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; Saparauas 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-Mendez 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; Leckeb & 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 (Kapinski & 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 (Kalibatbas 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.

**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 (Berrettella 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):

\[
MW = \lambda_{max} W, \quad \lambda_{max} n
\]

It indicates that the eigenvector corresponding to the largest eigenvalue \( \lambda_{max} \) 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 is 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)
- Basirat Bayggi et al., (2011) applied fuzzy AHP to Develop intellectual capital evaluation model in Hotel Industry;
- Aghdaie et 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);

![Figure 1. Framework of research](image-url)
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:

\[
S_i = \frac{m}{\sum_{j=1}^{n} M_{ij} g_i} \left[ \sum_{j=1}^{n} \sum_{i=1}^{m} M_{ij} \right]^{-1} 
\]  

(2)

Where \( M_{ij} \) is a triangular fuzzy number representing the extent analysis value for decision element \( i \) with respect to goal \( j \). \( M_{ij} \) 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:

\[
V(M_1 \geq M_2) = \sup_{x \in Y} \left[ \min \left( \frac{b_1 - b_2}{c_1 - a_2}, \frac{a_2 - c_1}{b_2 - b_1} \right) \right] 
\]  

(3)

And can be equivalently expressed as follo:

\[
V(M_1M_2) = \frac{1}{h} \cdot \frac{\min \left( \frac{b_1 - b_2}{c_1 - a_2}, \frac{a_2 - c_1}{b_2 - b_1} \right)}{1 - \min \left( \frac{b_1 - b_2}{c_1 - a_2}, \frac{a_2 - c_1}{b_2 - b_1} \right)} 
\]  

(4)

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

\[
M_i \text{ (} i = 1, 2, \ldots, k \text{) can be defined by } V(M \geq M_i, M_2, \ldots, M_k) = V[(M \geq M_i) \text{ and } (M \geq M_2) \text{ and } \ldots \text{ and } (M \geq M_k)] \min V(M M_i), i, 1, 2, 3, \ldots, k. 
\]  

(5)

Assume that:

\[
d'(A_i) \min V(S_i, S_k) 
\]  

(6)

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

\[
W' = (d'(A_1), \ldots, d'(A_n))^T 
\]  

(7)

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

\[
W = (d(A_1), \ldots, d(A_n))^T 
\]  

(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

<table>
<thead>
<tr>
<th>Linguistic scale for importance</th>
<th>Triangular fuzzy scale ((a,b,c))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Just equal</td>
<td>((1,0,1,0))</td>
</tr>
<tr>
<td>Equal importance</td>
<td>((1,0,1,0))</td>
</tr>
<tr>
<td>Weak importance of one over another</td>
<td>((1,0,3,0))</td>
</tr>
<tr>
<td>Essential or strong importance</td>
<td>((3,0,5,7,0))</td>
</tr>
<tr>
<td>Very strong importance</td>
<td>((5,0,7,9,0))</td>
</tr>
<tr>
<td>Extremely preferred</td>
<td>((7,9,0,9,0))</td>
</tr>
</tbody>
</table>

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 with \( i \). Reciprocals of above \( M_{ij}^{-1} = \left( \frac{1}{a}, \frac{1}{b}, \frac{1}{c} \right) \).

### 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 team member selection (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., 2008);
- 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.,...
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:

\[
\otimes X = \begin{bmatrix}
\otimes x_{11} & \otimes x_{12} & \ldots & \otimes x_{1m} \\
\otimes x_{21} & \otimes x_{22} & \ldots & \otimes x_{2m} \\
\vdots & \vdots & \ddots & \vdots \\
\otimes x_{n1} & \otimes x_{n2} & \ldots & \otimes x_{nm}
\end{bmatrix}, i = 1, n, j = 1, m
\]

Where \( \otimes x_{ij} \) denotes the grey evaluations of the \( i \)-th alternative with respect to the \( j \)-th attribute; \([\otimes x_{1i}, \otimes x_{2i}, \ldots, \otimes x_{mi}]\) 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:

\[
A^+ = \left\{ \max_{j \in J}(w_j) \left[ x_{ij}^+ \right] \right\}
\]

\[
A^- = \left\{ \min_{j \in J}(w_j) \left[ x_{ij}^- \right] \right\}
\]

Step 4: Determining weights of the criteria \( w_j \).

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:

\[
A^+_i = \max_{j \in J} (w_j) \left[ x^+_{ij} \right]
\]

\[
A^-_i = \min_{j \in J} (w_j) \left[ x^-_{ij} \right]
\]

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:

\[
d^+_i = \left( \frac{1}{2} \sum_{j=1}^{m} q_j \left[ x^+_{ij} - \bar{w}_j \right]^p + \left[ x^+_{ij} - \bar{b}_j \right]^p \right)^\frac{1}{p} \tag{14}
\]

\[
d^-_i = \left( \frac{1}{2} \sum_{j=1}^{m} q_j \left[ x^-_{ij} - \bar{w}_j \right]^p + \left[ x^-_{ij} - \bar{b}_j \right]^p \right)^\frac{1}{p} \tag{15}
\]

In equations (14) and (15), for \( p \geq 1 \) 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:

\[
d^+_i = \left( \frac{1}{2} \sum_{j=1}^{m} q_j \left[ x^+_{ij} - \bar{w}_j \right]^2 + \left[ x^+_{ij} - \bar{b}_j \right]^2 \right)^\frac{1}{2} \tag{16}
\]

\[
d^-_i = \left( \frac{1}{2} \sum_{j=1}^{m} q_j \left[ x^-_{ij} - \bar{w}_j \right]^2 + \left[ x^-_{ij} - \bar{b}_j \right]^2 \right)^\frac{1}{2} \tag{17}
\]

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:

\[
C^+_i = \frac{d^-_i}{d^+_i + d^-_i} \tag{18}
\]

Where \( 0 \leq C^+_i \leq 1 \). 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 industrial, 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 \( (A_2) \), 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

<table>
<thead>
<tr>
<th>Criteria Sub criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audience fit ( x_1 )</td>
</tr>
<tr>
<td>Educational level ( x_1-1 )</td>
</tr>
<tr>
<td>Age ( x_1-2 )</td>
</tr>
<tr>
<td>Content ( x_2 )</td>
</tr>
<tr>
<td>Impression rate ( x_3 )</td>
</tr>
<tr>
<td>Monthly cost ( x_4 )</td>
</tr>
<tr>
<td>Look &amp; feel ( x_5 )</td>
</tr>
<tr>
<td>User-friendliness ( x_5-1 )</td>
</tr>
<tr>
<td>Design ( x_5-2 )</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Variable Item</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education background Bachelor</td>
<td>3</td>
</tr>
<tr>
<td>Master</td>
<td>3</td>
</tr>
<tr>
<td>PhD</td>
<td>2</td>
</tr>
<tr>
<td>Groups Labani</td>
<td>4</td>
</tr>
<tr>
<td>Goshri</td>
<td>4</td>
</tr>
<tr>
<td>Sex Male</td>
<td>5</td>
</tr>
<tr>
<td>Female</td>
<td>3</td>
</tr>
<tr>
<td>Age 31-40</td>
<td>6</td>
</tr>
<tr>
<td>41-50</td>
<td>2</td>
</tr>
</tbody>
</table>
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.

### Criteria paired comparison matrix

<table>
<thead>
<tr>
<th></th>
<th>$X_1$</th>
<th>$X_2$</th>
<th>$X_3$</th>
<th>$X_4$</th>
<th>$X_5$</th>
<th>$X_6$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1$</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>3.000</td>
<td>5.000</td>
</tr>
<tr>
<td>$X_2$</td>
<td>0.200</td>
<td>0.333</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>0.200</td>
</tr>
<tr>
<td>$X_3$</td>
<td>0.143</td>
<td>0.200</td>
<td>0.333</td>
<td>0.111</td>
<td>0.143</td>
<td>0.200</td>
</tr>
<tr>
<td>$X_4$</td>
<td>1.000</td>
<td>0.300</td>
<td>5.000</td>
<td>7.000</td>
<td>9.000</td>
<td>0.200</td>
</tr>
<tr>
<td>$X_5$</td>
<td>0.143</td>
<td>0.200</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>$X_6$</td>
<td>1.000</td>
<td>3.000</td>
<td>5.000</td>
<td>7.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>

According to 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 are the criteria weights and $A_1, \ldots, A_6$ 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”.

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

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\otimes x_1$</td>
</tr>
<tr>
<td>$x_1$</td>
<td>max</td>
</tr>
<tr>
<td>$x_2$</td>
<td>6</td>
</tr>
<tr>
<td>$x_3$</td>
<td>4.5</td>
</tr>
<tr>
<td>$x_4$</td>
<td>6.5</td>
</tr>
<tr>
<td>$x_5$</td>
<td>7</td>
</tr>
<tr>
<td>$x_6$</td>
<td>5</td>
</tr>
</tbody>
</table>

| Optimal value | 8         | 8         | 8         | 8       | 9       | 8       |

In Table 7 the normalized decision-making matrix with value of each criterion expressed at intervals is presented.
The results of the calculation for each alternative are presented in Table 8.

### Table 8

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Normalized decision-making matrix (TOPSIS grey method)</th>
<th>Normalized values of criteria</th>
<th>Weights $q_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{x}_1$</td>
<td>$\bar{x}_2$</td>
<td>$\bar{x}_3$</td>
<td>$\bar{x}_4$</td>
</tr>
<tr>
<td>$A_1$</td>
<td>0.198</td>
<td>0.198</td>
<td>0.082</td>
</tr>
<tr>
<td>$A_2$</td>
<td>0.562</td>
<td>0.625</td>
<td>0.665</td>
</tr>
<tr>
<td>$A_3$</td>
<td>0.812</td>
<td>0.9370.75</td>
<td>0.812</td>
</tr>
<tr>
<td>$A_4$</td>
<td>0.875</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>$A_5$</td>
<td>0.625</td>
<td>0.75</td>
<td>0.75</td>
</tr>
</tbody>
</table>

According to the TOPSIS grey and the weight that calculated with FAHP methods the order of alternatives ranks is: $A_3 > A_1 > A_2 > A_5 > A_4$. 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 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


http://dx.doi.org/10.1016/j.autcon.2008.02.011


procesų suderinimas yra labai svarbus ir sudėtingas. Autoriai tiki, kad augimo etapo pasirinkimas nagrinėjamų pavyzdžių, šioje pramoneje yra svarbesnis nei kiti pasirinkimai.

**Metodika**

Šis darbas pateikia neapibrėžtų AHP ir TOPSIS grey metodų pritaikymą nagrinėjamam pavyzdžiui, siekiant parikioti geriausią reklamos strategiją per gaminio gryvavimo ciklą tuo metu, kai jis perkamiausias. Analitinis hierarchijos procesas (TOPSIS) gali išspręsti daugiaukitės sprendimo priimimo problemas. Jis gali suskaidyti būtų kokią sudėtingą problemas į keletą paprastesnių problemas ir sudėtinga sistema yra paverčiama hierarchine sistema. Kiekviename hierarchinei lygyje, atlikame n elementų porinius palyginimų. Vertė \( m_{ij} \) yra priskiriamai siekiant parodyti santykinę svarbą sprendimo elemento \( e_i \) svarbą prieš \( e_j \).

Norint rasti kickvieno elemento svarbą, yra apskaiciuojamas šio palyginimo matricos pirmenybės vektorius \( W = (w_1, w_2, \ldots, w_n) \): 

\[
MW = \lambda_{max} W, \lambda_{max} \geq n
\]  

Jis parodo, kad tikrinis vektorius, atitinkantis diadaizų porinio palyginimo matricos tikrinę vertę \( \lambda_{max} \), atspindinio sprendimo elementų santykinę svarbą. Tačiau, lingvistinis kintamojo vertinimo apibūdinimas dažniausiai yra neaiškus ir AHP yra neefektyvus, taikant neapibrėžtų palyginimų. Tokiu būdu, norint išspręsti neaiškumus, neapibrėžtos grupės gali būti sujungtos su poriniu palyginimu.

**Tyrimo rezultatai**
Tyrimo rezultatai parodė, kad kašmėnės išlaidos, turinys ir išsilavinimo lygis yra trys reklamos strategijoje svarbūs kriterijai. TOPSIS Grey metodas panaudojamas surinktų duomenų susintetinui. Apskaičiuojamos neapibrėžtų sintetinių apimčių vertės. Taip, TOPSIS yra naudingas kitose pramonės šakose, kaip pagrindas, ir gali būti naudingas kitose situacijose.