecenters), Applying Fuzzy AHP, SAW-G And TOPSIS GREY, A Case Study In Iran, *Technological And Economic Development Of Economy,* 18:2, 364-387. http://Dx.Doi.Org/10.3846/20294913.2012.685110

Hashemkhani Zolfani, S., Rezaeiniya, N., & Saparauskas, J. (2012b). Selecting the Best Multi-Role Artist of Rock Bands of Iran In 2000s By Applying ANP and TOPSIS GREY. *Economic Computation and Economic Cybernetics Studies and Research*, 46(2):193-211.

Hoek, J., & Gendall, P. (2006). Advertising and Obesity: a Behavioral Perspective. *J Health Commun,* 11(4), 409-23. http://Dx.Doi.Org/10.1080/10810730600671888

Hui, E. C. M., Lau, O. M. F., & Lo, K. K. (2009). A Fuzzy Decision-Making Approach for Portfolio Management with Direct Real Estate Investment. *International Journal of Strategic Property Management,* 13(2), 191-204. http://dx.Doi.Org/10.3846/1648-715X.2009.13.191-204

Hwang, C. L., & Yoon, K. (1981). Multiple Attribute Decision Making: A State of the Art Survey. In: Lecture Notes in Economics and Mathematical Systems 186, *Springer-Verlag, Berlin.* Http://Dx.Doi.Org/10.1007/978-3-642-48318-9

Hyun, S. S., Kim, W., & Lee, M. J. (2011). The Impact of Advertising on Patrons' Emotional Responses, Perceived Value, and Behavioral Intentions in the Chain Restaurant Industry: The Moderating Role of Advertising-Induced Arousal. *Journal of International Journal of Hospitality Management,* 30, 689-700. Http://dx.Doi.Org/10.1016/J.Ijhm.2010.10.008

Institute of Medicine. Advertising, Marketing and the Media: Improving Messages; 2004 (Online). *Available at* http://www.Iom.Edu/File.Aspx?ID=22609.

Joshi, A., & Hanssens, D. M. (2009). Advertising Spending and Market Anderson, Capitalization. Working Paper.*University of California, Los Angeles, School of Management.*

Kalibatas, D., Zavadskas, E. K., & Kalibatiene, D. (2011). The Concept of the Ideal Indoor Environment in Multi-Attribute Assessment of Dwelling-Houses. *Archives of Civil and Mechanical Engineering,* 11(1), 89-101. http://dx.Doi.Org/10.1016/S1644-9665(12)60176-9

Kaplinski, O., & Tamosaitiene, J. (2010). Game Theory Applications in Construction Engineering and Management. *Technological and Economic Development of Economy,* 16(2), 348-363. http://Dx.Doi.Org/10.3846/Tede.2010.22

Kaplinski, O., & Tupenaite, L. (2011). Review of The Multiple Criteria Decision Making Methods, Intelligent And Biometric Systems Applied In Modern Construction Economics. *Transformations in Business & Economics*, 10(1), 166-181.

Kaufmann, A., & Gupta, M. M. (1991). Introduction to Fuzzy Arithmetic Theory and Applications. *New York: Van nostr And Reinhold, 1991.*

Kersuliene, V., & Turskis, Z. (2011). Integrated Fuzzy Multiple Criteria Decision Making Model For Architect Selection. *Technological and Economic Development of Economy,* 17(4), 645-666. http://dx.Doi.Org/10.3846/20294913.2011.635718

Kotler, P., & Keller, K. L. (2006). Marketing Management (12nd Edition). Upper Saddle River, NJ: *Pearson Prentice Hall.*

Krishnamurthy, S. (2001). The Effects of Provision Points on Generic Advertising Funding. Marketing. *Market Lett*; 12, 25-315. http://Dx.Doi.Org/10.1023/A:1012268221707

Lecknby, J. D., & Kim, H. C. (2002). Creative Factors In Interactive Advertising. Florida. Center for Interactive Advertising. Department Of Advertising College Of Communication. *the University Texas At Austin, Texas 78712.*

Lee, S. F., Tsai, Y. C., & Wen-Jang J. (2006). An Empirical Examination of Customer Perception of Mobile Advertising. *Information Resource Management Journal,* 19, 39-55. Http://Dx.Doi.Org/10.4018/Irmj.2006100103

Lee, S. H. (2010). Using Fuzzy AHP To Develop Intellectual Capital Evaluation Model For Assessing Their Performance Contribution In A University. *Expert Systems with Applications,* 37, 4941–4947. http://dx.Doi.Org/10.1016/J.Eswa.2009.12.020

Levitt, T. (1965). Exploit The Product Life Cycle. Harvard Business Review, 43(6), 81-94.

Lin, Y. H., Lee, P. C., Chang, T. P., & Ting, H. I. (2008). Multi-Attribute Group Decision Making Model Under the Condition of Uncertain Information, *Automation in Construction,* 17(6), 792-797. http://dx.doi.org/10.1016/j.autcon.2008.02.011

Luyt, R. (2011). Representation of Gender in South African Television Advertising: A Content Analysis, *Sex Roles,* 65, 356-370. http://dx.doi.org/10.1007/s11199-011-0027-0

MacCrimon, K. R. (1968). Decision Making Among Multiple Attribute Alternatives: A Survey and Consolidated Approach, *Rand Memorandum, RM-4823-ARPA.*

McKay-Nesbitt, R. V., Manchandab, M. C., Smith, B., & Huhmann, A. (2011). Effects of age, Need for Cognition, and Affective Intensity on Advertising Effectiveness. *Journal of Business Research,* 64, 12-17. http://dx.doi.org/10.1016/j.jbusres.2009.09.013

Medineckiene, M., Zavadskas, E. K. & Turskis Z. (2011). Dwelling Selection by Applying Fuzzy Game Theory, *Archives of Civil and Mechanical Engineering,* 11(3), 981-697. http://dx.doi.org/10.1016/S1644-9665(12)60109-5

Michalopoulos, T., Hogeveen, H., Heuwelink, E., & Oude Lansink, A. G. J. M. (2008). Multi-Criteria Assessment of Ethical Aspects in fresh tomato Systems: Plant Genomics Technology Innovation and Food Policy uses, *12th Congress of the European Association of Agricultural Economists – EAAE, pp. 1-9.*

Onut, S., Kara, S. S., & Efendigil, T. (2008). A Hybrid Fuzzy MCDM Approach to Machine tool Selection. *Journal of Intelligent Manufacturing*, 19, 443-453. http://dx.doi.org/10.1007/s10845-008-0095-3

Opricovic, S., & Tzeng, G. H. (2004). Compromise Solution by MCDM Methods: A Comparative Analysis of VIKOR and TOPSIS, *European Journal of Operational Research*, 156, 445-455. http://dx.doi.org/10.1016/S0377-2217(03)00020-1

Rojas-Mendez, J. I., Daviesb, G., & Madran, C. (2009). Universal Differences in Advertising Avoidance behavior: A Cross-Cultural Study. *Journal of Business Research*, 62, 947-954. http://dx.doi.org/10.1016/j.jbusres.2008.08.008

Royne, M. B., & Levy, M. (2008). Does Marketing Undermine Public Health? *Journal of Common Market Studies*, 25(7), 473-5.

Podvezko, V. (2009). Application of AHP Technique. *Journal of Business Economics and Management*, 10(2), 181-189. http://dx.doi.org/10.3846/1611-1699.2009.10.181-189

Saaty, T. L. (1980). The Analytic Hierarchy Process: Planning, Priority Setting, Resources Allocation. London: *McGraw-Hill.*

Sakai, N., Tanaka, G., & Shimomura, Y. (2003). Product Life Cycle Design Based on Product life Control. In: *Proceedings of the third International Symposium on Environmentally Conscious Design and Inverse Manufacturing, Tokyo,* 102-108.

Saparauskas J., Zavadskas, E. K., & Turskis, Z. (2011). Selection of Facade's Alternatives of Commercial and Public Buildings Based on Multiple Criteria. *International Journal of Strategic Property Management*, 15(2), 189–203. http://dx.doi.org/10.3846/1648715X.2011.586532

Schnaars, S. P. (1991). Marketing Strategy: A Customer-Driven Approach, *Free Pr ISBN-10: 0029279534.*

Shankar, V. (2008). Strategic Marketing Resource Allocation: Methods and Insights, in Marketing Mix Decisions: New Perspectives and Practices, *Kerin and O'Regan, eds. American Marketing Association, pp.154–83.*

Sivilevicius, H. (2011). Modelling the Interaction of Transport System Elements. *Transport,* 26(1), 20-34. http://dx.doi.org/10.3846/16484142.2011.560366

Solomon, M. R., & Stuart, E. W. (1997). Marketing: Real People, Real Choices. Upper Saddle River, NJ: *Prentice Hall.*

Song, P., Xu, H., Techatassanasoontorn, A., & Zhang, C. (2010). The Influence of Product Integration on Online advertising effectiveness, *Journal of Electronic Commerce Research and Applications,* 10, 288–303. http://dx.doi.org/10.1016/j.elerap.2010.09.003

Story, M., & French, S. (2003). Food Advertising and Marketing Directed at Children and Adolescentsin the US. *International Journal of Behavioral Nutrition and Physical Activity*, *1(3)*, *(Online) Available at http://www.ijbnpa.org/content/pdf/1479-5868-1-3.pdf.*

Story, M., & French, S. (2004). Food Advertising and Marketing Directed at Children and Adolescentsin the US. *International Journal of Behavioral Nutrition and Physical Activity*, *1(3), (Online) Available at http://www. ijbnpa.org/content/pdf/1479-5868-1-3.pdf.* http://dx.doi.org/10.1016/S0002-8223(02)90421-9

Story, M., Neumark-Sztainer, D., & French, S. (2002). Individual and Environmental Influences Onadolescent Eating behaviors. *Journal of the American Dietetic Association*, 102(3):S40–51.

Tamosaitiene, J., Bartkiene, L., & Vilutiene, T. (2010). The New Development Trend of Operational Research in Civil Engineering and Sustainable Development as a Result of Collaboration between German–Lithuanian–Polish Scientific Triangle. *Journal of Business Economics and Management,* 11(2), 316-340. http://dx.doi.org/10.3846/jbem.2010.16

Turskis, Z., & Zavadskas, E. K. (2010a). A novel method for multiple criteria analysis: grey additive ratio assessment (ARAS-G) method. *Informatica*, 21(4), 2010, 597-610. http://dx.doi.org/10.3846/transport.2010.52

Turskis, Z., & Zavadskas, E. K. (2010b). A new Fuzzy Additive Ratio Assessment Method (ARAS–F). Case study: the Analysis of Fuzzy Multiple Criteria in Order to Select the Logistic Centers Location. *Transport, 25(4),* 423-432.

Ulubeyli, S., & Kazaz, A. (2009). A Multiple Criteria Decision - Making Approach to the Selection of Concrete Pumps. *Journal of Civil Engineering and Management,* 15(4), 369-376. http://dx.doi.org/10.3846/1392-3730.2009.15.369-376

Vann, J. W., Rogers, R. D., & Penrod, J. P. (1987). The Cognitive Effects of Time-Cmoressed Advertising. *Journal of Advertising,* 16, 10-19.

Walailak, A., & McCarthy, B. (2002). An Application of the Analytical Hierarchy Process to International Location Decision-Making". In M. Gregory (Ed.) *Proceedings of The 7th Annual Cambridge International Manufacturing Symposium: Restructuring Global Manufacturing. Cambridge, England: University of Cambridge.*

Walters, P. G. P., Whitla, P., & Davies, H. (2008). Global strategy in the international advertising industry. *Journal of International Business Review,* 17, 235–249. http://dx.doi.org/10.1016/j.ibusrev.2008.01.005

Wu, S. I., Wei, P. L., & Chen, J. H. (2008). Influential Factors and Relational Structure of Internet Banner Advertising in the Tourism Industry. *Journal of Tourism Management*, 29, 221-236. http://dx.doi.org/10.1016/j.tourman.2007.03.020

Yang, Z. L., Bonsall, S., & Wang, J. (2009). Use of hybrid multiple uncertain attribute decision making techniques in safety management. *Expert Systems with Applications,* 36(2), 1569-1586. http://dx.doi.org/10.1016/j.eswa.2007.11.054

Yazdani, M., Alidoosti, A. & Zavadskas, E. K. (2012). Risk Analysis of Critical Infrastructures Using Fuzzy COPRAS. *Ekonomska istrazivanja*, 24(4), 27-40

Zadeh, L. A. (1965). Fuzzy sets. *Information Control*, 8, 338–353. http://dx.doi.org/10.1016/S0019-9958(65)90241-X

Zavadskas, E. K., Kaklauskas, A., Turskis, Z., & Tamosaitiene, J. (2008). Selection of the Effective Dwelling House Walls by Applying Attributes Values Determined at Intervals. *Journal of Civil Engineering and Management,* 14(2), 85-93. http://dx.doi.org/10.3846/1392-3730.2008.14.3

Zavadskas, E. K., & Turskis, Z. (2011). Multiple Criteria Decision Making (MCDM) Methods in Economics: an Overview. *Technological and Economic Development of Economy*, 17(2), 397-427. http://dx.doi.org/10.3846/20294913 .2011.593291

Zavadskas, E. K., Turskis, Z., & Tamosaitiene, J. (2011). Selection of Construction Enterprises Management Strategy Based on the SWOT and Multi-Criteria Analysis. *Archives of Civil and Mechanical Engineering,* 11(4), 1063-1082. http://dx.doi.org/10.1016/S1644-9665(12)60096-X

Zavadskas, E. K., Turskis, Z., & Tamosaitiene, J. (2010b). Risk Assessment of Construction Projects. *Journal of Civil Engineering and Management,* 16(1), 33-46. http://dx.doi.org/10.3846/jcem.2010.03

Zavadskas, E. K., Vilutiene, T., Turskis, Z., & Tamosaitiene, J. (2010a). Contractor Selection for Construction Works by Applying SAW-G and TOPSIS GREY Techniques. *Journal of Business Economics and Management,* 11(1), 34-55. http://dx.doi.org/10.3846/jbem.2010.03

Zavadskas, E. K., Kaklauskas, A., & Vilutiene, T. (2009). Multicriteria Evaluation of Apartment Blocks Maintenance contractors: Lithuanian case study. *International Journal of Strategic Property Management,* 13(4), 319-338. http://dx.doi.org/10.3846/1648-715X.2009.13.319-338

Zikmund, W. G., & d'Amico, M. (1999). Marketing (12nd edition). Cincinnati, OH: *South-Western College Publishing.*

Sarfaraz Hashemkhani Zolfani, Nahid Rezaeiniya, Morteza Pourhossein, Edmundas Kazimieras Zavadskas

Reklamos strategijos parinkimo sprendimai remiantis produkcijos gyvavimo ciklu taikant FAHP ir TOPSIS GREY: augimo etapo perspektyva

Santrauka

Manoma, kad reklama yra galinga ekonominė ir socialinė jėga. Reklama pateikia informaciją, kuri padeda vartotojams pasirinkti ko jiems reikia. Viena iš pramonės šakų, kurioje reklama daro įspūdingą įtaką, yra maisto pramonė.

Remdamiesi santykiniu konkurenciniu lankstumu, gamintojai rinkodaros biudžetą, skirtą skatinimo priemonėms, įvairiai paskirsto (Shankar, 2008). Pastaruoju metu, kasdienio vartojimo prekes (plg. angl. CPG – *consumer packaged goods*) gaminančiose įmonėse, šis paskirstymas pasikeitė – nuo reklamos į pardavimų skatinimą (Shankar 2008).

Sprendimų priėmimas arba „problemos sprendimas“ yra vienos arba kelių alternatyvų pasirinkimo procesas. Pasirinkimas reklamai tinkamų žiniasklaidos priemonių yra sprendimas, priimamas remiantis skirtingais veiksniais ir gali būti vertinamas įvairiais aspektais. Į jį gali būti žvelgiama kaip į daugiakriterio sprendimų priėmimo (angl. MCDM – *Multiple Criteria Decision Making*) problemą (Zavadskas, Turskis 2011).

Šiame tyrime autoriai bando atskleisti *gaminio gyvavimo ciklo* (plg. angl. PLC – *Product Life Cycle*) svarbą reklamos procese. Šiame tyrime nagrinėjamas maisto pramonėje esantis pavyzdys. Skaičiuojant kiekvieno kriterijaus svorius ir svarbą bus taikomas ne apibrėžtas *analitinis hierarchijos procesas* AHP (plg. angl. *Analytic Hierarchy Process*), o TOPSIS (plg. angl.*Technique for Order Preference by Similarity to Ideal Solution*). *Grey* bus taikomas siekiant parodyti kiekvienos alternatyvos svarbą.

Gaminio gyvavimo ciklas. PLC, tai tarsi bendra gaminio charakteristika, kuri askleidžia gaminio pardavimų eigą nuo jo atsiradimo, t.y patekimo į rinką iki jo pašalinimo iš rinkos. PLC šiame tyrime yra taikomas kaip stipri reklamos priemonė. Maisto pramonės gaminiai turi galiojimo datas, todėl

procesų suderinimas yra labai svarbus ir sudėtingas. Autoriai tiki, kad augimo etapo pasirinkimas nagrinėjamuoju pavyzdžiu, šioje pramonėje yra svarbesnis nei kiti pasirinkimai.

Metodika. Daugiakriteris sprendimų priėmimas (MCDM) yra perspektyvi operacijų tyrimo sritis. Ji pateikia platų metodų spektrą priimantiems sprendimus asmenims ir analitikams. Daugiakriterė analizė (plg. angl. MCA – *Multiple criteria analysis*) sudaro galimybes tirti kelias alternatyvas. Hui ir kt., (2009) įtraukė neapibrėžtumo koncepciją į linijinį programavimą, kad gautų geriausią įmanomą portfolio rezultatą. Deng (1982) išplėtė *Grey* sistemos teoriją ir aprašė operacijas *grey* skaičiais.

Šis darbas pateikia neapibrėžto AHP ir TOPSIS *grey* metodų pritaikymą nagrinėjamam pavyzdžiui, siekiant parikti geriausią reklamos strategiją per gaminio gyvavimo ciklą tuo metu, kai jis perkamiausias.*Analitinis hierarchijos procesas* (AHP) gali išspręsti daugiakriterio sprendimo priėmimo problemas. Jis gali suskaidyti bet kokią sudėtingą problemą į keletą paprastesnių problemų ir sudėtinga sistema yra paverčiama hierarchine sistema. Kiekviename hierarchiniame lygyje, atliekami *n* elementų poriniai palyginimai. Vertė m_{ij}yra priskiriama siekiant parodyti santykinę sprendimo elemento e_i svarbą prieš e_j.

Norint rasti kiekvieno elemento svorį, yra apskaičiuojamas šio palyginimo matricos pirmenybės vektorius $W= (w_1,w_2, . . .,w_n)^T$:

$$MW = \lambda_{max}\mathrm{W}, \lambda_{max} \geq n \qquad (1)$$

Jis parodo, kad tikrinis vektorius, atitinkantis didžiausią porinio palyginimo matricos tikrinę vertę (λ_{max})

atspindi sprendimo elementų santykinę svarbą. Tačiau, lingvistinis kintamojo vertinimo apibūdinimas dažniausiai yra neaiškus ir AHP yra neefektyvus, taikant neapibrėžtai problemai. Tokiu būdu, norint išspręsti neaiškumus, neapibrėžtos grupės gali būti sujungtos su poriniu palyginimu.

Neapibrėžto AHP metodas. Zadeh (1965) pirmasis pristatė neapibrėžtos grupės teoriją, kuri padeda nagrinėti neaiškumus, kilusius dėl netikslumo ar neapibrėžtumo. Trišalis neapibrėžtas skaičius, daugelyje taikymo sričių yra plačiausiai taikoma narystės funkcija. Ji apibūdinama kaip normali ir išgaubta neapibrėžta X subgrupė ir žymima $\tilde{A} = (a, b, c)$.

Šiame tyrime, trišaliai neapibrėžti skaičiai yra naudojami norint parodyti subjektyvius porinius ekspertų sprendimų palyginimus tarp tokių pasirinkimų: „visiškai vienoda"„„vienoda svarba", „menka svarba", „didelė svarba", „labai didelė svarba", ir ypač „pageidaujama svarba".

Šiame darbe taikomas Chang apimties analizės metodas (Chang, 1996), pagal kurį apibūdinama neapibrėžta sintetinės apimties vertė.

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]^{-1}$$

Kur M_i^j yra trišalis neapibrėžtas skaičius, parodantis apimties analizės vertę sprendimo elementui i.

Tikimybės $M_1 \geq M_2$ laipsnis yra apibūdinamas kaip:

$$V(M_1 \geq M_2) = \sup_{x \geq y} [\min(,)] \big(,\big)\big]$$

Pirmenybės Eilės Tvarkos pagal Panašumą į Idealų Sprendimą Technika (TOPSIS). TOPSIS metodas priklauso MCDM grupei ir nustato sprendimus iš galutinės alternatyvų grupės. Jis gali įtraukti kriterijų santykinius svorius. Vienintelės reikalingos subjektyvios sąnaudos yra svoriai. Lin *ir kt.* (2008) išvystė TOPSIS metodą su grey skaičiaus operacijomis problemos sprendimui turint neapibrėžtą informaciją.

Lin *ir kt.* (2008) pasiūlė TOPSIS metodo modelį su intervalais nustatytomis požymių vertėmis, kuris apima tokius žingsnius:

- Žingsnis 1: Svarbiausių požymių grupės pasirinkimas, apibūdinant alternatyvas;
- Žingsnis 2: Sprendimų priėmimo matricos $\otimes X$ sudarymas.
- Žingsnis 3:Sudaryti normalizuotas grey sprendimų matricas
- Žingsnis 4: Kriterijų q_j. svorių nustatymas
- Žingsnis 5: Sudaryti grey svorių normalizuotas sprendimų priėmimo matricas.
- Žingsnis 6: Nustatyti teigiamas ir neigiamas idealias alternatyvas kiekviemam sprendimų priėmėjui.
- Žingsnis 7: Apskaičiuoti teigiamų ir neigiamų idealių alternatyvų atskyrimo matmenį.
- Žingsnis 8: Apskaičiuoti santykinį artumą C_i^+, iki teigiamos idealios alternatyvos grupei.
- Žingsnis 9: Surikiuoti pirmenybės tvarka.

Nagrinėjamas pavyzdys. Šio darbo tikslas yra panaudoti naują hibridinį MCDM metodų modelį renkantis Reklamos strategiją gaminio gyvavimo ciklo augimo stadijoje. Nagrinėjama kompanija yra Kalleh Company, seniausia ir įžymiausia maisto pramonės kompanija Irane.

Chang apimties metodas panaudojamas surinktų duomenų susintetinimui. Apskaičiuojamos neapibrėžtų sintetinių apimčių vertės. Taikant TOPSIS, surikiuojamos alternatyvos ir pasirenkama geriausia strategija.

Išvada. Pagrindinis šio darbo tikslas yra išnagrinėti Gaminio Gyvavimo Ciklą (PLC) reklamos procese. Mūsų atveju, Irane, Kalleh Company turi tinkamą reklamos strategiją. Šis tyrimas bandė parodyti augimo stadijos svarbą kaip nagrinėjamą pavyzdį.

Tyrimo rezultatai parodė, kad kasmėnesinės išlaidos, turinys ir išsilavinimo lygis yra trys reklamos strategijoje svarbūs kriterijai. TOPSIS Grey rezultatai parodė, kad laikraštis yra geriausias būdas reklamai, po to seka televizija, po jos radijas, lauko reklama ir internetas bei trumposios žinutės. Šis tyrimas gali būti naudingas kitose pramonės šakose, kaip pagrindas, ir gali būti išvystytas kitoje situacijoje.

Raktažodžiai: *reklama; neapibrėžtas analitinis hierarchijos procesas (FAHP); sprendimų priėmimas remiantis daugeliu kriterijų (MCDM), TOPSIS grey, gaminio gyvavimo ciklas (PLC).*

The article has been reviewed.

Received in November, 2011; accepted in December, 2012.