

APPLICATION OF HYBRID MADM METHODS FOR PERFORMANCE EVALUATION IN MANUFACTURING

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ABSTRACT

The paper is focused on the application of methods of multiple attribute decision making methods and techniques from the perspective of top managers. Attention is paid to the decomposition of multiple-criteria methods of decision making under certainty, which can be used to determine allocation of preferences to criteria, attributes or variables in a wide range of tasks in the field of business economics and management. The goal of the paper is to present a systematic decision making procedure that combines selected multiple attribute decision making (MADM) methods of SAW and COPRAS-G combined with analytic hierarchy process (AHP) for performance evaluation with practical example on performance evaluation in a manufacturing company. AHP is applied to facilitate group decision making among managers and to set their priorities for further performance evaluation.

KEY WORDS

Analytic hierarchy process, multiple attribute decision making, COPRAS-G, performance evaluation.

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Introduction

Decision making is important and significant part of business economics. When a decision making problem occurs, there is usually a limited number of possible variants but also number of criteria according to which the optimal variant is selected. To solve this problem, the multiple attribute decision making methods are usually employed. Set of multiple criteria decision making (MCDM) methods can be divided into two main streams: the multiple attribute decision making (MADM) methods with finite number of alternatives and mathematical optimization linear programming (MOLP). In this case, we concentrate on

the MADM methods that are more convenient for use in decision making problems within the business domain. The MADM methods are well developed and have a strong mathematical basis.

Though, several software solutions are available, they are not among business tools used on daily basis. Non-expert users who deal with relatively complex but straight forward decision making problems should be able to use them more often. When determining the significance of a pair of criteria for the object investigated, an expert should mentally 'weigh' the respective importance of other pairs of the criteria

considered. When the number of criteria is large, it is a challenging problem. Practical application of MADM methods has revealed that only a few experts could avoid contradictions in filling out questionnaires (matrices), on which MADM approach is based. Transitivity of the evaluation criteria is often violated, thus demonstrating the limitations of these methods.

The goal of the paper is present and evaluate a systematic decision making procedure that combines selected multiple attribute decision making (MADM) methods of simple additive weighting (SAW) and complex proportional assessment with grey numbers (COPRAS-G) developed by Zavadskas et al. (2009) combined with analytic hierarchy process (AHP) introduced by Saaty (1980) for performance evaluation with practical example in a manufacturing company. Combination of selected methods is applied to ensure reliable evaluation using qualitative and quantitative data sources as well as subjective and objective preferences. AHP is applied to facilitate group decision making among managers and to set their priorities for further performance evaluation.

The paper is structured as follows. The first part deals with up to date research in the field of MADM methods application in the field of performance evaluation. Next part shortly introduces selected MADM methods and the novel systematic decision making procedure for performance evaluation. In the third part an application of proposed approach in a manufacturing company is performed. The fourth part deals with discussion of results. In the conclusion, the findings are summarized to make suggestions for application of MADM methods in performance evaluation and in general.

1. Performance evaluation with AHP and other MADM methods

In today's competitive world it is very important to build on the competitive activities of business. Companies today must think about their business strategy, especially now in the turbulent times. Businesses are having a difficult period when long term strategies are hard to establish. Large numbers of firms have their own vision and mission but means of getting towards them are hard to implement (Clinton et al. 2002; Pan 2006). Strategic thinking must adapt. It is necessary to evaluate more variables then before but at the same time the schedules and resources are stretched and product cycles are also getting shorter. Strategic decisions can be divided into development (growth) and maintaining. Developmental decision sets a new direction for the organization and have a dynamic character. In contrast maintaining decisions are focused on maintaining the existing organizational activities. This does not mean that they are simpler and less important. Therefore, differ only in the nature of its definition. Simon (1993) identified three basic skills for strategic decision making:

- predicting the shape of the future;
- creation of alternatives applicable in a constantly changing environment,
- the ability to quickly and efficiently implement a strategic decision to transfer planning.

The actual decision is based on correct and comprehensive formulation of the problem. If a management underestimates this stage, it can suffer from bad decisions due to inaccurate selection criteria and alternatives. Finally, the conditions in which the decision is taken must be given, to preserve the context and the possibility of control. To solve decision making problems in

management and business, the multiple attribute decision making methods (MADM) are usually employed. The popularity of MADM application has risen in recent times (Ishizaka, Labib 2011; Zavadskas et al. 2014; Yildiz, Yayla 2015). It has been successfully applied in many management decision making problems, for example SWOT analysis, Balanced Scorecard (BSC), benchmarking, strategic planning etc. Set of MADM methods can be divided into two main streams: problems with finite number of alternatives and mathematical programming. In this case, we will concentrate on the MADM methods that are more practical in use for decision making problems in business. In recent years, there has been a shift towards more frequent use of decision support tools and methods see (Velmurugan, Narayanasamy 2009). Unfortunately, their implementation is still not widespread among small and medium sized companies. There have been efforts to implement more innovative tools to firms but they are mostly used for supportive tasks not for actual decision making (Mertins et al. 2011). The analytic hierarchy process (AHP) and analytic network process (ANP) can be named among the most commonly used and reviewed. These methods represent a group of decomposition multiple attribute decision making approaches that were developed by Saaty (1980, 1996) and Saaty and Vargas (2006). However, their use is limited when it comes to number of criteria or alternatives. Other scholars have concentrated their efforts on methods that can deal with larger numbers of criteria and alternatives. When there is a need for relatively quick ranking and ordering of items decision makers can rely on methods like step-wise weight assessment ratio analysis (SWARA) and COPRAS-G. In these methods, each decision maker chooses the importance of each criterion. Then all

decision makers rank the criteria from the first to the last one. The overall ranks to the group of decision makers are determined per the average value of ranks (Zavadskas et al. 2009). SWARA method is uncomplicated and managers can easily work with it. The main advantage of this method in decision making is that in some problems, priorities are defined based on policies of companies or countries and there aren't any needs for evaluation to rank criteria. When the ranking is already known from previous analysis or decision making, then SWARA can be useful for some issues that priorities are known. The main advantage of this approach is that its user could directly input judgment data without any previous mathematical calculations and make a list of alternatives that share similar properties.

MADM methods with pair-wise comparisons facilitate decision making process and evaluation of used factors in a way that allows them to provide transparent and more reliable solutions. In this case pair-wise comparison can serve as a tool and is base for AHP and ANP as well as for example DEMATEL method developed by Fontela and Gabus (1976). The user must break down difficult and complex decisions into small judgments. However, when the number of comparisons is large, it is very time consuming to provide pair-wise judgments for all combinations. This discourages most managers. In the period when there is a shortage of resources and time they are not willing to accept further difficulty. The aim is to convince them of MADM advantages and counteract against the shortcomings. Presented methods are also used to facilitate group decisions and to handle conflicting views of decision makers and other stakeholders. Methods of AHP and ANP do not need too much explanation as they are well known and used as well as DEMATEL.

The process of performance evaluation in business deals per se with multidimensional problems. These stretch across the whole business activities (external factors) and organization (internal factors). A top manager or line manager uses a lot of different information sources, both qualitative and quantitative, and must perform subjective and objective judgments. In this case, he/she needs a tool which can be used for evaluation of particular situation or in decision making combining all aspects. Multiple attribute decision making methods can be used as tools which can encapsulate both types of factors and both types of information (Tzeng, Huang 2011). Further, they can prioritize these factors and based on the also select a group of most favorable alternatives. MADM methods can also serve as a basis for more transparent and traceable decision making and can also be considered for group decision making.

ANP model proved to be more indecisive when the priorities were more equally distributed among alternatives as mentioned in application on Porter's Five Forces analysis (Franek, Kresta 2013) or SWOT analysis (Franek, Zmeskal 2013).

Both hierarchical AHP and network ANP methods are combined in case of firm's evaluation using BSC or in implementation of Balanced Scorecard (BSC) measures within an organization (Reisinger et al. 2003). In this study authors use AHP for allocation of weights when implementing the BSC. The whole structure follows BSC measures and it has four levels. This application shows advantages of such approach. The AHP/ANP methodological fundamentals help to achieve more accurate allocation of priorities among large number of different measures. On the other hand, demands on time when designing and executing the whole process meant that this could not be effectively applied on regular

basis. Another type of application which has been investigated is strategy selection based on BSC model using AHP/ANP decision making methodology. This is a straightforward process that utilizes BSC measures and dimensions as decision making criteria and business strategic alternatives. In Varma et al. (2008) authors used the AHP for weight allocation and then evaluated the pre-developed strategic alternatives. The result was allocation of priorities among strategies as support information for decision maker. In this case the more thorough decision making process enabled by AHP gives a more objective picture of the decision maker's priorities. In general, the whole BSC-AHP/ANP model consists of up to 7 steps (Saaty 2006):

- mission and goal setting;
- identification of major strategic alternatives;
- definition of score cards per 4 dimensions (BSC perspectives);
- identification of relevant measures in tactical, operative and long-term perspective;
- design of AHP/ANP structure with weight estimation and allocation among measures;
- application of AHP/ANP on identification of priorities among strategic alternatives;
- development of strategy maps according to the results.

Regular use could be recommended. However, it will always need time to convince managers that in this regard the methodology has its merits. Altogether the BSC and AHP/ANP share some characteristics that can be beneficial for further development of their combination in managerial use: multidimensional approach, relatively small number of measures, optimization approach, network model, strategy selection and cohesion, objective decision making, group decision making, transparency.

There are some MCDM models developed for Balance Scorecard. Nevertheless, a question emerges whether they have any justification and whether they represent a contribution to corporate practice. Each of them can be said to have its role as to bring a new view of company performance (Mikusova 2011). According to Saaty (1996), BSC can be designed based on the AHP method because the method is based on problem solving that spans from the spectrum from instant awareness to fully integrated consciousness by organizing perception, judgments and feelings into hierarchy of forces which influence decision results. Since it enables its users to decompose the problem into several criteria and sub criteria, it is also possible to use it in selecting and ranking the correct and appropriate measures in BSC.

Various methods exist for subjective weight determination; the simplest ones are linear methods, in which are subjectively determined non-normalized weights of individual criteria in a priori agreed ranking scale. Second group includes so called non-linear methods, e.g. pair-wise comparison, where belongs i.e. Saaty method. In this paper the aforementioned Saaty's method is used. On the other hand, if the criteria can be measured in a comprehensive and reliable way so they can represent true nature of their scope and quantity then the decision maker can rely on "hard" data that represent measurable reality so called objective weight determination. In this case the decision maker can also combine both subjective and objective approaches. In this paper entropy based weight determination is used. This approach is based on Shannon entropy (Shannon 1948). The entropy is based on information theory. It basically measures fluctuations in datasets. The most variable criteria get the highest priority. In this pa-

per, we used this approach on normalized data towards measures of monthly goals that were set by the management. These were measured in percentage of goals met. Overall, the number and strength of relationships between the criteria is not universal and depends on the subjective judgment of the decision maker. If we want to compare the results received with AHP and ANP.

In order to solve the problem of multiple criteria decision making this detailed procedure should be followed:

- specification of the decision making (individual, group),
- definition of the objectives of the decision problem,
- description of the decision situation, problem definition and explanation of the reason for the decision (decision object) – to choose the best alternatives, prioritization, defining the weights,
- decomposition of the problem and creating a hierarchy or a network,
- determination of alternatives (e.g. strategy, products, etc.),
- definition of criteria groups and individual criteria (e.g. factors, attributes, scale),
- graphical representation of the decision problem structure (hierarchy or network),
- a brief description of selected methods (conditions of their use),
- selection of a data standardization method if needed, conversion of the minimization criteria for maximizing (conditions using methods – independence, multicollinearity, etc.),
- selection of an appropriate method for determining weights,
- application of the method on decision making problem,
- a result – record in the table (local and global scales, the calculation of the utility function, the order of the general criteria), presentation of appropriate plot or

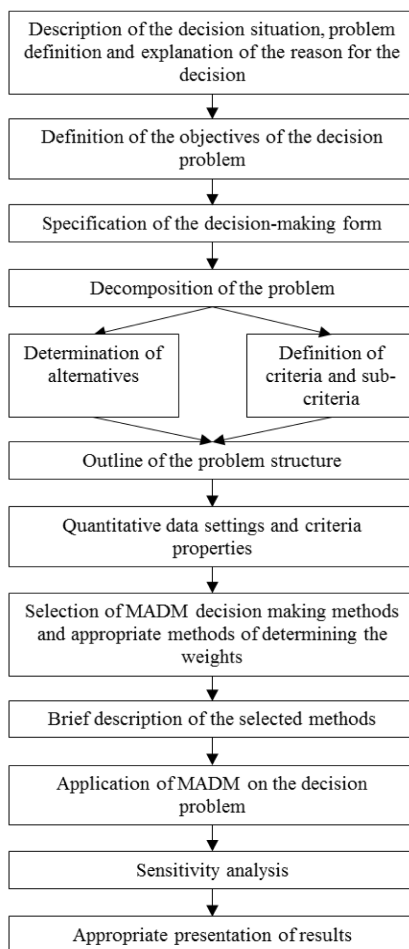
additions to the specified hierarchical structure.

The whole procedure is showed in the Figure 1. The following description of the procedure is also used to analyze the individual applications of AHP and ANP on various decision problems. By that logic we can compare approaches in the use of these methods, which are presented in the literature. Part of the description is also a graphic outline hierarchy, which reveals the author's logic in solving the problem. Especially with ANP method, in which the center of attention for internal feedback is necessary using structure analysis. The following section contains an example of authentication using a combination of methods AHP, SAW and COPRAS-G using subjective and objective weights.

The application is based on enterprise performance evaluation the "Performance Scorecard" from 2013 and their evaluation in comparison with the beginning of 2014. The aim of verification is not only to find causes gaps in performance, but also set the process of performance evaluation using selected methods. The result should be to evaluate performance, identifying key factors and proposals to modify the existing Performance Scorecard. Chapters are sorted according to the general procedure using MADM methods as of Figure 1. This procedure should facilitate decision making process using multiple attribute decision making methods. Results should be discussed and used as a decision support not as precise solutions. MADM methods have their limitations and are based on specific conditions thus the resulting numbers cannot be perceived as precise measurements. However, use of MADM methods such as weight estimation, calculation of scores for ranking of alternatives help the decision maker to better understand and compare several

options before he makes his final decision. The sensitivity analysis also helps to determine the robustness of the final decision and influence of criteria on the result. Appropriate presentation of results means a way how the results should be interpreted and presented for final decision.

Figure 1. General methodological procedure for application of MADM on business and management tasks



Source: Own elaboration.

2. Description of the decision situation, problem definition and object decision

For application and verification of multiple attribute decision making methods of nonlinear decomposition was chosen issue of performance evaluation using enterprise performance evaluation system the "Plant Performance Scorecard", which is used in a medium sized company, which is part of the supply chain in the automotive industry in the Czech Republic. The enterprise has foreign ownership and individual management principles and practices are subject to the parent group. Problem concerns the complex system of evaluation of business performance during the 12 months based on historical data from 2013. The goal is to find the key indicators and reduce the number of those indicators, according to the influence and importance for the final evaluation. Experts have given their subjective evaluation using AHP. The input data for the objective determination of weights, SAW and COPRAS-G methods use nominal value of the Performance Scorecard indicators in the form of current values and values relative to the achievement of goals.

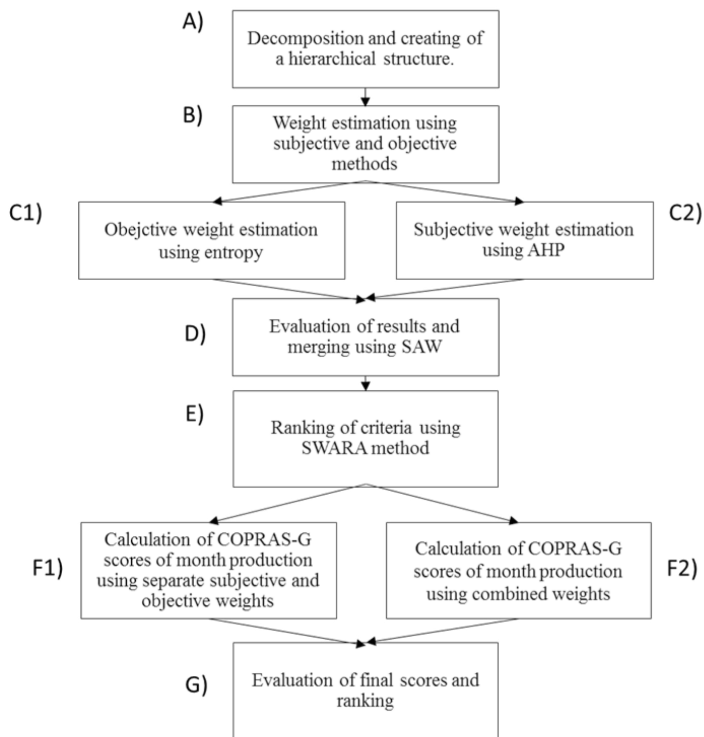
The aim of the decision problem is to evaluate the importance of the performance standards of corporate performance assessment system the "Plant Performance Scorecard" and subsequent comparison of the average of the current state of the target alternative assessment, the maximum attainable alternative minimum acceptable alternative (according to the results of the worst performance of the year) and an alternative based on average ratings:

- assessment of the importance of criteria (performance standards),
- evaluation ranking alternatives – enter-

prise performance status in particular months.

The procedure (Figure 2) is based on theoretical and methodological framework set out in previous section. The basic starting any job is characteristic of the problem and its decomposition to determine the nature of decision making methods, i.e. whether it will be a linear or non-linear case. The following example, the assessment of business performance is perceived as linear due to the parallel nature of evaluation of individual criteria (monitored performance measures). In this case the Performance Scorecard is structured hierarchically into two levels (A). Each level is then pair-wise compared using AHP. Derived weights from AHP are used in SAW as input priorities for ranking and in COPRAS-G for estimation of the final score. The first step is to analyze the nature of the chosen criteria, the decision maker must consider what approach is used to determine the weights (B). There are three options: (i) determining the weights subjectively (C1), (ii) an objective weighting by calculation of the weights from the available information and data (C2), and (iii) a combination of both approaches (D). In this application, all approaches are used and tested, since dataset provided by Plant Performance Scorecard supports all three options. Thus, the decision-maker may use a combination of expert estimation priorities (weights) using pairwise comparison of methods or simple methods of ranking or scoring a direct and objective manner, e.g. the entropy method. Combining the results of both approaches will be represented by subjective expert insight and relies also on the actual value (D).

Figure 2. Methodological application procedure selected MADM methods to evaluate the company's performance using Plant Performance Scorecard



Source: Own elaboration.

Following evaluation of criteria preferences (D) the procedure continues with ranking of criteria using SWARA method (E). To calculate overall scores of monthly productions using different weights the COPRAS-G methods is applied to interval data based on Plant Performance Scorecard (F1 and F2). Finally, the scores of monthly performances ranking are compared and evaluated (G).

3. Application of the proposed decision procedure on performance evaluation

Corporate Performance Scorecard consists of an evaluation of each monthly performance data in these indicators. The

order of performance of the individual months can be evaluated separately using COPRAS-G method. Weights (priorities) that enter the calculation can therefore be used from objective (entropy), subjective (AHP) or combined (SAW) estimation.

The next step is to evaluate options which may now be designed to determine the current position in relation to competitors, members of the supply chain. A variant may also be an organizational unit of the company, which is subject to the same evaluation. Comparing the options is based on an expert evaluation method using AHP.

Overall performance evaluation based on the existing corporate Performance Scorecard using MADM methods provides

a range of results and new information:

- the order of priorities of individual criteria (standards) determined using subjective, objective or a combination of both approaches to determine the weights,
- management receives information about which criteria can be considered as important,
- ranking of monthly performance evaluated based on data (interval or crisp) from the Plant Performance Scorecard using COPRAS-G method. The result gives managers an overview of the company's performance in these months according to different preferences that were allocated to particular criteria. The results can then be compared and analyzed.

Decision makers are represented by a group of executives who are members of the committee, which continuously evaluates business performance using Plant Performance Scorecard, which represents

a set of selected standards, which monitor main production activities of the company and is used to evaluate the objectives set. The group of decision-makers is diverse and provides a subjective decision-making group wide enough range. Group decision was ingested in determining the weights using the method of AHP. All inputs from individual decision-makers (evaluators) in this case only averaged. Distribution of weights among decision-makers were uniform. Decomposition of the problem is based on corporate Performance Scorecard. It consists of the five areas, each of which has assigned benchmarks set by the management of the company. Areas include safety (Safety), product quality (Quality), supply (Delivery), costs (Costs) and human resources (HR). Each area has a different number of monitored metrics and are different in nature and evaluation units.

Table 1. The Plant Performance Scorecard

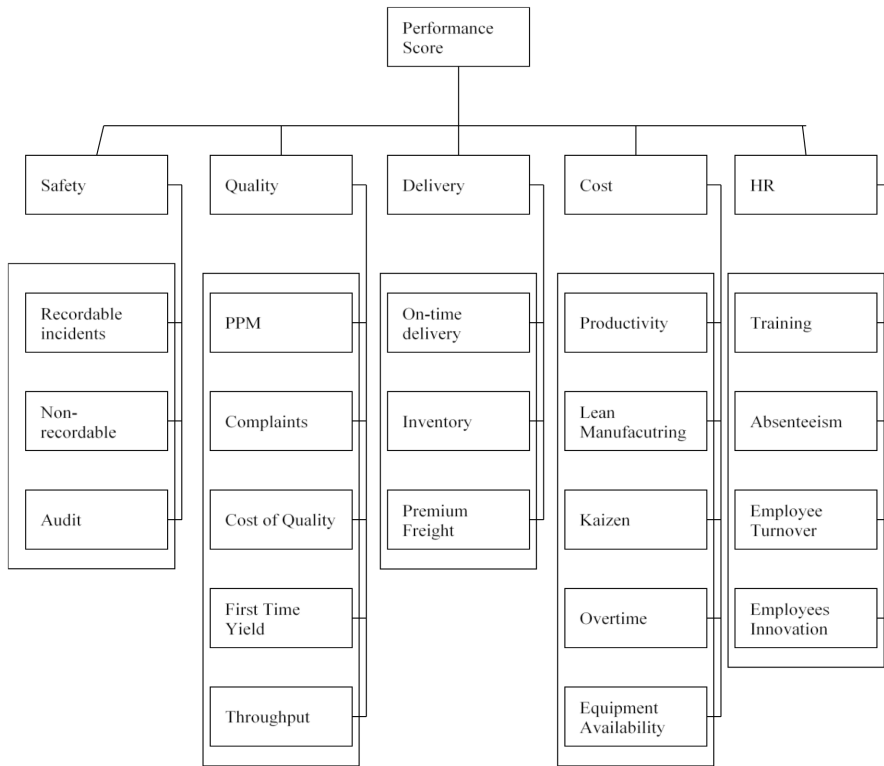
	Safety	Quality	Delivery	Cost	HR
Measures (monthly)	Recordable incidents	Parts per million (PPM)	Just-in-time	Productivity	Training
	Non-recordable incidents	Complaints	Inventory Turns (monthly)	Lean manufacturing	Absenteeism
	Audit	Cost of quality	Premium Freight	Kaizen meeting	Employee turnover
		First Time Yield		Overtime	Employees innovation
		Rolled Throughput		Equipment availability	

Source: Own elaboration.

The plant Performance Scorecard was further assembled into a structure corresponding to the current classification in the company, see Figure 3. It is an objective decision making, which is used to evaluate the performance of the company. Default hierarchical structure has three levels: (i) target, (ii) a set of criteria (iii) individual criteria.

Default hierarchical structure allows decision makers problem decomposition and show the relationships between the different criteria. By default, the hierarchical structure of the criteria is considered independent. Conditions of independence are necessary when using an analytical hierarchical process as a method of deciding or determining weights. System view of the enterprise, however indirectly excludes independence.

Figure 3. Default hierarchical structure Plant Performance Scorecard



Source: Own elaboration.

The Performance Scorecard is based primarily on normalized percentages, when normalization is performed for a given annual targets (100%), this data was used to calculate the weights of objective criteria (criteria). Entropy method was employed to calculate the objective weights, which is robust method for non-homogenous data. This approach was applied to both the overall data of criteria, and data on the entire set of sub-criteria (standards). The resulting values of weights are included in Table 2.

The procedure for determining the combined weights using the method of SAW is described in the following paragraph. It can be concluded that the representa-

tion of scales, which most closely approximates reality regarding personal assessment of experts and objective evaluation based on measurable data, it is good to combine these two perspectives. This will serve a simple combination of subjective and objective data using the SAW (Simple Additive Weighting), which can be written as follows:

$$w_{SAW} = \frac{w_{si} \times w_{oi}}{\sum_{i=1}^n w_{si} \times w_{oi}}$$

where w_{SAW} represents the combined weight and w_{si} and w_{oi} are subjective or objective weights i^{th} criteria.

Table 2. Subjective and objective allocation weights of the criteria

Criteria groups	Local weights		Criteria	Global criteria weights		
	Subjective (AHP)	Objective (entropy)		AHP	Objective global weights (entropy)	Combined weights by SAW
Safety	0,0523	0,4585	Recordable incidents	0,0035	0,0512	0,0064
			Non-recordable incidents	0,0114	0,3418	0,1405
			Audit	0,0374	0,1662	0,2234
Quality	0,2012	0,0525	Parts per million (PPM)	0,0838	0,0000	0,0000
			Complaints	0,0096	0,0580	0,0000
			Cost of quality	0,0202	0,0119	0,0000
			First Time Yield	0,0498	0,0000	0,0000
			Rolled Throughput	0,0377	0,0000	0,0000
Delivery	0,4207	0,3074	On-time	0,2948	0,0001	0,0000
			Inventory	0,0850	0,0078	0,0268
			Premium Freight	0,0409	0,1294	0,2975
Cost	0,2448	0,1357	Productivity	0,0890	0,0011	0,0000
			Lean manufacturing	0,0111	0,0001	0,0000
			Kaizen	0,0362	0,0000	0,0000
			Overtime	0,0196	0,2425	0,0000
			Equipment availability	0,0890	0,0004	0,0021
HR	0,0811	0,0460	Training	0,0373	0,0143	0,0562
			Absenteeism	0,0054	0,0264	0,2467
			Employee turnover	0,0121	0,0000	0,0000
			Improvement program	0,0264	0,0001	0,0003

Source: Own elaboration.

We have performed three weights calculations: based on subjective methods of AHP, objective methods of entropy and combination of both approaches.

The resulting local scales by objective and subjective approach is significantly different in sequence and values (Table 2). Expert view of the importance of the criteria (standards) prefers timely delivery (Delivery), cost (Cost) and quality (Quality). Objective approach based on measurable data, however, emphasize safety (Safety), followed by delivery (Delivery) and cost (Cost). Objective approach represents actual performance against plan failures, but cannot fully represent the views of managers and their perception of the situation according to experience and general corporate preferences.

A similar contradiction is also at the individual local evaluation criteria. Objec-

tive global weights replicate the values of weights corresponding to individual groups. Weight (priority) obtained by the AHP is consistent. Global weights estimated using AHP show the highest preference for timely deliveries (On-time), productivity (Productivity), availability of equipment (Equipment) and inventories (Inventory).

The combination of subjective and objective perspective by SAW, then provides a compromise view. The highest value is determined for additional supplies (Premium Freight), absence (Absence), safety audit (Audit) and failing to accidents (Non-Recordable Incidents). This solution, i.e. the distribution of preferences, represents the objective occurrence of deficiencies according to the preferences of entropy and subjective preference, i.e. experts evaluated criteria.

4. Evaluation of the order of business performance according to Plant Performance Scorecard using methods COPRAS-G method

Interval data have been used to determine the objective weights using the method of entropy. Evaluation at the corporate level is at present carried out according to the average achieved values of standardized benchmarks to set goals. Multiple criteria method of COPRAS-G can be used to evaluate the performance of each month using preferences (weights) provided by experts (representatives of management) and monthly values of criteria (criteria) in those months (evaluated alternatives). To calculate and determine the sequence of monthly performance status (months) were used per the weights set by AHP, entropy and combinations thereof (w_{SAW}). Results of calculations for COPRAS-G method using different types of weights are presented in Table 4.

The resulting ranking (where 0 is the best value) of monthly performance is arranged according to the values calculated using the combined weights w_{SAW} . Results of the two weighting methods are substantially identical, except for the third and ninth month. The best performance is achieved in the 5th, 6th and 1st month, but the difference in values is not very dramatic. If we compare the results using the subjective weights from AHP and entropy separately, the results differ more by virtue of using subjective and objective approaches.

Table 4. Evaluation order of months using COPRAS-G method

COPRAS-G			
Months	AHP (Qj)	Entropy (Qj)	wSAW (Qj)
5	0,0077	0	0
6	0	0,0784	0,0058
1	0,1105	0,0215	0,0303
10	0,2400	0,3342	0,1861
7	0,0710	0,6905	0,3798
4	0,6720	0,7412	0,5515
3	0,3335	0,4998	0,6361
8	0,7379	0,3460	0,6780
2	0,5118	0,3339	0,7127
9	0,9708	0,1813	0,7668
11	0,3751	0,9417	0,8854
12	0,3344	1	1

Source: Own elaboration.

According to the expert preferences (subjective weighting) ranking using COPRAS-G, the 7th and 11th month are ranked very differently in comparison with objective scales. Hence the large difference between ranking with subjective and objective weighting can be assessed by Pearson correlation, which is 0,175. This suggests very low correlation. However, the ranking of the 1st, 5th, 6th and 10th month is comparable using all three methods of weighting.

Conclusions

The goal of this paper was to evaluate novel method of COPRAS-G and also to discuss use of different weighting methods that can be applied in performance evaluation. Practical applications are often associated with more levels, criteria and constraints. We can identify four basic areas using MADM methods. The first one is to estimate relative, subjective or objective weights (importance, preferences, priorities) between the factors and criteria that are based on the original concept or model. In this case, the process management model and methods in a hierarchical structure solved by the method of AHP, which

is supplemented by SAW and COPRAS-G. The second method of application is aimed at establishing an order of priorities selected factors or strategic alternatives. The base is setting a decision-making goal, usually a choice of the best strategy option (in the case of SWOT analysis, Porter's analysis of competitive forces), appropriate indicators (measures) or areas for further improvement (Balanced Scorecard). The aim is to estimate the relative priorities chosen alternatives/options. On this basis, the manager (user) can decide on further action. There is no consensus among the chosen methods. It all depends on the conditions and requirements that the manager puts on the selected method. Finally, the fourth way of using MADM methods is in examination of an industry organization. This is an extension of the analytical properties of managerial methods and models. Based on reviewed studies the AHP can be recommended for simple operational decision problems. Comprehensive strategic decision-making and evaluation should be done using ANP. The ANP in the form of super matrix is better able to capture the essence of strategic management and decision-making. Emphasis must be placed on the logical interpretation of found links between internal factors and indicators of managerial model or method. We also cannot forget the area of group decision making, which specifics have a big impact on the use of multiple criteria decision making methods in determining the preferences and priorities.

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