Beheshti, M., Amoozad Mahdiraji, H., Zavadskas, E.K. (2016), "Strategy Portfolio Optimisation: A COPRAS G-MODM Hybrid Approach", *Transformations in Business & Economics*, Vol. 15, No 3C (39C), pp.500-519.

---------TRANSFORMATIONS IN --------
BUSINESS & ECONOMICS



# STRATEGY PORTFOLIO OPTIMISATION: A COPRAS G-MODM HYBRID APPROACH

**[1]Moein Beheshti**
*Department of Management,*
*University of Tehran*
*Kish International Campus*
*Niyayesh St., Mirmohanna Blvd*
*Kish*
*Iran*
*Tel.: +98 912 447 3696*
*Fax: +98 21 88006477*
*E-mail: mbeheshti@ut.ac.ir*

**[2]Hannan Amoozad Mahdiraji**
*Faculty of Management*
*University of Tehran*
*Nasr Bridge, Jalal Al Ahmad Exp.*
*Tehran*
*Iran*
*Tel.: +98 21 61117616*
*Fax: +98 21 88006477*
*E-mail: h.amoozad@ut.ac.ir*

**[3]Edmundas Kazimieras Zavadskas**
*Faculty of Civil Engineering*
*Vilnius Gediminas Technical University*
*Saulėtekio al. 11*
*LT-10223 Vilnius*
*Lithuania*
*Tel.: +386 1 5892 786*
*Fax: +386 1 5892 698*
*E-mail: edmundas.zavadskas@vgtu.lt*

[1]**Moein Beheshti**, is currently a Master's student in business and administration in the University of Tehran, International Kish Campus. His main interest area focuses on strategic planning and multiple-criteria decision making methods. Moreover, he is currently working on Markov chain applications in management science.

[2]**Hannan Amoozad Mahdiraji**, PhD, is currently a faculty member and an Assistant Professor of University of Tehran, Department of Management. He received his Ph.D. in operation and manufacturing management from University of Tehran in 2012. His main interest areas include multiple-criteria decision making methods and supply chain management. Since 2013 he has published more than 16 researches in famous international journals; furthermore, he has published nearly 20 researches in international conferences.

[3]**Edmundas Kazimieras Zavadskas**, Dr. Habilius, Professor, Dr. Honoris Causa of Poznan (Poland), St Petersburg (Russia) and Kiev (Ukraine) Universities. Member of Lithuanian Academy of Sciences, Ex-president of Lithuanian Operational Research Society, President of Alliance of Experts of Projects and Buildings of Lithuania. He is an Editor-in-Chief of the following journals: *Journal of Civil Engineering and Management, Technological and Economic Development of*

*Economy; Editor of the International Journal of Strategic Property Management*. Works as an assistant, senior assistant, associate professor, professor at the Department of Construction Technology and Management, Vilnius Gediminas Technical University (Lithuania). In 1987 became a Dr. Sc. at Moscow Civil Engineering Institute (construction technology and management). Author of 14 monographs in Lithuanian, English, German and Russian languages. Research interests: building technology and management, decision making theory, automation in design, decision support systems.

*Received*: February, 2016
*1st Revision*: May, 2016
*2nd Revision*: June, 2016
*Accepted*: July, 2016

***ABSTRACT*. *Designing organisational strategies in various businesses is a commonly employed practice; nevertheless, nowadays the strategy portfolio optimisation is one of the major controversial issues. This research proposes an inclusive model to evaluate and select organisational strategies based on the boundaries of its resources. In order to achieve such a model, first of all, a grey COPRAS model is applied to evaluate organisational strategies under uncertain circumstances. Subsequently, on the basis of the aforementioned method, a mixed integer multi-objective linear programming model is depicted to optimise the strategy selection process according to COPRAS-G strategy significance results and with regard to time, cost and other structural constraints as well as organisational policies. Ultimately, a mixed COPRAS G-MODM is transformed to a binary goal programming model and the suggested approach is employed in Iran Mercantile Exchange for strategy portfolio optimisation.***

***KEYWORDS***: Strategy planning, MIP, COPRAS, COPRAS-G.

***JEL classification***: M10, M19, C02, C61.

## Introduction

In recent years, organisation's environments are becoming ambiguous and interconnected and managers feel the necessity to think and learn strategically, formulate their strategies effectively, cope with unstable circumstances and develop organisational infrastructure for adaption and implementation of their strategies (Bryson, 2011; Ene1 *et al*., 2014). Strategic planning is a manager's weapon to survive and grow in the unsteady environment (Bryson, 2011; Bryson, 2015). Bryson conceives that this tool can be translated as a guideline that helps managers to know what to do, how, and why to do accordingly (Bryson *et al*., 2009).

Literature suggests that strategic planning can be beneficial to understanding the environment; considering the related gaps; supporting organisational capability in utilising resources more efficiently; improving company's competitive position and provisioning the future environments and works as a torch for decision makers to predict and produce better judgments (Cordeiro, 2013; Bryson, 2011; Bryson, 2015). Strategic plans need to connect the company's mission to its vision; hence, a realistic and integrated plan is needed to make a thriving company; however, it is worth noting that the most important evaluating factor for a promising plan is making it balanced. Being capable to perform all possible strategies is nearly impossible considering organisational limitations. Determinant resources including time, budget and human resources confine companies to employ all the preferred strategies in the vast majority of cases; therefore, nowadays strategies of portfolio optimisation constitute one of the most controversial issues. This research considers an inclusive model to evaluate and select organisational strategies based on the boundaries of its resources. In order to achieve such a model, first of all, a grey COPRAS model is applied to evaluate organisational strategies under uncertain circumstances. Subsequently, on the basis of the aforementioned method a mixed integer multi-objective linear programming model is depicted to optimise the strategy selection process according to COPRAS-G results and with regard to time, cost and other structural constraints as well as organizational policies. The remaining part of the paper is organised as follows: first of all, the strategy planning, selection and optimisation have been introduced, the COPRAS-G method is illustrated; a mixed COPRAS G-MODM approach is provided in figures and the designed method is employed in Iran Mercantile Exchange (hereafter IME) for the strategy portfolio optimisation.

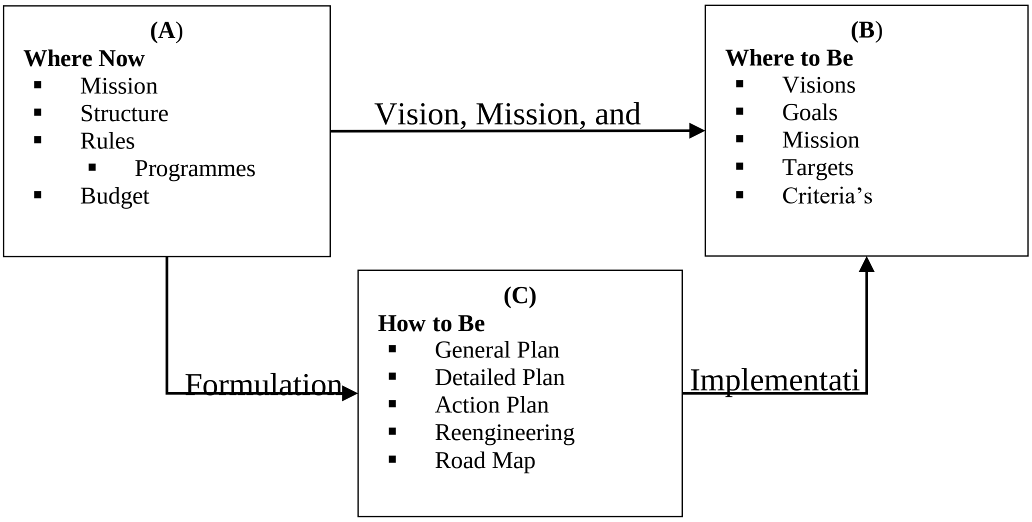
## 1. Strategy Planning Optimisation

### *1.1 Strategic Planning*

Strategic management and strategic planning (henceforth SP) are often used interchangeably; though, they are not identical concepts (Poister, 2003). The concept of SP was depicted by Igor Ansoff in 1965 (Mintzberg, 1994a). SP emanated from military field and emerged as a focus in business organisations in the mid-1960s to mid-1970s (Dooris, 2003; Mintzberg, 1994b). Scholars believe that SP is becoming an organisational culture rather than being a printed plan (Sullivan, Richardson, 2011). Spreading this culture effectively prepares people to decide and act upon the impacts of strategies on organisation; thus, employees are encouraged to look for global objectives rather than short-term benefits, this being a reason to design a fastidious SP in organisations (Al-Turki, 2011).

SP is one part of an organisation's management effort and is seen by some as the principal part of that effort (Poister *et al*., 2010; Boyne, Walker, 2010). Strategy is defined as a board term that helps organisations cope with their environment as well as improve services and performance in the future. One of the recent definitions for strategic planning provided by Kaye who states that it is a systematic process via which an organization agrees on and builds key stakeholder commitment to priorities that are essential to its mission and responsive to the organisational environment. Strategic planning guides the acquisition and allocation of resources to achieve these priorities (Alison, Kaye, 2015).

Miscellaneous SP models are presented by scholars and McNamara summarises them as Conventional; Issues-Based; Organic; Real-time; Alignment and Inspirational strategic planning (McNamara, 2003). One of the best and most touchable SP models is presented by Bryson and Alston (2004) and called ABCs of strategic planning (Bryson, Alston 2004) encompassing where we are, where we want to go and how to get there. (Scharmer, 2009). Identifying and declaring the vision, mission, and goals transfers an organisation from A to B; strategy formulation and detailed planning transfers an organisation from A to C; eventually, how to perform and employ plans and strategies transforms an organisation from B to C (Bryson, 2011). Detailed information is demonstrated in *Figure 1*.




*Source:* Bryson and Alston (2004).

*Figure 1.* **The ABCs of Strategic Planning**

Kotter (1996) believes that the implementation of SP could probably have positive consequences for the decision makers, planners, institutions and citizens as it makes organisations courageous, means confronting key beliefs and looking at prospects of new ideas. (Kotter, 1996) It is necessary since many actors are content with the status quo due to the fact that they are afraid, of the consequences of change (Albrechts, 2005; Kotter, 2008).

There are common misunderstandings over what SP actually is. Some managers believe that SP is an annual blue print that can reduce risks, a linear mathematical procedure or a way of substituting numbers for tangibles. (Keller, 1983; Alison, Kaye, 2015). SP is an ongoing process that requires leaders to question the status of stated initiatives, changes in the environment, new requirements for learning, and adjustments to the plan continually (Chance, Williams, 2009).

Although many researchers conceive that implementing strategic planning correctly may result in a better and more effective organisational decision making since it makes the employees think, act, and learn strategically or enhance their responsiveness and reliance while boosting organisational legitimacy (Nutt, Backoff, 1992; Barry, 1997; Nutt, 2002); on the other hand, being engaged in SP is not enough, a decisive point is its alignment to organisation's decisions or its fails (Goodstein *et al.*, 1993; Reeves, 2008), as a case in point of the appalling fact is the rate of 70% failure of implementing strategic plans (Reeves, 2008).

All in all SP is simply a set of concepts, procedures, and tools that must be applied wisely to specific situations; furthermore, even when they are applied wisely, there is no guarantee of success (Bryson, 2015; Sullivan, Richardson, 2011). There has been a trend in the literature on organisational strategy to move the focus from SP to strategy as this managerial approach encompasses distinct processes, practices and people (Cummings, 2008). An important point is the way that organisations used to plan, rather the way it is now being planned, as the environment is getting more fleeting, the long-term analysis and planning is becoming meaningless and managers need emergent and fluid approaches in organisation levels to come up with strategies to grant efficiency and performance (Cummings, 2008; Cummings, Wilson, 2003), the strategy needs to lead organisations to a viable and profitable position (Carter *et al.*, 2008; Chakravarthy, White, 2002).

### *1.2 Strategy Optimisation*

The developmental stage of SP is considered the main factor of success in its implementation and scholars believe this is likely to be the reason of most SPs failure in recent years (Al-Turki, 2011). It is obvious that each industry needs its exclusive SP and the fact that the same SP framework is used for different industries is another downfall that managers need to be aware of. The lack of evaluation and optimisation makes planners adopt strategies that are not specifically designed for an organisation (Reeves *et al*., 2012).

Selecting a suitable strategy is critical. It is decisive to analyse the ups and downs of each strategy to make sure that it is going to deliver efficiency and probability to the organisation in the future, since there are several alternative yet feasible ways an objective can be achieved it is prudent to consider the option that is the most attractive, effective and viable. The strategic options are evaluated against the metrics of impact, cost and resource requirement as well as the ease of implementation (Al-Turki, 2011).

Choosing the best strategy is usually a difficult task. Selecting a suitable strategy is likely to be a predictive gambling game that managers "bet" on their organisation since the managers need a great sense of foresee in order to make decisions in the current time and hope for its successful aftermath in the future (Farzipoor Saen, Azadi, 2011; Weigelt, Macmillan, 1988).

**Table 1. The recently used strategy selection methods**

| Researchers(s) | Proposed Method(s) |
|---|---|
| **Hastings, 1996** | AHP method |
| **Chiou *et al*. 2005** | Fuzzy AHP |
| **Carneiro, 2008** | Group decision support system |
| **Chien *et al*. 1999** | Portfolio matrices |
| **Kajanus *et al*. 2001** | Swaps method |
| **Cheung and Suen 2002** | Multi attribute utility model |

*Source:* Farzipoor Saen and Azadi (2011).

Strategy selection is one of the most challenging decision-making areas the management of a company encounters (Carneiro, 2008). The long term effects and the fact that strategies are usually non-repetitive alongside the fact that retaining the status quo of strategy cannot be considered an alternative are the obstacles of selecting strategies (Khatami Firouzabadi *et al*., 2008). *Table 1* is a summary of the works of various scholars and the proposed methods to solve this hazardous issue.

### *1.3 SWOT Analysis*

Among the available methods that support the strategy development process (including SPACE, IEM, SWOT, MSM, BCG etc.) the so called SWOT analysis which stands for Strength, Weakness, Opportunities and Threat is the most known and widely used. The perpetuate SWOT analysis is a simple and catchy method used by many researches and practitioners. Although it seems smooth, it is gone beyond assessing alternatives and is being used in complex decision-making situations (Helmes, Nixon, 2010). SWOT is a straightforward framework that indicates the significance of external and internal forces to understanding the sources of competitive advantage. It is a logical approach on which every organisation should assess its external and internal environment to adopt its strategy (Ghazinoory *et al*., 2011). The advocates of SWOT indicate that its strengths refer to the intrinsic abilities to compete and grow strong. The weaknesses include the intrinsic deficiencies that cripple the growth and survival. Opportunities are the better chances and prologues that exist for growth. Threats are the externally wielded challenges, which might contain inherent strengths, accelerate weakness and stifle opportunities from being exploded (Gupta, Mishra, 2016). Furthermore, it channels expert discussion and interaction when participating in setting-up and strategy prioritisation (Terrados *et al*., 2007). Decision makers are able to prioritise SWOT, which initiates qualitative as well as quantitative methods. Kajanus *et al*. (2012) also depicts that factors can be classified within SWOT categories as well as ranking alternative strategy options. Multi-Criteria Decision Support (MCDS) methods are used widely by researchers as they enable a more systematic assessment of SWOT factors. A commonly used MCDS method is the Analytic Hierarchy Process (AHP) performing a pairwise comparison of factors respecting strategies (Saaty, 1980). AHP assumes that factors operate independently from one another, not being true in every case. Accordingly, the Analytic Network Process (ANP) incorporates interdependencies among factors for assessing their relative importance (Catron *et al*., 2012; Rauch *et al*., 2015). SWOT analysis is a commonly used instrument of strategic planning, but often inadequate deployment leads to ending-up with long lists of general, sometimes meaningless, described factors. In such case, the later strategy development process is often not related to the SWOT output (Hill, Westbrook, 1997).

**Table 2. Blank SWOT matrix with questions**

| Strengths | Weaknesses |
|---|---|
| Advantages/ Capabilities | Disadvantages/ Requirements |
| Opportunities | Threats |
| Impressive effects/ Possible opportunities | Possible competition scenarios/ Prominent Factors |

*Source:* Rauch *et al*. (2015), Rauch (2007).

Moreover, many SWOT analyses lack ranking the importance of different factors within a category (Hill, Westbrook, 1997; Rauch *et al*., 2015). In this research a preliminary aim is to fix this problem and transform SWOT analysis into a more meaningful Strategy Planning process. *Table 2* presents a blank SWOT matrix.

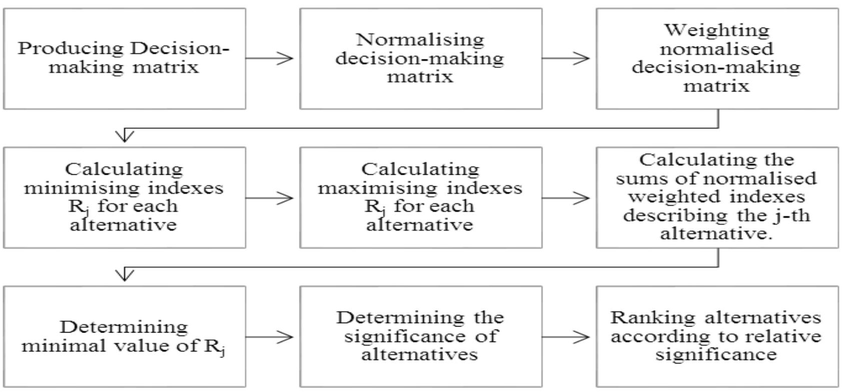
### *1.4 COPRAS Method*

Decision makers need to choose the most efficient alternatives, investigate criteria's importance and choose the best among them and the Decision Analysis is concerned with the situation in which a DM has to choose among several alternatives by considering a particular set of usually conflicting criteria (Hashemkhani Zolfani, Bahrami, 2014). Multiple-Criteria Decision Making (MCDM) can be applied for complex decisions involving a lot of criteria (Antucheviciene *et al*., 2011; Zavadskas *et al*., 2014; Mardani *et al*., 2015; Zavadskas *et al*., 2016a). Researchers have implemented a variety of methods to examine their cases; nonetheless, it was observed that different MCDM methods can produce diverse, not always coinciding ranking results (Antucheviciene *et al*., 2011). COPRAS, TOPSIS and VIKOR are the top assessed methods that scholars frequently use (Stefano *et al*., 2015; Mulliner *et al*., 2016; Mardani *et al*., 2016; Zavadskas *et al*., 2016b). Antucheviciene has compared these thee methods, conceiving that although they are accurate if the ranking results of two methods differ, choosing the results of COPRAS method would be a wise decision as it is more accurate (Antucheviciene *et al*., 2011). Podvezko has also examined SAW technique which is also a widely used and comfortable method, admitting that COPRAS method eliminates the drawbacks of SAW and scholars findings would be more accurate if they used it instead of SAW (Podvezko, 2011). Complex Proportional Assessment (hereafter COPRAS) method was introduced by Zavadskas and Kaklauskas (1996). The reliability and accuracy of COPRAS method is acknowledged by scholars and nowadays it is used to solve different engineering and management multi-attribute problems similarly to its use for solving different engineering and management multi-attribute problems the in the period of 1996-2016 (Akhavan *et al*., 2015; Rasiulis *et al*., 2016; Haghnazar Kouchaksaraei *et al*., 2015; Ecer, 2014; Cereska *et al*., 2016a, Cereska *et al*., 2016b).

COPRAS-G is a developed method applicable in uncertain situations by multiple-attribute values expressed in intervals, using a stepwise evaluation procedure to rank the alternatives in terms of their significance and utility degree (Madhuri *et al*., 2010; Tavana *et al*., 2013).

### *1.5 COPRAS-G Method*

We are living in an uncertain world where clear situations rarely. Deng has worked on vague information called grey intervals, which lack certainty and are usually obtained with poor information (Deng, 1982). COPRAS-G is a method based on such numbers. Grey system is easily calculated, doesn't need distribution of samples; besides, the quantified outcomes do not result in contradictory conclusions of qualitative analysis and the generated model is a transferred functional model which is effective when dealing with discrete data (Deng, 1988). These advantages encouraged researchers to Grey Analysis more frequently (Amoozad Mahdiraji *et al*., 2011; Razavi *et al*., 2015; Amoozad Mahdiraji *et al*., 2016). In 2008, Zavadskas developed COPRAS-G method on the basis of real circumstances of decision making and the application of Grey system (Zavadskas *et al*., 2008a). The compromise ranking method using grey numbers was also performed by other scholars (Liou *et al*., 2015; Nguyen *et al*., 2014; Tavana *et al*., 2013). The procedure of using the COPRAS-G method encompasses steps shown in *Figure 2*.




*Source:* Zavadskas *et al*. (2008b).

*Figure 2.* **Procedure of COPRAS-G**

The procedure of applying the COPRAS-G method consists of the following steps (Zavadskas *et al.*, 2008b; Madhuri *et al.*, 2010):

1. First of all, choosing the most decisive criteria is considered, and upon interpr*et al*ternatives DM matrix (X) generates:

$$X = \begin{bmatrix} [w_{11}; b_{11}] & \cdots & [w_{1m}; b_{1m}] \\ [w_{21}; b_{21}] & \cdots & [w_{2m}; b_{2m}] \\ \vdots & \ddots & \vdots \\ [w_{n1}; b_{n1}] & \cdots & [w_{nm}; b_{nm}] \end{bmatrix}; \quad j = 1,...,n \ , \ i = 1,...,m \tag{1}$$

*Where* $w_{ij}$ and $b_{ij}$ indicate the smallest value (the lower bound) and the biggest value (the upper bound) respectively.

2. The relative importance of each criterion (weights) $q_i$ is to be calculated applying the possible methods such as AHP, ANP, Shannon’s Entropy, LINMAP, WASPAS, etc.

3. Next, the following formula is applied to normalise the decision-making matrix $\bar{X}$ (Hwang, Yoon, 1981; Zavadskas, 1987; Zavadskas *et al.*, 2008a):

$$\overline{w_{ij}} = \frac{w_{ij}}{\frac{1}{2}.(\sum_{j=1}^{n} w_{ij} + \sum_{j=1}^{n} b_{ij})} = \frac{2.w_{ij}}{\sum_{j=1}^{n} w_{ij} + \sum_{j=1}^{n} b_{ij}} \tag{2}$$

$$\overline{b_{ij}} = \frac{b_{ij}}{\frac{1}{2}.(\sum_{j=1}^{n} w_{ij} + \sum_{j=1}^{n} b_{ij})} = \frac{2.b_{ij}}{\sum_{j=1}^{n} w_{ij} + \sum_{j=1}^{n} b_{ij}} \ ; \quad j = 1,...,n \ , \ i = 1,...,m \tag{3}$$

*Where m* is the number of attributes and *n* is the number of the alternatives compared. Accordingly, the decision-making matrix is normalised as provided below (Zavadskas *et al.*, 2008b; Madhuri *et al.*, 2010):

$$\overline{X} = \begin{bmatrix} [\overline{w_{11}}; \overline{b_{11}}] & \cdots & [\overline{w_{1m}}; \overline{b_{1m}}] \\ [\overline{w_{21}}; \overline{b_{21}}] & \cdots & [\overline{w_{2m}}; \overline{b_{2m}}] \\ \vdots & \ddots & \vdots \\ [\overline{w_{n1}}; \overline{b_{n1}}] & \cdots & [\overline{w_{nm}}; \overline{b_{nm}}] \end{bmatrix}; \quad j = 1,...,n \ , \ i = 1,...,m \tag{4}$$

4. Afterwards, the calculation of the weighted normalised decision-making matrix ( $\hat{X}$ ) is examined. The weighted normalised values $\hat{x}_{ij}$ are calculated as follows (Zavadskas *et al.*, 2008a; Madhuri *et al.*, 2010):

$$\hat{w} = \overline{w_{ij}}.q_j \tag{5}$$

$$\hat{b} = \overline{b_{ij}}.q_j \tag{6}$$

*Where* $q_j$ is the significance (weight) of the *j* attribute. Later, the weighted normalised decision-making matrix is formed as stated below:

$$\hat{X} = \begin{bmatrix} [\hat{w}_{11};\hat{b}_{11}] & \cdots & [\hat{w}_{1m};\hat{b}_{1m}] \\ [\hat{w}_{21};\hat{b}_{21}] & \cdots & [\hat{w}_{2m};\hat{b}_{2m}] \\ \vdots & \ddots & \vdots \\ [\hat{w}_{n1};\hat{b}_{n1}] & \cdots & [\hat{w}_{nm};\hat{b}_{nm}] \end{bmatrix}; \quad j = 1,\dots,n\ ,\ i = 1,\dots,m \tag{7}$$

5. Having generated the weighted normalised decision-making matrix, the sums $P_j$ of the attribute values, whose larger values are more preferable are calculated; besides, the sums $R_j$ of attribute values, whose smaller values are more preferable for each alternative are scrutinised (Zavadskas *et al.,* 2008a; Madhuri *et al.,* 2010).

$$P_j = \frac{1}{2}.\sum_{i=1}^{k}(\hat{w}_{ij} + \hat{b}_{ij}) \tag{8}$$

$$R_j = \frac{1}{2}.\sum_{i=k+1}^{m}(\hat{w}_{ij} + \hat{b}_{ij})\ ;\ i = k,\dots,m \tag{9}$$

Where ***k*** indicates the number of attributes to be maximized and $(m - k)$ presents the number of attributes which must be minimised.

6. The minimal value of $R_j$ is determined and the relative weight of each alternative $Q_j$ is calculated by employing equation (10) and (11). (Zavadskas *et al.,* 2008b; Madhuri *et al.,* 2010):

$$R_{\min} = \min R_j\ ;\ j = 1,\dots,n \tag{10}$$

$$Q_j = P_j + \frac{R_{\min}.\sum_{j=1}^{n} R_j}{R_j.\sum_{j=1}^{n} \frac{R_{\min}}{R_j}} \rightarrow Q_j = P_j + \frac{\sum_{j=1}^{n} R_j}{R_j.\sum_{j=1}^{n} \frac{1}{R_j}} \tag{11}$$

7. In order to calculate the utility degree of each alternative, at first the optimal criterion K is determined as follows (Zavadskas *et al.*, 2008a; Tavana *et al.,* 2013):

$$K = \max Q_j\ ;\ j = 1,\dots,n \tag{12}$$

Subsequently, the degree of the utility of alternatives is determined by comparing the alternatives under consideration with the best alternative. The values of the utility degree range from 0% (for the worst alternative) to 100% (for the best alternative). The utility degree of each alternative *j* is calculated as follows (Zavadskas *et al.,* 2008a; Tavana *et al.,* 2013):

$$N_j = \frac{Q_j}{Q_{\max}} \times 100\% \tag{13}$$

*Where* $Q_j$ and $Q_{max}$ represent significances of the alternatives obtained from equation (11).

## 2. COPRAS G - MODM Strategy Portfolio Optimisation

Nowadays, strategy portfolio optimisation is one of the main controversial issues. In this research an inclusive model is arranged to evaluate and select organisational strategies based on its resource boundaries. In order to achieve such a model, a two phase approach is advanced.

**Phase 1. Strategy Definition and Evaluation.** Preliminary, strategies are defined on the basis of SWOT analysis and critical success factors (CSFs). Subsequently, primary strategies are evaluated and ranked upon COPRAS-G method. In order to achieve the evaluation of strategies, equations (1) to (13) mentioned in section (2.5) are employed. As a result, the significance measure of each strategy is obtained.

**Phase 2. Strategy Selection and Optimisation.** As previously presented, structural constraints including budget, time, quality, risk and organisational policies defined by the authorities are critical in strategic plans; nonetheless, they are not considered according COPRAS-G ranking model. Accordingly, these limitations are included to reduce the risk of strategic implementation. To optimise the strategy selection process considering structural barriers and organisational policies alongside with the significance of each strategy gained from COPRAS-G method, a bi-objective integer model is determined as below. The first object ($Z_1$) indicates the maximisation of overall significance point for the selected strategies, while the second object ($Z_2$) minimises the overall budget related to the selected strategies.

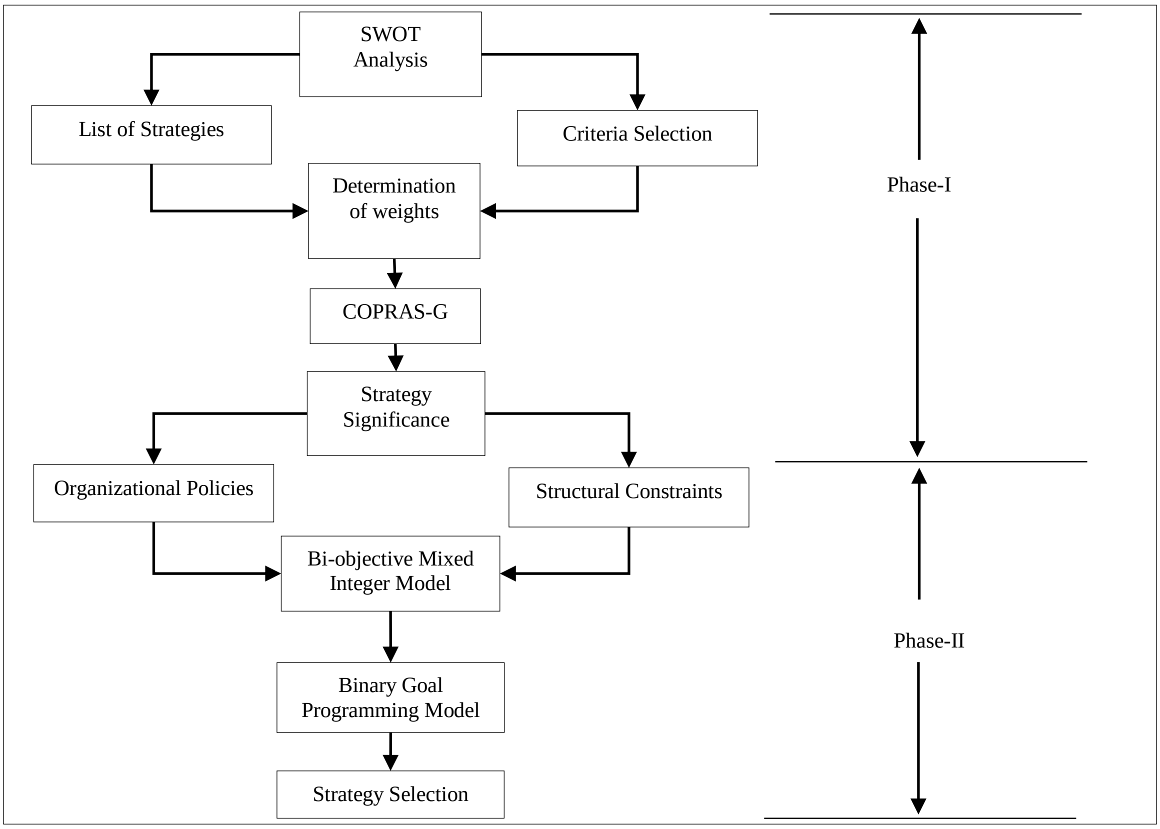
$$Max\, Z_1 = \sum_{i=1}^{n} Q_i . S_i \tag{14}$$

$$Min\, Z_2 = \sum_{i=1}^{n} B_i . S_i \tag{15}$$

In equation (14) and (15), $S_i$ is an integer zero or one decision-making variable for selecting or not selecting a specific strategy, in addition (i) presents each strategy number from 1 to n. Moreover, $Q_i$ illustrates the significance point of each strategy calculated by COPRAS-G method; furthermore, $B_i$ denotes the estimated budget required for the implementation of each strategy. In conjunction with the objective functions, the constraints of the proposed model are subjected to the organisational policies defined by the managerial board or the chief executive officer. To solve the above-mentioned bi-objective model, each object is solved separately and the results are transformed to a binary goal programming model indicated below.

$$\begin{aligned}
&Min\, Z = d_1^+, d_1^-, d_2^+, d_2^- \\
&S.T: \\
&\sum_{i=1}^{n} Q_i . S_i - d_1^+ + d_1^- = Z_1 * \\
&\sum_{i=1}^{n} B_i . S_i - d_2^+ + d_2^- = Z_2 * \\
&Organizational\ \ Policies \\
&S_i = 0 \ or \ 1 \\
&d_i \geq 0
\end{aligned} \tag{16}$$

$Z_1^*$ presents the optimal value of significance function individually, while $Z_2^*$ illustrates the optimal value of budget function without considering the strategy significance point. The suggested approach is summarised in *Figure 3*.




*Source:* created by the authors.

*Figure 3.* **COPRAS G-MODM Proposed Model**

## 3. Case Study

The recommended approach mentioned in the previous section is employed in a real case of Iran Mercantile Exchange Company (IME). Launched in 2007 following the merger of the metal and agriculture commodity exchanges, Iran Mercantile Exchange, being the sole commodity exchange of the Iranian capital market, has developed into the leading, most transparent and diverse spot as well as derivative marketplace in the MENA region handling around 25 million tons of commodities from industrial to petrochemical and petroleum as well as agriculture products worth approximately 14 billion USD annually. The company provides a trading platform for buyers and sellers, bringing together industries, trade and economic sectors, individuals, companies and institutions that trade physical commodities in spot market and hedge or gain profit by accepting risk in the derivatives market. The IME Export Trading Floor (Export Ring) in the Persian Gulf offers the worldwide traders and end users the widest range of global benchmark products across all major asset classes, including asphalt and bitumen grades as petroleum products, iron ore and minerals as well as chemicals and polymers. The prices of the export ring are quoted as reference by the renowned international price vendors and publishers including Argus, ICIS and Metal Bulletin. As part of the exchange commitment to providing innovative financial tools and risk management solutions to the marketplace, IME offers a wide array of exchange-cleared instruments like futures, parallel and standard Salam, commodity deposit certificates and warrants.

In 2015, by employing SWOT, IEM and MSM methods besides CSFs analysis, eight key strategies were emanated from an integrated strategy planning model in IME shown in *Table 3*. The decisive point is that the given attractiveness point (gained from QSPM) is the outcome of the decision of managerial board and disbursement for strategies accomplishment. In addition, the estimated budget (in million IRR) required for the implementation of each strategy is calculated and stated by the financial deputy.

**Table 3. IME Strategies obtained from brain storming sessions**

| Budget Estimation | Attractiveness Score | Strategy Definition | Strategy Code |
|---|---|---|---|
| 3500 | 2.39 | Developing Derivative Contracts | SP1 |
| 3000 | 2.58 | Financial Tools Development According to Customer Needs | SP2 |
| 1000 | 2.38 | Developing Market depth | SP3 |
| 1500 | 2.08 | Employing Financial Institutes Capacity | SP4 |
| 1000 | 2.19 | Customers Service Development | SP5 |
| 4500 | 1.98 | Continuous optimization in IT capabilities | SP6 |
| 1000 | 1.92 | Extending IME's position in market | SP7 |
| 500 | 1.89 | Developing IME's International Trades | SP8 |

*Source:* created by the authors.

The CSFs method results in an identified set of organisational critical success factors, which represent key performance areas that are essential for the organisation to accomplish its mission. IMEs CSFs are attained from brainstorming sessions and the provided weights are calculated by applying the average of managerial board opinion. *Table 4* presents the CSF importance rates upon interval numbers.

**Table 4. CSF importance rate**

| Grey Importance | CSFs | CSFs No. |
|---|---|---|
| [0.9,1] | Market Share of Commodities | 1 |
| [0.6,0.9] | IT Infrastructure | 2 |
| [0.9,1] | Option Contract Share | 3 |
| [0.4,0.5] | Future Contract Share | 4 |
| [0.4,0.5] | HR Capabilities | 5 |
| [0.9,1] | International Market Share | 6 |

*Source:* created by the authors.

**Table 5. Converted grey values for IMEs CSFs weight**

| Normalised Grey Weight | CSFs | CSFs No. |
|---|---|---|
| [0.183,0.204] | Market Share of Commodities | 1 |
| [0.122,0.183] | IT Infrastructure | 2 |
| [0.183,0.204] | Option Contract Share | 3 |
| [0.081,0.102] | Future Contract Share | 4 |
| [0.816,0.102] | HR Capabilities | 5 |
| [0.183,0.204] | International Market Share | 6 |

*Source:* created by the authors.

The unscaled normalised weights presented in the aforementioned table are shown in the following table applying equation (2) and (3).

The consensus and mutual agreements of managerial board achieved during the brainstorming sessions is demonstrated in *Table 6* (decision-making matrix) indicating the situation of each strategy on the basis of CSFs.

**Table 6. Impact of each CSFs on IMEs strategies**

| Strategy /Criteria | C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|
| SP1 | H | NH | M | H | NL | VH |
| SP2 | VH | H | M | VH | M | H |
| SP3 | NH | VH | H | M | M | H |
| SP4 | VH | NL | NL | NL | M | H |
| SP5 | M | M | M | M | VH | NL |
| SP6 | NL | H | M | H | H | H |
| SP7 | L | H | NL | NL | VH | M |
| SP8 | VL | L | VL | NL | M | H |

*Source:* created by the authors.

Values mentioned in *Table 6* are converted to Grey numbers; thus, the decision-making matrix is transferred to *Table 7*.

**Table 7. IMEs converted strategies to grey numbers using the scales table**

| Strategy /Criteria | C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|
| SP1 | [8,9] | [6,7] | [5,6] | [8,9] | [4,5] | [9,10] |
| SP2 | [9,10] | [8,9] | [5,6] | [9,10] | [5,6] | [8,9] |
| SP3 | [6,7] | [9,10] | [8,9] | [5,6] | [5,6] | [8,9] |
| SP4 | [9,10] | [4,5] | [4,5] | [4,5] | [5,6] | [8,9] |
| SP5 | [5,6] | [5,6] | [5,6] | [5,6] | [9,10] | [4,5] |
| SP6 | [4,5] | [8,9] | [5,6] | [8,9] | [8,9] | [8,9] |
| SP7 | [3,4] | [8,9] | [4,5] | [4,5] | [9,10] | [5,6] |
| SP8 | [1,2] | [3,4] | [1,2] | [4,5] | [5,6] | [8,9] |

*Source:* created by the authors.

*Table 8* is the initial decision-making matrix with the attribute values described in intervals and weighted normalised values of attributes describing the compared alternatives, employing equations (2), (3), (5) and (6).

**Table 8. IMEs initial decision and weighted normalised matrix**

| Str. No/ Crit. | $C_1$ | | $C_2$ | | $C_3$ | | $C_4$ | | $C_5$ | | $C_6$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Optimisation Direction | *max* | | *max* | | *max* | | *max* | | *max* | | *max* | |
| $\otimes w_i$ | [0.183,0.204] | | [0.122,0.183] | | [0.183,0.204] | | [0.081,0.102] | | [0.816,0.102] | | [0.183,0.204] | |
| | $\otimes x_1$ | | $\otimes x_2$ | | $\otimes x_3$ | | $\otimes x_4$ | | $\otimes x_5$ | | $\otimes x_6$ | |
| | $\underline{w}_1$ | $\overline{b}_1$ | $\underline{w}_2$ | $\overline{b}_2$ | $\underline{w}_3$ | $\overline{b}_3$ | $\underline{w}_4$ | $\overline{b}_4$ | $\underline{w}_5$ | $\overline{b}_5$ | $\underline{w}_6$ | $\overline{b}_6$ |
| SP1 | 8 | 9 | 6 | 7 | 5 | 6 | 8 | 9 | 4 | 5 | 9 | 10 |
| SP2 | 9 | 10 | 8 | 9 | 5 | 6 | 9 | 10 | 5 | 6 | 8 | 9 |
| SP3 | 6 | 7 | 9 | 10 | 8 | 9 | 5 | 6 | 5 | 6 | 8 | 9 |
| SP4 | 9 | 10 | 4 | 5 | 4 | 5 | 4 | 5 | 5 | 6 | 8 | 9 |
| SP5 | 5 | 6 | 5 | 6 | 5 | 6 | 5 | 6 | 9 | 10 | 4 | 5 |
| SP6 | 4 | 5 | 8 | 9 | 5 | 6 | 8 | 9 | 8 | 9 | 8 | 9 |
| SP7 | 3 | 4 | 8 | 9 | 4 | 5 | 4 | 5 | 9 | 10 | 5 | 6 |
| SP8 | 1 | 2 | 3 | 4 | 1 | 2 | 4 | 5 | 5 | 6 | 8 | 9 |

**Table 8 (continuation). IMEs initial decision and weighted normalised matrix)**

| Normalised weighted values of the attributes describing the compared alternatives – Matrix $\otimes X$ | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\hat{w}_1$ | $\hat{b}_1$ | $\hat{w}_2$ | $\hat{b}_2$ | $\hat{w}_3$ | $\hat{b}_3$ | $\hat{w}_4$ | $\hat{b}_4$ | $\hat{w}_5$ | $\hat{b}_5$ | $\hat{w}_6$ | $\hat{b}_6$ |
| SP1 | 0.029 | 0.037 | 0.013 | 0.023 | 0.022 | 0.029 | 0.012 | 0.018 | 0.006 | 0.009 | 0.026 | 0.032 |
| SP2 | 0.033 | 0.204 | 0.017 | 0.030 | 0.022 | 0.029 | 0.014 | 0.020 | 0.007 | 0.011 | 0.023 | 0.029 |
| SP3 | 0.022 | 0.029 | 0.020 | 0.033 | 0.035 | 0.044 | 0.008 | 0.012 | 0.007 | 0.011 | 0.023 | 0.029 |
| SP4 | 0.033 | 0.041 | 0.008 | 0.016 | 0.017 | 0.024 | 0.006 | 0.010 | 0.007 | 0.011 | 0.023 | 0.029 |
| SP5 | 0.018 | 0.024 | 0.011 | 0.020 | 0.022 | 0.029 | 0.008 | 0.012 | 0.013 | 0.018 | 0.011 | 0.016 |
| SP6 | 0.014 | 0.020 | 0.017 | 0.030 | 0.022 | 0.029 | 0.012 | 0.018 | 0.012 | 0.017 | 0.023 | 0.029 |
| SP7 | 0.011 | 0.016 | 0.017 | 0.030 | 0.017 | 0.024 | 0.006 | 0.010 | 0.013 | 0.018 | 0.014 | 0.019 |
| SP8 | 0.003 | 0.008 | 0.006 | 0.013 | 0.004 | 0.048 | 0.006 | 0.010 | 0.007 | 0.011 | 0.023 | 0.029 |

*Source:* created by the authors.

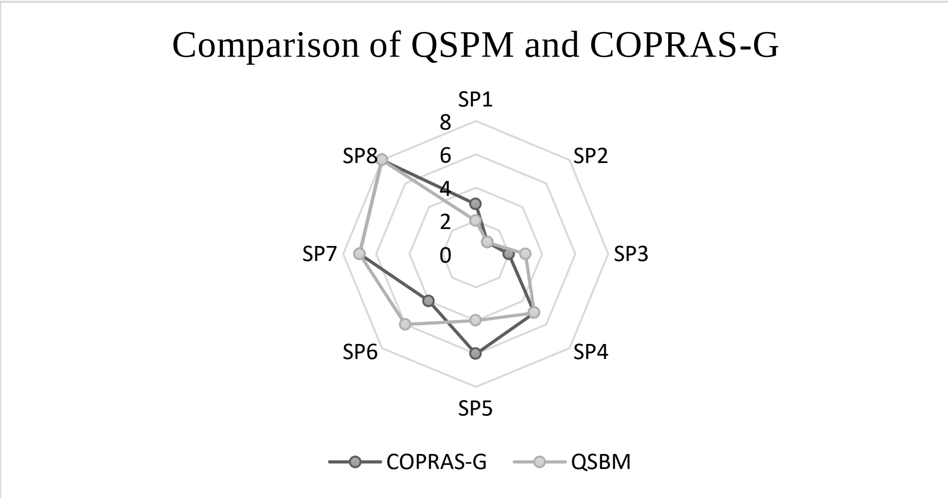
By obtaining the normalised weighted values of alternatives, evaluation of the utility degrees of strategies is required. By calculating the equation (11) the significance ($Q_i$) of each strategy and by implementing equation (13) the utility degree of each strategy is achieved. The results are summarised in *Table 9*.

**Table 9. The summary of IMEs Strategy ranking by COPRAS-G and QSPM**

| SP Alternatives | $Q_i$ | $N_i$ | COPRAS-G Rank | QSPM Rank |
|---|---|---|---|---|
| SP1 | 0.128 | 58.3% | 3 | 2 |
| SP2 | 0.219 | 100% | 1 | 1 |
| SP3 | 0.136 | 62.1% | 2 | 3 |
| SP4 | 0.112 | 51.2% | 5 | 5 |
| SP5 | 0.101 | 46% | 6 | 4 |
| SP6 | 0.121 | 55.3% | 4 | 6 |
| SP7 | 0.097 | 44.4% | 7 | 7 |
| SP8 | 0.084 | 38.2% | 8 | 8 |

*Source:* created by the authors.

The considered strategies were previously ranked during the managerial board brainstorming sessions in IME through QSPM matrix and the rankings of COPRAS-G method acknowledge the priority of strategic planning options. Based on the outcome of *Table 9*, the ranking order through the QSPM method stands as SP2>SP1>SP3>SP5>SP4>SP6>SP7>SP8. Although the COPRAS-G method under uncertainty prioritises the alternatives as SP2>SP3>SP1>SP6>SP4>SP5>SP7>SP8. The radar chart presented in *Figure 4* illustrates QSPM strategy ranking under certain situation, compared to the COPRAS-G strategy ranking considering uncertain circumstances.




*Source:* created by the authors.

*Figure 4.* **QSPM and COPRAS-G Comparison Chart**

By obtaining the significance of each strategy applying the COPRAS-G method, budget and some other relative constraints are implied to make a zero or one bi-objective integer optimisation model for IMEs strategy. Furthermore, the IME's board of directors have also set some policies and limitations consisting of:

1) Six strategies have to be chosen;
2) First strategy is completely dependent on the second one;
3) Second and fourth strategies are discord;
4) There is a deficient relativity between strategy 2 and 6;
5) There is a deficient relativity between strategy 8 and 5.

Considering $Q_i$ and $B_i$ of each strategy, alongside with the aforementioned policies, the bi-objective integer model used in order to identify and select the suitable strategies is presented below:

$$Max\,Z_1 = 0.128S_1 + 0.219S_2 + 0.136S_3 + 0.112S_4 + 0.101S_5 + 0.121S_6 + 0.097S_7 + 0.084S_8$$
$$Min\ Z_2 = 3500S_1 + 3000S_2 + 1000S_3 + 1500S_4 + 1000S_5 + 4500S_6 + 1000S_7 + 500S_8$$
$$St:$$
$$Policy\ 1)\ S_1 + S_2 + S_3 + S_4 + S_5 + S_6 + S_7 + S_8 = 6$$
$$Policy\ 2)\ S_1 - S_2 = 0$$
$$Policy\ 3)\ S_2 + S_4 \le 1$$
$$Policy\ 4)\ S_2 - S_6 \le 0$$
$$Policy\ 5)\ S_8 - S_5 \le 0$$
$$S_i = o\,or\,1$$

To solve the above-mentioned bi-objective binary model; initially, each object is solved by using the LINGO 16.0 software and the results are presented in *Table 10*.

**Table 10. LINGO results for each objective function**

| Object | Object Value | $S_1$ | $S_2$ | $S_3$ | $S_4$ | $S_5$ | $S_6$ | $S_7$ | $S_8$ |
|---|---|---|---|---|---|---|---|---|---|
| $Z_1$ | 0.802 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| $Z_2$ | 9500 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |

*Source:* created by the authors.

Subsequently, the bi-objective model is transformed to a binary goal programming model to minimise the distance of each objective function from the related optimal solution. The transformed model is as follows:

$$Min \;\; Z = d_1^+ + d_1^- + d_2^+ + d_2^-$$
$$St:$$
$$Goal \;\; 1) \; 0.128S_1 + 0.219S_2 + 0.136S_3 + 0.112S_4 + 0.101S_5 + 0.121S_6 + 0.097S_7 + 0.084S_8 - d_1^+ + d_1^- = 0.802$$
$$Goal \;\; 2) \; 3500S_1 + 3000S_2 + 1000S_3 + 1500S_4 + 1000S_5 + 4500S_6 + 1000S_7 + 500S_8 - d_2^+ + d_2^- = 9500$$
$$Policy \;\; 1) \; S_1 + S_2 + S_3 + S_4 + S_5 + S_6 + S_7 + S_8 = 6$$
$$Policy \;\; 2) \; S_1 - S_2 = 0$$
$$Policy \;\; 3) \; S_2 + S_4 \leq 1$$
$$Policy \;\; 4) \; S_2 - S_6 \leq 0$$
$$Policy \;\; 5) \; S_8 - S_5 \leq 0$$
$$S_i = o \, or \, 1$$

By employing the LINGO 16.0 software, the above-mentioned goal programming model is solved and the results are illustrated in *Table 11*, indicating that the third to eight strategy of IMEs should be implemented costing 9500 (million IRR). However the significance of strategies gained from COPRAS-G method experiences a 0.151 disorder.

**Table 11. Goal Programming Results**

| Object | Object Value | $S_1$ | $S_2$ | $S_3$ | $S_4$ | $S_5$ | $S_6$ | $S_7$ | $S_8$ | $d_1^+$ | $d_1^-$ | $d_2^+$ | $d_2^-$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Z | 0.151 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0.151 | 0 | 0 |

*Source:* created by the authors.

Although it seems that strategies 1 and 2 are the best choices, managers should always consider limitations and constraints that might impact their decision-making process. The lack of sufficient resources is a key point that managers need to consider before making decisions. It is conspicuous that the final selected strategies would be as $S_3$; $S_5$; $S_4$; $S_6$; $S_7$; $S_8$.

## Conclusions

This research schedules an inclusive model to evaluate and select organisational strategies based on its resource boundaries. In order to achieve such a model, first of all, a grey COPRAS model is applied to evaluate the organisational strategies upon uncertain circumstances. Subsequently, on the basis of the aforementioned method, a mixed integer multi-objective linear programming model is depicted to optimise the strategy selection process according to the results of COPRAS-G strategy significance and considering time, cost and other structural constraints and organisational policies.

Subsequently, the bi-objective model is transformed to a goal programming binary model for the strategy selection process. Eventually, the mixed COPRAS G-MODM approach is employed in Iran Mercantile Exchange for strategy portfolio optimisation. From the eight strategy designed in IMEs company, the proposed method eliminated the first and second strategies; hence, others remained for implementation. Other MCDM ranking methods, alongside with fuzzy logic could be considered for future researches.

## References


Akhavan, P., Barak, S., Maghsoudlou, H., Antucheviciene, J. (2015), "FQSPM-SWOT for strategic alliance planning and partner selection; case study in a holding car manufacturer company", *Technological and Economic Development of Economy*, Vol. 21, No 2, pp.165-185.

Albrechts, L. (2005), "Creativity as a drive for change", *Planning Theory*, Vol. 4, No 3, pp.247-269.

Alison, M., Kaye, J. (2015), *Strategic Planning for Nonprofit Organizations: A Practical Guide for Dynamic Times*, Hoboken, John Wiley & Sons.

Al-Turki, U. (2011), "A framework for strategic planning in maintenance", *Journal of Quality in Maintenance*, Vol. 17, No 2, pp.150-162.

Amoozad Mahdiraji, H., Razavi, S.H., Pourjam, R. (2011), "A Grey Mathematical Programming model to Time Cost Trade-offs in Project Management under Uncertainty", *International conference on grey systems and intellegent service*, Nanjing, IEEE, pp.709-719.

Amoozad Mahdiraji, H., Razavi, S.H., Hashemi, S.S., Zavadskas, E. (2016), "An interval multi objective critical path method considering time, cost, quality and risk", *E&M Economics and Management*, Vol. 19, No 1, pp.49-61.

Antucheviciene, J, Zakarevicius, J., Zavadskas, E.K. (2011), "Measuring Congruence of Ranking Results Applying Particular MCDM Methods", *Informatica*, Vol. 22, No 3, pp.319-338.

Barry, B.W. (1997), Strategic planning workbook for nonprofit organizations, revised and updated Edition, St. Paul, MN, Amherst H. Wilder Foundation.

Boyne, G.A., Walker, R.M. (2010), "Strategic management and public service performance: The way ahead", *Public administration review*, Vol. 70, No S1, pp.185-192.

Bryson, J.M., Alston, F.K. (2004), *Creating and Implementing Your Strategic Plan: A Workbook for Public and Nonprofit Organizations*, 2nd Edition, San Francisco, Jossey-Bass.

Bryson, J. (2011), *Strategic planning for public and nonprofit organizations: a guide to strengthening and sustaining organizational achievement*, 4th Edition, San Francisco, Jossey-Bass.

Bryson, J. (2015), Strategic Planning for Public and Nonprofit Organizations, *International Encyclopedia of the Social Behavioral Sciences*, pp.516-517.

Bryson, J.M., Crosby, B.C., Bryson, J.K. (2009), "Understanding strategic planning and the formulation and implementation of strategic plans as a way of knowing: The contributions of actor-network theory", *International Public Management Journal*, Vol. 12, No 2, pp.172-207.

Carneiro, A. (2008), "A group decision support system for strategic alternatives selection", *Management Decision*, Vol. 39, No 3, pp.218-226.

Carter, C., Clegg, C., Kornberger, M. (2008), *A very short, fairly interesting and reasonably cheap book about studying strategy*, London, Sage.

Catron, J., Stainback, G., Dwivedi, P., Lhotka, J. (2012), "Bioenergy development in Kentucky: A SWOT-ANP analysis", *Forest Policy and Economics*, No 28, pp.38-43.

Cereska, A., Podvezko, V., Zavadskas, E.K. (2016a), "Operating Characteristics Analysis of Rotor Systems Using MCDM Methods", *Studies in Informatics and Control*, Vol. 25, No 1, pp.59-68.

Cereska, A., Zavadskas, E.K., Cavallaro, F., Podvezko, V., Tetsman, I., Grinbergienė, I (2016b), "Sustainable Assessment of Aerosol Pollution Decrease Applying Multiple Attribute Decision-Making Methods", *Sustainability*, Vol. 8, No 7, pp.586, doi: 10.3390/su8070586.

Chakravarthy, B.S., White, R. (2002), "Strategy process: Forming, implementing and changing strategies", in: H. T.A. Pettinrew (Ed.), *Handbook of strategy and management*, London, Sage, pp.183-205.

Chance, S., Williams, B. (2009), "Assessing university strategic plans: A Tool for consideration", *Educational Planning*, Vol. 18, No 1, pp.38-54.

Cheung, S., Suen, H. (2002), "Multi-attribute utility model for dispute resolution strategy selection", *Construction Management and Economics*, Vol. 20, No 7, pp.557-568.

Chien, T., Lin, C., Tan, B., Lee, W. (1999), "A neural networks-based approach for strategic planning", *Information & Management*, No 35, pp.357-364.

Chiou, H.K., Tzeng, G.H., Cheng, D.C. (2005), "Evaluating sustainable fishing development strategies using fuzzy MCDM approach", *Omega*, Vol. 33, No 3, pp.223-234.

Cordeiro, W. (2013), "Small Businesses Ignore Strategic Planning at their Peril", *Academy of Business Research Journal*, No 3, pp.22-30.

Cummings, S. (2008), "Strategy: Past, present and future", in: D.B. Hansen (Ed.), *The Sage handbook of new approaches in management and organization*, London, Sage, pp.184-194.

Cummings, S., Wilson, D. (2003), *Images of strategy*, Oxford, Blackwell.
Deng, J. (1982), "Control problems of grey system", *Systems and control letters*, Vol. 1, No 5, pp.288-294.
Deng, J. (1988), "Introduction to Grey System Theory", *The journal of grey theory*, Vol. 1, No 1, pp.1-24.
Dooris, M. (2003), "Two decades of strategic planning", *Planning in higher education*, Vol. 31, No 2, pp.26-32.
Ecer, F. (2014), "A hybrid banking websites quality evaluation model using AHP and COPRAS-G: a Turkey case", *Technological and Economic Developement of Economy*, Vol. 20, No 4, pp.758-782.
Ene1, J.C., Ene, E.E., Tsegba, I.N. (2014), "Driving Performance through Strategic and Financial Planning (The Nigerian Experience)", *IOSR Journal of Business and Management (IOSR-JBM)*, Vol. 16, No 12, pp.74-83.
Farzipoor Saen, R., Azadi, M. (2011), "A chance-constrained data envelopment analysis approach for strategy selection", *Journal of Modelling in Management*, Vol. 6, No 2, pp.200-214.
Ghazinoory, S., Abdi, M., Mehr, M. (2011), "SWOT methodology: a state-of-the-art review for the past, a framework for the future", *Journal of Business Economics and Management*, Vol. 12, No 1, pp.24-28.
Goodstein, L., Nolan, T., Pfeiffer, J.W. (1993), *Applied Strategic planning: How to develop a plan that really works*, 1st Edition, New York, McGrew-Hill.
Gupta, G., Mishra, R.P. (2016), "A SWOT analysis of reliability centered maintenance framework", *Journal of Quality in Maintenance Engineering*, Vol. 22, No 2, pp.130-145.
Haghnazar Kouchaksaraei, R., Hashemkhani Zolfani, S., Golabchi, M. (2015), "Glasshouse Locating Based on SWARA-COPRAS Approach", *International Journal of Strategic Property Management*, Vol. 19, No 2, pp.111-122, doi:10.3846/1648715x.2015.1004565.
Hashemkhani Zolfani, S., Bahrami, M. (2014), "Investment proritizing in high tech industries based on SWARA-COPRAS approach", *Technological and Economic Development of Economy*, Vol. 20, No 3, pp.534-553.
Hastings, S. (1996), "A strategy evaluation model for management", *Management Decision*, Vol. 34, No 1, pp.25-34.
Helms, M., Nixon, J. (2010), "Exploring SWOT analysis – where are we now?: A review of academic research from the last decade", *Journal of Strategy and Management,* Vol. 3, No 3, pp.215-251.
Hill, T., Westbrook, R. (1997), "SWOT analysis: It's time for a product recall", *Long Range Planning*, Vol. 30, No 1, pp.46-52.
Hwang, C.L., Yoon, K. (1981), *Multiple Attribute Decision Making: Methods and Applications*, New York, Springer-Verlag.
Kajanus, M., Ahola, J., Kurttila, M., Pesonen, M. (2001), "Application of even swaps for strategy selection in a rural enterprise", *Management Decision*, Vol. 39, No 5, pp.394-402.
Kajanus, M., Leskinen, P., Kurttila, M., Kangas, J. (2012), "Making use of MCDS methods in SWOT analysis-lessons learnt in strategic natural resources management", *Forest Policy and Economics*, Vol. 20, pp.1-9.
Keller, G. (1983), *Academic Strategy: The management revolution in American higher education*, Baltimore, The Johns Hopkins University Press.
Khatami Firouzabadi, S.M., Henson, B., Barnes, C. (2008), "A multiple stakeholders' approach to strategic selection decisions", *Computers and Industrial Engineering*, Vol. 54, No 4, pp.851-865.
Kotter, J. (1996), *Leading Change*, Boston, Harvard Business School Press.
Kotter, J. (2008), *Leading Change*, Boston, Harvad Business School Press.
Liou, J.J.H., Tamosaitiene, J., Zavadskas, E.K., Tzeng, G.-H. (2016), "New hybrid COPRAS-G MADM Model for improving and selecting suppliers in green supply chain management", *International Journal of Production Research*, Vol 54, No 1, pp.114-134, doi:10.1080/00207543.2015.1010747.
Madhuri, C., Anand Chandulal, J., Padmaja, M. (2010), "Selection of best web site by applying COPRAS-G method", *International Journal of Computer Science and Information Technologies*, Vol. 1, No 2, pp.138-146.
Mardani, A., Zavadskas, E.K., Govindan, K., Senin, A.A., Jusoh, A. (2016), "VIKOR Technique: A Systematic Review of the State of the Art Literature on Methodologies and Applications", Sustainability, Vol. 8, No 1, pp.1-38, doi:10.3390/su8010037.
McNamara, C. (2003), *Field Guide to Nonprofit Strategic Planning and Facilitation*, Minneapolis, Authenticity Consulting.
Mintzberg, H. (1994a), "Rethinking Strategic Planning Part I: Pitfalls and Fallacies", *Long Range Planning*, Vol. 27, No 3, pp.12-21.
Mintzberg, H. (1994b), *The rise and fall of strategic planning*, New York, The Free Press.
Mulliner, E., Malys, N., Maliene, V. (2016), "Comparative analysis of MCDM methods for the assessment of sustainable housing affordability", *Omega*, Vol. 59, Part B, pp.146-156.

Nguyen, H.T., Dawal, S.Z.M., Nukman, Y., Aoyama, H. (2014), "A hybrid approach for fuzzy multi-attribute decision making in machine tool selection with consideration of the interactions of attributes", *Expert Systems with Applications*, Vol. 41, No 6, pp.3078-3090, doi:10.1016/j.eswa.2013.10.039.

Nutt, P.C. (2002), *Why decisions fail: Avoiding the blunders and traps that lead to debacles*, San Francisco, Berrett Koehler.

Nutt, P.C., Backoff, R.W. (1992), *Strategic management of public and third-sector organizations: A handbook for leaders*, San Francisco, Jossey-Bass.

Podvezko, V. (2011), "The Comparative Analysis of MCDA Methods SAW and COPRAS", *Inzinerine Ekonomika-Engineering Economics*, Vol. 22, No 2, pp.134-146.

Poister, T. (2003), *Measuring performance in public and nonprofit organizations*, San Francisco, Jossey-Bass.

Poister, T.H., Edwards, L.H., Edwards, J., Arnett, S., Berryman, A. (2010), *The impact of strategic planning on performance in public local transit aganices*, Boston.

Rasiulis, R., Ustinovichius, L., Vilutienė, T., Popov, V. (2016), "Decision model for selection of modernization measures: public building case", *Journal of Civil Engineering and Management*, Vol. 22, No 1, pp.124-133.

Rauch, P. (2007), "SWOT analyses and SWOT strategy formulation for forest owner cooperations in Austria", *European Journal of Forest Research*, Vol. 126, No 3, pp.413-420.

Rauch, P., Wolfsmayr, U.J., Borz, S.A., Triplat, M., Krajnc, N., Kolck, M., Oberwimmer, R., Ketikidis, Ch., Vasiljevic, A., Stauder, M., Muhlberg, Ch., Derczeni, R., Oravec, M., Krissakova, I., Handlos, M. (2015), "SWOT analysis and strategy development for forest fuel supply chains in South East Europe", *Forest Policy and Economics*, Vol. 61, pp.87-94.

Razavi, S., Akrami, H., Hashemi, S., Amoozad Mahdiraji, H. (2015), "An Integer Grey Goal Programming For Project Time, Cost and Quality Trade-Off", *Inzinerine Ekonomika-Engineering Economics*, Vol. 26, No 1, pp.93-100.

Reeves, D. (2008), "Making Strategic Planning Work", *Educational Leadership*, Vol. 65, No 4, pp.86-87.

Reeves, M., Love, C., Tillmanns, P. (2012), Your Strategy needs a strategy, Harvard Business Review, Vol. 90, No 9, pp.76-83.

Saaty, T. (1980), *The Analytic Hierarchy Process Planning, Priority Setting, Resource*, New York, McGraw-Hill.

Scharmer, C.O. (2009), *Theory U: Leading from the future as it emerges*, San Francisco, Berrett-Koehler.

Stefano, N.M., Casarotto, N., Vergara, L.G.L., Rocha, R.U.G. (2015), "COPRAS (Complex Proportional Assessment): State of the Art Research and its Applications", *Ieee Latin America Transactions*, Vol. 13, No 12, pp.3899-3906.

Sullivan, T., Richardson, E. (2011), "Living the plan: Strategic Planning Aligned with Practice and Assessment", *Journal of Continuing Higher Education*, Vol. 59, No 1, pp.2-9.

Tavana, M., Momeni, E., Rezaeiniya, N., Mirhedayatian, S.M., Rezaeiniya, H. (2013), "A novel hybrid social media platform selection model using fuzzy ANP and COPRAS-G", *Expert Systems with Applications*, Vol. 40, No 14, pp.5694-5702, doi:10.1016/j.eswa.2013.05.015.

Terrados, J., Almonacid, G., Hontoria, L. (2007), "Regional energy planning through SWOT analysis and strategic planning tools: impact on renewables development", *Renewable and Sustainable Energy Reviews*, Vol. 11, No 6, pp.1275-1287.

Weigelt, K., Macmillan, I. (1988), "An Interactive Strategic Analysis Framework", *Strategic Management Journal*, Vol. 9, No Supplement, pp.27-40.

Zavadskas, E. (1987), *Комплексная оценка и решение ресурсосберегающих решений в гражданском строительстве*, Vilnius, Mokslas, [Complex evaluation and solution of resource-saving decisions in civil engineering, *in Russian*].

Zavadskas, E.K., Mardani, A., Turskis, Z., Jusoh, A., Nor, K.M.D. (2016b), "Development of TOPSIS Method to Solve Complicated Decision-Making Problems: An Overview on Developments from 2000 to 2015", *International Journal of Information Technology & Decision Making*, Vol. 15, No 3, pp.645-682, doi:10.1142/s0219622016300019.

Zavadskas, E.K., Turskis, Z., Tamosaitiene, J. (2008a), "Selection of Construction Project Managers By Applying COPRAS-G Method", *The 8th International Conference "reliability and statistics in transportation and communication*, Riga, RelStat'08, pp. 344-350.

Zavadskas, E., Kaklauskas, A. (1996), "Determination of an efficient contractor by using the new method of multi criteria assessment", in: D.A. Langford (Ed.), *International Symposium for The Organization and Management of Construction. Shaping Theory and Practice*, Vol. 2, pp.94-104.

Zavadskas, E., Kaklauskas, A., Turskis, Z., Tamosaitiene, J. (2008b), "Selection of the effective dwelling house walls by applying attributes values determined at intervals", *Journal of civil engineering and management*, Vol. 14, No 2, pp.85-93.

Zavadskas, E.K., Antucheviciene, J., Turskis, Z., Adeli, H. (2016a), "Hybrid multiple-criteria decision-making methods: A review of applications in engineering", *Scientia Iranica*, Vol. 23, No 1, pp.1-20.

Zavadskas, E.K., Turskis, Z., Kildiene, S. (2014), "State of Art Surveys of Overviews on MCDM/MADM Methods", *Technological and Economic Development of Economy*, Vol. 20, No 1, pp.165-179, doi:10.3846/20294913.2014.892037.

**PORTFELIO OPTIMIZAVIMO STRATEGIJA: COPRAS G-MODM HIBRIDINIS METODAS**

**Moein Beheshti, Hannan Amoozad Mahdiraji, Edmundas Kazimieras Zavadskas**

**SANTRAUKA**

Strateginis planavimas yra nuolatinis procesas, kuris verčia lyderius abejoti valstybės nustatytais reglamentais, aplinkos pokyčiais, naujais mokymosi reikalavimais ir nuolatiniu plano reguliavimu. Nepaisant to, portfelio strategijos optimizavimas šiandien yra vienas iš pagrindinių ginčytinų klausimų. Šiame tyrime siūlomas modelis, kuriuo įvertinamos ir parenkamos organizacinės strategijos, pagrįstos išteklių ribomis. Norint sukurti tokį modelį, visų pirma, taikomas pilkasis COPRAS modelis, kuris leidžia įvertinti organizacijos strategijas esant neaiškioms aplinkybėms. Vėliau, remiantis minėtu metodu, optimizuoto strategijos proceso pasirinkimui naudojamas mišrus sveikasis daugiatikslis tiesinis programavimo modelis. Čia remiamasi COPRAS-G strategijos reikšmių rezultatais atsižvelgiant į laiką, išlaidas ir kitus struktūrinius suvaržymus bei organizacinę politiką. Galiausiai, mišrus COPRAS G-MODM yra transformuojamas į dvejetainį tikslinį programavimo modelį. Siūlomas modelis buvo pritaikytas Irano įmonės "Mercantile Exchange" portfelio strategijos optimizavimui.

*REIKŠMINIAI ŽODŽIAI:* strategijos planavimas, MIP, COPRAS, COPRAS-G.