APPLYING MULTICRITERIA DECISION AID IN A WEIGHTED BALANCED SCORECARD METHOD FOR SUPPORTING DECISION MAKING IN CHANGE MANAGEMENT

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Abstract

The Balance Scorecard (BSc) constitutes one of the most important tools developed in recent years supporting the strategic planning and change management of large firms and organisations. The main advantages of BSc are that: a) provides a multi-dimensional measurement system for organizational success based on the four pillars (Financial, Customers, Internal process and Learning and Innovation) which are further analysed in objectives, indices, goals and actions, b) supports the linking of the four pillars with the strategic vision and business goals, c) a value system of indices is developed aiding the top management to track the achievements according to the desired progress. This research work presents the utilization of the Multicirteria Decision Aid WAP method into the BSc in order to identify priorities of the objectives expressed in weight vectors at each BSc level. The WAP method could estimate robust weight vectors in regards with the preferences of the Decision Maker (DM), requiring limited preference information and utilizing Linear Programming techniques. The proposed enrichment of the BSC method with weight vectors from the WAP method has advantages since: a) the preferences of the DM according to the strategic goals are taken into consideration, b) provides flexibility to handle the changes process while can be adapted according to the DM attitudes, c) enriches the rationality of the value system while the weights vectors are reflecting the DM preferences eliminating the arbitrary, d) supports the decision making process for the appropriate action plan selection to be adopted increasing the effectiveness of the change management. The proposed methodological adaptation of the BSc is illustrated through a real world case study concerning a large firm which is attainting to expand in other international markets.

Keywords: Change Management, Balanced Scorecard, Multicriteria Decision Aid

1. INTRODUCTION

Change management constitutes a continuous and required process for the survival and improvement of organisations and enterprises. The systemic theoretical framework provide tools to handle the complexity of multidimensional structures in real world economical and organisational systems through the analysis and study of the system components and their interrelation (Kellert, 1993). These systemic based tools have been applied in a wide range of complex cases such as political science, management, economics, sociology (Kaplan and Norton, 1993). The core issue of the systemic approaches refers to the understanding of systems behavior as a whole and simultaneously to the analysis and description of the interactivities between the discrete separate modules of the whole system under the dynamic operational environment conditions (Kaplan and Norton, 1992). The aims of the systemic approaches are focused on the identification and recognition of the bottlenecks into the systems operation and the picturing of the degrees of freedom or interrelations among the components of the system (Laitinen, 2002). The deep and clear knowledge of the systems make effective their management in the continuous changing and dynamic environment. Heraclitus said that everything is flowing (Montanari et al., 2013).

In the business environment, change management is a continuous process with high degree of complexity and ambiguity, while requires:

- A predesigned action plan to be followed in order to achieve the predefined change management goals.

- A continuous inspect of the factors influencing the effective function of the firm, which are related to the actions planning.
- The handling of many conflicting factors to keep balance among them.
- The recognisition and comprehension of the factors nature in regards with the action change plan, the achievements, the dynamic internal and external environment and the convergence among them.
- The identification and design of feedbacks to be taken, in order to track the progress, keep it on the path and discover new alternative routes.

Balanced Scorecard (BSc) is a methodological frame to support the changing process in modern businesses, providing tools which allow executives and Decision Makers (DMs) to identify ways to handle the complicate changing processes. The backbone of BSc is the value system which is established in a way to provide an overall view of the business success, through a set of measurements in predefined key points of view. The core of the BSc is linked with the vision and the strategy of the organisation which is accompanied by the four pillars: a) financial issues, b) customers, c) internal processes, d) learning and innovation (Kaplan and Norton, 1996a, 1996b). For every pillar is used a limited set of representative ratios and indexes reflecting points of view related to critical achievements and target goals. The set of ratios or indices used for every pillar imprints the results from the overall business operation at the crucial related components. In addition every ratio or index is using the initial business status, the aims and goals identified by the management according to the strategic plan and the future perspectives. The achievements in regards with these aims and goals are related to a set of actions which are implemented accordingly to efficiently achieve them. Another crucial point for the effective implementation of BSc is the identification and analysis of the interrelations among the four pillars, while the change into one usually affects in a non-linear form the others.

BSc method has been widely used in the last decades by many firms and public organisations constituting the backbone of their operational management system and the means to track their development changes. The strategic planning can be modeled into a value system by the precise identification of the business goals to be achieved regards to the points of view related with the four pillars. The BSc proposed by Kaplan and Norton (1992) handles these different points of view and links them to a value system in an un-weighted way by considering these parameters having the same relevant importance. However, in the real world has been proven that the different points of view are not equally important. The value system is unique for each case and is defined by the external environment, the business targets and the preferences of the top management. This discrimination of the relative importance among the elements of the BSc have been also recognized by others researchers such as Delias et al. (2008), Ferreira, (2013) and Grigoroudis et al. (2012). Kunz et al. (2016) in their work state that "Value-focused thinking is a decision-making philosophy that fits perfectly with Balanced Scorecard creation" and they propose a procedure for analysts by combining the Balanced Scorecard with value-focused thinking in order to preserve each concept's strengths. One important axiom used in the MCDA that could strengthen the Balanced Scorecard creation is the required consistency conditions for the used set of indices and ratios (Roy, 1985) where: a) for every index or ratio must be clear the monotonicity of the preference b) every point of view related to pillars and the change attitudes must be expressed in the set of indices and ratios and c) ought to be achieved a satisfactory level of mutual independency of the indices and ratios.

Multicriteria Decision Aid (MCDA) Analysis approaches provide the methodological frame to identify the factors influencing the decision making and estimate the relative importance among the criteria by taking into account the preference structure of the DM. A considerable number of research works have been done the last years in order to link the BSc approach with MCDA in order to fulfill the need to distinguish the importance among the pillars and create a more reliable value system to measure the achievements to the goals. The most common used approaches are based on Analytic Hierarchical process (AHP) method (Cebeci, 2009; DeWayne, 2004; Feili et al., 2011; Fletcher and Smith, 2004; Karra and Papadopoulos, 2005; Lee et al., 2008; Pérez et al., 2017; Reisinger et al., 2003) or Analytic Network Process (ANP) method (Bhattacharya et al., 2014; Leung et al., 2006; Santos et al., 2015; Tavana et al., 2013; Yüksel and Dağdeviren, 2010). Generally, the AHP is based on a hierarchy which on the top level is the target goals, the next levels are the criteria and sub-criteria and at the last level is the alternatives to be evaluated (Saaty, 1980), while the ANP is structured as a network (Saaty, 1996). For both of them a value system is estimated by using pair wise comparisons based on a 9^{th} levels scale together with eigenvalue techniques. The priorities of each element on the different hierarchical levels are

assessed leading to the estimation of the overall priorities on the alternatives. Method of AHP can be easily implemented but there are a lot of arguments (Bana e Costa and Vansnick, 2008) concerning the precise of the results as well as its flexibility to be used in a environment which requires continuous adaptations (Siskos and Spyridakos, 1999), while AHP required a lot of preference information through the pair-wise comparison. One interesting work combining MCDA with Balanced Scorecard is done by Grigoroudis et al. (2012) in which Key Performance Indicators (KPIs) values system was developed incorporating MCDA UTASTAR method into the BSc model.

This paper present a MCDA approach for the estimation of the relative significance of the factors involved into the BSc by incorporating the capabilities provided by the Weights Assessment through Prioritisations (WAP) method (Tsotsolas et al., 2016). WAP provides an easy and flexible way to model the preference of the DMs and estimate weight vectors for the BSc value system which are reflecting the vision, the strategy, the external environment conditions and the DM preferences. The proposed approach ensures the extraction of the DM preferences with a friendly and interactive way to support their decisions in regards with the target goals and the action planning.

The paper includes the introduction and five more sections. The second section presents the main features of the BSc method while in section three the WAP method for the estimation of the weights vectors is presented. Then, in the fourth section the proposed weighted BSc approach is analysed and is illustrated in the next section through a real world case study. The last section includes the conclusion together with future perspectives in the change management field.

2. THE BALANCED SCORECARD METHOD AND CHANGE MANAGEMENT

Over the last years, one of the most widely used methodological approaches to review and manage the change in firms and organizations are based on BSc (Hoque, 2014). BSc approaches are usually accompanied with other methodological frames such as S.W.O.T analysis, Strategic Maps (Kaplan and Norton, 2005), Polarity Management (Johnson, 2014) in order to support the top management on the initial stages, reviewing the change progress process and identification of actions to be implemented keeping the firm on the designed path of change. S.W.O.T. analysis is a strategic planning tool aiding the DM to record the internal strengths and weaknesses together with the external opportunities and threats in order to design the appropriate future business strategy. Kaplan and Norton (2008a, 2008b) in their work suggests the link between BSc and an organisational strategy map as an important step for ensuring and increasing the business effectiveness.

The BSc method proposes the utilisation of a limited set of indices and ratios expressing and reflecting the important points of the discrete four pillars (Financial, Internal Process, Learning and Innovation and Customer or Beneficiaries) as well as their interactions in relation to the vision and the goals of the changing process (Niven, 2006). The set of indices or ratios selected to be used in BSc in every case depends on the nature of the firm or organisation, the sector, the goals and aims of the change process, the vision and the strategic plan and is the result of a laborious and complicated study. The aims and the goals of the change process is mapped into specific values into the BSc set of indices and ratios which are linked with actions to be implemented in order to achieve them in specific time horizon. So for every pillar a structure is constructed with the objectives and purposes of the changing process, the indices and ratios which can evaluate the degree of the corresponding success, the initial and the expected (goal) values, the current values and the actions to be taken in order to meet the expected achievements.

Actually, BSc leads to the determination of a structured value system for monitoring the change and support the decision as far as the management of the effective implementation of the change process and achievements. This value system is consisting of: a) the objectives to be achieved by the Change process in time milestones, b) the indices and ratios to be used for the evaluation of the change achievements, c) the initial values of the indices and ratios, d) the expected values of the indices and ratios in the time milestones, e) the achieved values for every milestone, f) the action to be implemented in order to ensure success of the specific objectives.

Although the BSc methodology has been considered a useful approach by practitioners and researchers, there are several criticism points. One of them is related to the exhaustiveness of the four pillars as many scholars have pointed out that the environmental and social directions are usually ignored as important aspects in the

original BSc and propose an expansion of the method by adding sustainability direction in the analysis (Butler et al., 2011; Kalender and Vayvay, 2016; Rabbani et al., 2014). Also, some researchers have been questioned the claims of causality in the relationships between the four pillars (Norreklit, 2000) , while others supports it (Yu et al., 2008). Finally, the exploitation of BSc in many cases rises up the need to take into consideration the priorities of the firm's top management according to the strategic plans which is described as difficult process (Chenhall and Langfield-Smith, 2007; Hoque, 2014). This work contributes to that by proposing a methodology for the estimations of business priorities.

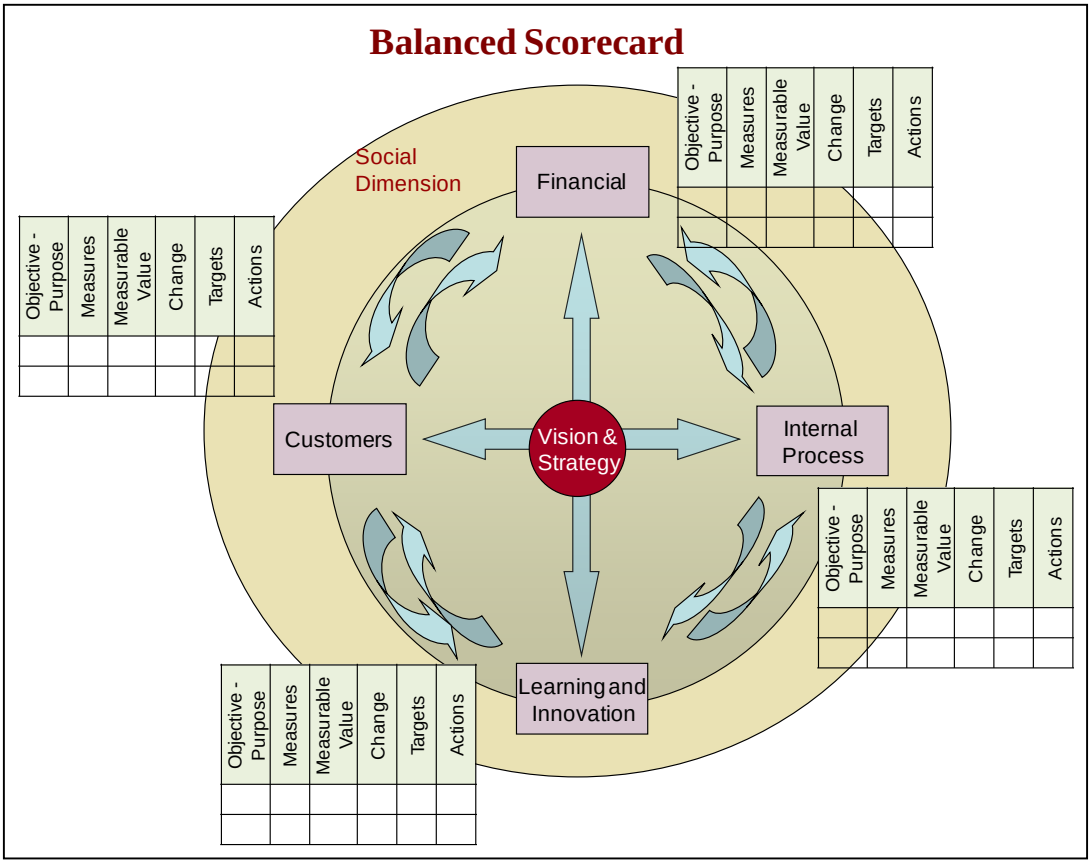

Figure 3: The balanced scorecard developed by Kaplan and Norton (1992).

3. THE WAP METHOD (MULTICRITERIA APPROACH FOR PRIORIZATION)

The MCDA includes a set of techniques and methodological approaches for the estimation of the criteria weights reflecting the DMs' preferences. The weights of the criteria (consistent family of criteria) are used by the most MCDA methods for discrete alternatives such as the ELECTRE methods (Roy, 1990) of the outranking relation methodological frame, the MultiAttribute Utility Theory - MAUT (Fishburn, 1970; Keeney and Raiffa, 1976), the Disaggregation - Aggregation approach (Jacquet-Lagreze and Siskos, 1982; Bana e Costa and Vansnick, 1994). The most popular for the estimation of criteria weights are the Simos technique (Figueira and Roy, 2002; Simos, 1990a, 1990b), the compensatory technique used in MAUT (Keeney and Raiffa, 1976), AHP (Saaty, 1980) and the WAP method (Tsotsolas et al., 2016).

Tsotsolas et al. (2016) proposed the WAP method in order to provide a more structured and robust approach for the estimation of the criteria relevant importance. The method utilizes visual tools and linear programming techniques to assess the weight vector w_i, i=1, 2, ..., n for a consistent family of n criteria expressed by the following formulae:

w_i, $i = 1, 2, n$, where n the number of criteria and $0 \le w_i \le 1$

$$\sum_{i=1}^{n} w_i = 1$$

The estimation of the criteria weights is based on two crucial preference information expressed by the DMs. The first one concerns the priorities of the criteria which are expressed by the rank-ordering of the criteria in classes of importance from the most importance to the less. The second is related with the relative importance of the criteria for the decision making which is expressed through the indices of $z_r = w_r/w_{r+1}$. The z indices are identified for every pair of successive criteria or sets of ex aequo criteria sorted by their ranking. An important feature of the WAP method is that it is not required a precise identification of the z indices but a range $[zmin_r, zmax_r]$ where the value of z_r can vary. For two successive criteria or set of ex aequo criteria, (ie. g_r, g_{r+1}) the range $[zmin_r, zmax_r]$ is identified so as $zmin_r \le z_r \le zmax_r$. In order to support the DM to identify these ranges of values, a visual interactive techniques have been developed and implemented in special software where the DM is asked to identify in a double bar graph how much he/she believes that the higher ranked criterion is more important than the next in the ranking order. The proposed approach progresses with the following steps (Figure 2):

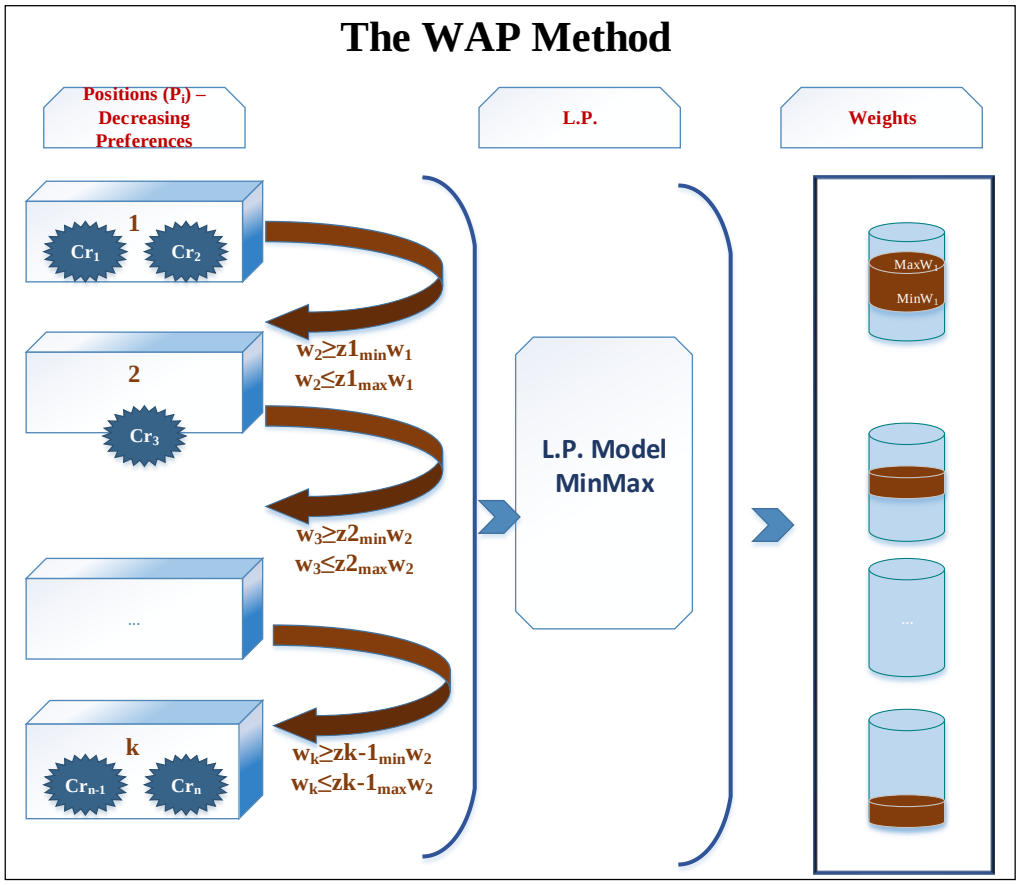

Figure 2: Simplified diagram of the WAP method.

- DMs rank order the criteria and the ex aequo sets of criteria in a pair wise manner. So, the DMs are asked to sort the n criteria into m classes ($m \le n$). Every class includes one criterion or a set of ex aequo criteria.
- With the aid of visual techniques the DM articulates the ranges of the relative importance between two commencing criteria or set of ex aequo criteria concluding to the identification of the ranges $[zmin_r, zmax_r]$. Figure 3 presents the way the limits of the z_r index range are identified by the DM. Scroll bars are used to assist the visualization of the difference of the relative importance between two successive criteria or ex

aequo sets of criteria. The $zmin_r$ and $zmax_r$ values are automatically calculated and presented with bars and special labels.

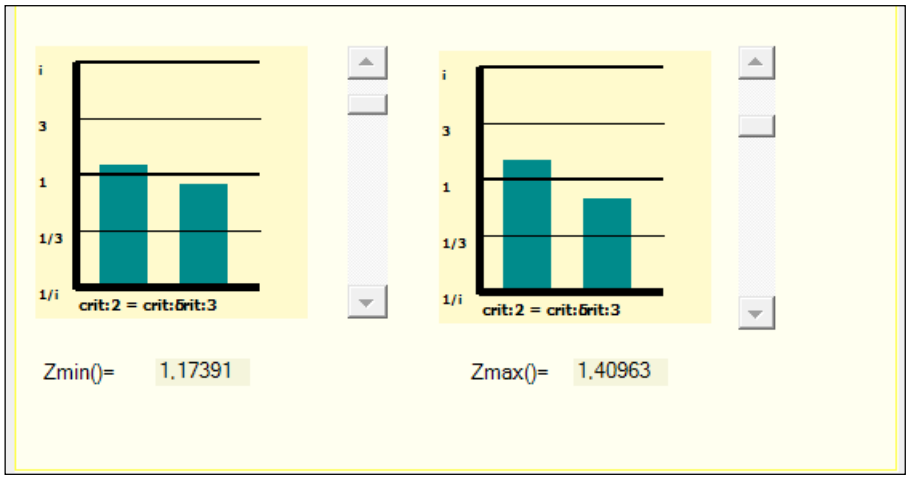

Figure 3: Double Bars Graph for the identification of the zmin and zmax.

- Having identified the zmin and zmax for all the pairs of the successive classes the following 2n Linear Programming problems are constructed and solved.

  $\text{Min } p_i \ \& \ \text{Max } p_i, \ \text{for } i = 1, 2, ..., n$

  s.t.

  - $p_i - p_{i+1} = 0$, if g_{i+1} is followed by g_i and g_{i+1} belongs to the same importance class (j) as g_i
  - $p_i - p_{i+1} \geq z\min_j$, $p_i - p_{i+1} \leq z\max_j$ if g_i is followed by g_{i+1}, g_i belongs to most importance class (j) as g_i and g_{i+1} belongs to class $j+1$
  - $p_1 + p_2 + ... + p_n = 1, \ p_1 \geq 0, \ p_2 \geq 0, \ ..., \ p_n \geq 0$

  Actually, the solutions emerging from the above LPs will lead to the identification of the minimum and maximum values of the criteria weights bordered by the m-dimensional hyper-polyhedron of the weights vectors satisfying the DM's preferences.
- The robustness of the estimated hyper-polyhedron is calculated through the utilization of two indices. The first type of indices used is the range between the maximum and minimum values of the criteria weights for every criterion,

  $\mu_i = (\max(p_{ij}) - \min(p_{ij}))$, p_{ij} the weight of the i criterion of the j, where $i = 1,2,...,n, \ j = 1,2,...,m,$

  n : the number of criteria and m : the number of vertices of hyper – polyhedron

  The indices μ_i provide a picture, at first glance, of the extent of robustness in each criterion. The second index used represents the normalized standard deviation of the different solutions corresponding to the hyper-polyhedron vertices, where the value 1 corresponds to total robustness of the preference models. This normalized index is called Average Stability Index (ASI) (Grigoroudis and Siskos, 2002) and is given by the following formula:

  $$ASI = 1 - \frac{\sum_{i=1}^{n} \sqrt{\left(m\left(\sum_{j=1}^{m} \left(p_i^j\right)^2 \right) - \left(\sum_{j=1}^{m} p_i^j \right)^2 \right)}}{m\sqrt{(n-1)}}, \ n: \text{number of criteria}, \ m: \text{number of hyper - polyhedron vertices}$$
- Following, the barycenter (the mean value of weights of every criterion) is estimated. If the values of the barycenter are considered as satisfactory by the DM along with the level of robustness, then it can be used

as a working vector of weights for the next steps. Otherwise, there are two main capabilities provided by the proposed approach. The first focuses on updating or altering certain initial preferences, such as the values of the zmin and zmax or the criteria ranking. The second capability concerns a set of feedbacks, triggered by the robustness analysis utilising the tomographical approach (Spyridakos et al., 2015) and the acqiosition of additional preference information, leading to a hyper-polyhedron with higher levels of robustness.

4. WEIGHTED BALANCED SCORECARD APPROACH

The proposed approach in this research is focused on the development of a weighted BSc (WBSc) based on the WAP method. WAP method was selected because provides a structured frame to estimate weights of the criteria with high level of robustness without:

- the assumption and simplification of Simos technique (Siskos and Tsotsolas, 2015)
- the complexity and demanding preference information which are used in MAUT, AHP, and MACKBETH
- the need to use global preferences on the alternative actions or a reference set of alternative actions.

The proposed methodological frame incorporates into BSc structured value system weight of the ratio and indices on each Pillar together and the weights among the Pillars. So the structured value system of BSc includes

- The four Pillars of BSc approach (Financial Aspects, Internal Process, Customer Beneficiary, Learning and Innovation).
- The measures (indices or rates) (r_{ij}) grouped per pillar (not more than five per pillar) evaluating a specific points of view of the change management aims.
- The weights of the Pillars (W_i, i = 1, 2, 3, 4) picturing the relative importance of the Pillars as far as the aims of change management to be achieved, for which $W_1+W_2+W_3+W_4=1$.
- The weight of every measure (points of view) (w_{ij}) included into the pillars for which, $\sum_{j=1}^{n_i} w_{ij} = 1,\ i = 1,\ ..,\ 4$
- The initial values of the indices and rations (r_{ij}^0)
- The expected values of the indices and ratios in the time milestones (r'_{ij})
- The Achievement Indices Y_i and y_{ij} which are used in order to quantify the degree of achievements of the change in regards with the targets on each Pillars and generally on the total business success.
- The actions to be implemented in order to succeed the specific objectives.

The proposed SWBSc approach is progressed into two separate stages (figure 4). The first initialization stage includes the activities concerning the design and preparation of the Weighted BSc method for the case examined. The second stage (evaluation and feedbacks) is triggered periodically during the implementation of the changing process. The frequency of the evaluation and feedbacks is depended on the case examined and the ongoing results of the change management process.

Phase 1- Initialization Stage: The design of the WBSc model is taking place in this stage taking into consideration the vision and the strategy of the firm or organisation together with the planned changes. This process will conclude to the estimation of the main features of the WBSc structured value system. For the estimation of the weights the WAP method is exploited separately for the pillars and for the measures of every pillar. Also, the goals to be achieved at the end of the change are determined and pictured into the target values of the measures (r'_{ij}).

Phase 2 - Evaluation and Feedbacks: The evaluation and feedbacks phase constitute an ongoing process and is triggered by the change management team periodically. The current situation and the achievements are pictured into the current values of measures (r_{ij}) used in the WBSc method. Then, for every measure the degree of the achievements is calculated (y_{ij}) by the formulae.

$$y_{ij} = \frac{r_{ij} - r_{ij}^{0}}{r_{ij}^{'} - r_{ij}^{0}},\ i = 1, \ldots, 4 \text{ and } j = 1, \ldots, n_i,\ r_{ij}$$

Following, the weighted achievement Index for every pillar (R_i) and the total weighted achievement Index (R) are estimated using the following Formulae:

$$R_i = \sum_{i=1}^{n_i} w_{ij} y_{ij}\ ,\ \ j = 1, \ldots, 4$$

$$R = \sum_{i=1}^{4} W_i R_i$$

The analysis of the results of this value system support the picturing and analysis of the degree that the change process is on the path, the divergences and the points to be examined, while delays are obtained. This analysis and the utilisation of a what if analysis process can support the decision aid process to identify feedbacks to be taken, adaptation of the action plan and reconsideration of the goals posed at the initial or a previous evaluation stage.

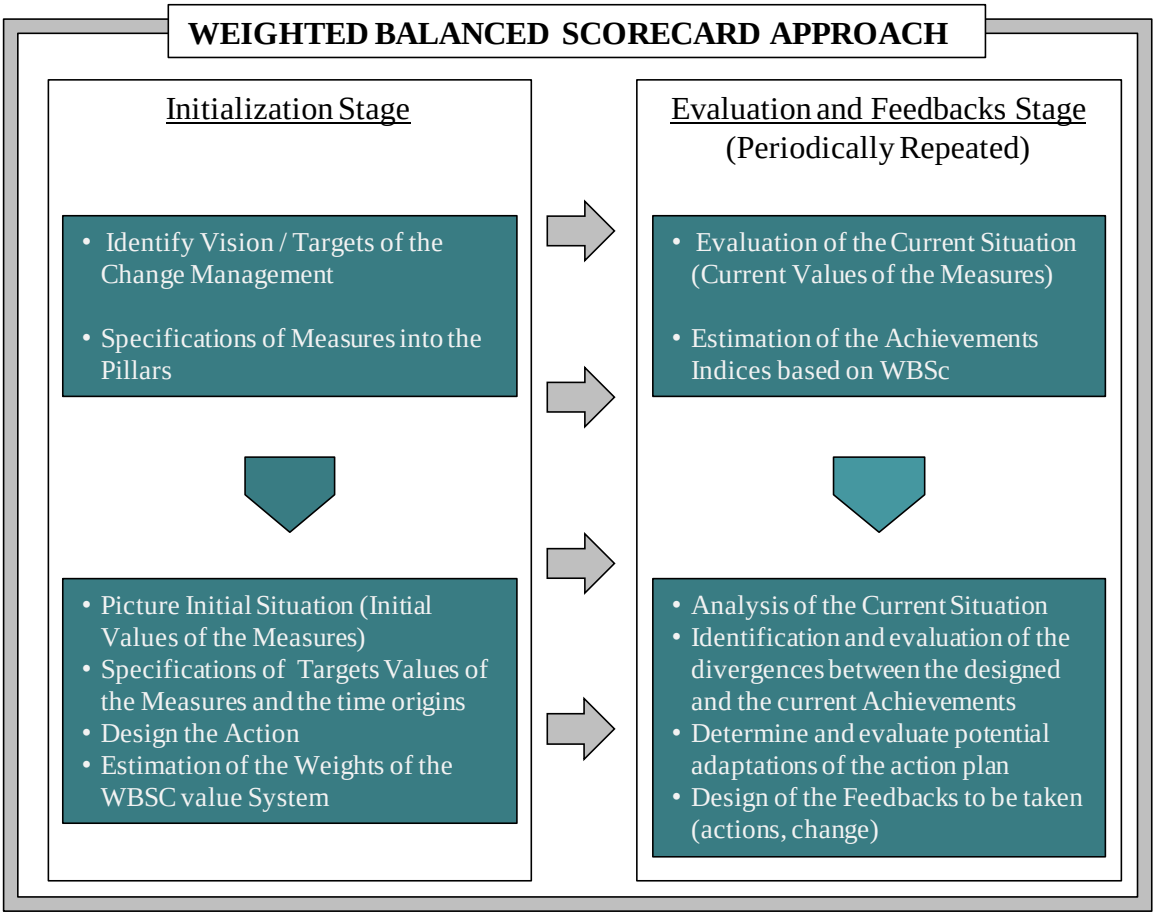

Figure 4: Stages of the proposed Weighted Balanced Scorecard method

5. ILLUSTRATION EXAMPLE

The proposed WBSc method will be illustrated through a real world case study concerning a Greek firm which is a leader in their sector with a main strategic target to expand in other countries of European Union (EU). The firm assets consist of a headquarters office, the production unit, warehouses and 333 stores with more than 1500 employees worldwide. In this case study the structure of weighted BSc has been developed with the cooperation of the top management (Initialization Stage), while the evaluation and feedbacks stage was

implemented using simulation data for illustrative purposes. The complexity and the interrelations among the factors influencing the firm's development is pictured through the simplified strategic map (figure 5), which is provided by the change management team. This simplified strategic map has been used to support the identification of the business objectives and the construction of a value system together with an action plan in WBSc method.

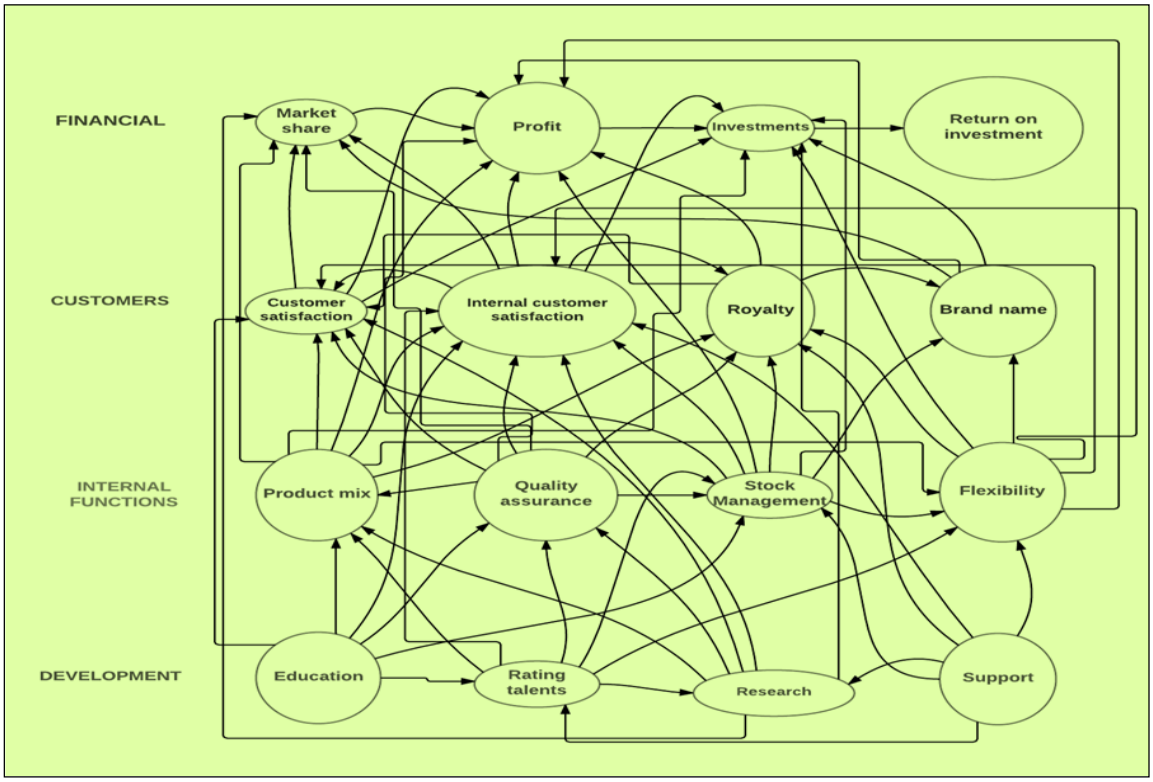

Figure 5: Strategic map of the company (real case study)

The analysis of this information leads to our case in the development of 16 indices for the four pillars. Table 1 presents these indices together with the estimated initial values (r_{ij}^{0}), the target values ($r_{ij}^{'}$) reflecting the top management expectations and the relative actions to be implemented. The developed action plan was based on strategic selections such as investment on innovative products, expanding to national and international markets, improving the quality, customer orientation, improving business efficiency through re-engineering of internal processes and last but not least the implementation of a human resources program.

Table 1: The Structured BSC for the examined case including indices, initial values, goals and actions to be implemented

FINANCIAL DIMENSION				
Objectives and Purposes	Indices	Initial Value (r_{1j}^{0})	Goal ($r_{1j}^{'}$)	Actions
Increase Market Share	Market Share (%)	10	14	• Development of Innovative Products • Develop the Franchises Abroad
Increase Profitability	Net Profit/ Income (%)	8	12	• Maintaining good quality of products • Improvement of Lean production • Incorporate new technologies to business procedures

Investments and Development	Budget R&D / Total Expanses (%)	30	35	• Create new trends and innovative products • Expansion to International market
Return Of Investment	Net Profit/ Capital (%)	20	25	• Investment on new market • Optimize the internal Process (Lean production)
CUSTOMER DIMENSION				
Objectives and Purposes	Indices	Initial Value (r_{2j}^{0})	Goal ($r_{2j}^{'}$)	Actions
Increase Customer Satisfaction	Complains/ costumers (%)	5	3	• Training Staff • Increase of Quality control • Replace old Equipment
Internal customer satisfaction	Average internal customer satisfaction (0-100)	72	78	• Pay-rise of employee • Training the Staff • Enhance the Mental Model with social events
Royalty of customers	Frequent customers/ overall customers (%)	52	60	• Rewards of constant frequent customers
Brand Name	Total number of customers (thousand)	160	200	• Develop of a promotion (tv) • New Logos and promotional material
INTERNAL PROCESS DIMENSION				
Objectives and Purposes	Indices	Initial Value (r_{3j}^{0})	Goal ($r_{3j}^{'}$)	Actions
Product mix	New Products Income / Total Income (%)	12	20	• Introduction of new products according to market needs • Expansion to botanic and other products
Quality Assurance	Product Failure (%)	2	1	• Increase sample checks • Training the production staff
Inventory control	Inventory Cost/Total Cost (%)	6	4	• Optimize the Inventory Cost
Flexibility	Solved problems/operational problems (%)	50	80	• Quality walk to whole company
DEVELOPMENT AND INNOVATION DIMENSION				
Objectives and Purposes	Indices	Initial Value (r_{4j}^{0})	Goal ($r_{4j}^{'}$)	Actions
Staff Specialization	Training hours annually per staff	36	40	• Targeted training sessions
Recruitment	Certified staff/total staff (%)	37	55	• Personnel evaluation • Opened recruitment processes
Research and Development	Research & Innovation Budget/Expanses (%)	7	11	• Cooperation with research institutes • Exploit the R&D external knowledge

Talent support and inspiration	Implemented Employee Proposals / Rational accepted proposals (%)	32	41	• Rewarding Proposals • Enhance human resources practices

In the initialization stage the firm's top management team with the DM analyst cooperation moves forward to the enrichment of the structured BSc value system with their preferences structure estimating weight vectors. Extensive dialogues took place in order to identify the ranking order of the objectives and the ranges of Z indices both required by the WAP method. Table 2 and Table 3 include the ranking, the ranges of Z indices, the estimated weights for each major dimension (W_i) and for the objectives in each pillar (w_{ij}), respectively. These tables constitute the backbone of the proposed structured WBSc method on which will be based the monitoring and the change management process. The estimated ASI indices (table 2 and 3) indicate high level of robustness at all BSc hierarchical levels, while they are varying between 0.972 and 0.9941. This ensures the reliability to utilize the estimated Barycenters as the equivalent weights of BSc elements.

Worth to be mentioned that the higher weight is assessed to the innovation and development dimension (0.351) followed by the internal process dimension (0.259), while the less important one is the financial dimension (0.176). Also, the higher estimated weight for all the objectives across all pillars is referring to the quality assurance (0.421) of internal process pillar followed by the internal customers satisfaction (0.38) of customers pillar, the increase profitability (0.373) of financial pillar and the talent support inspiration (0.3506) of innovation and development pillar. The lower estimated weights are referring to the flexibility of internal process pillar (0.076) and the brand name of the customer's pillar. Additionally, the relevant importance for quality assurance together with the inventory control included in the internal process dimension is equal to (0.737), while the sum of the weights for the objectives concerning the internal and external customer satisfaction included in the customers pillar exceeds the value of 0.70. All the above information is given to the DM in order to justify the rationality of the multi-criteria analysis results according to his preferences and validate the estimated weights with the firm's strategic plan.

Table 2: Pillars ranking, ranges of z values for the successive criteria and the estimated weights.

PILLARS	RANKING	[Zmin - Zmax]	Weights (Barycenter)
INNOVATION AND DEVELOPMENT	1	[1.25, 1.47]	0.351
INTERNAL PROCESS	2	[1.13, 1.30]	0.259
CUSTOMERS	3	[1.15, 1.30]	0.214
FINACIAL	4		0.176
		ASI:	0.982

Table 3: Objectives ranking for each pillar, ranges of z value and the estimated weights.

Pillar	Objectives and Purposes	Ranking	[Zmin - Zmax]	Weights (Barycenter)
FINANCIAL	Increase Profitability	1	[1.174, 1.56]	0.373
	Increase Market Share	2	[1.25, 1.32]	0.275
	Investments and Development	3	[1.44, 1.67]	0.214
	Return Of Investment	4		0.138
			ASI:	0.976
Pillar	**Objectives and Purposes**	**Ranking**	**[Zmin - Zmax]**	**Weights (Barycenter)**
CUS	Internal customer satisfaction	1	[1.13, 1.22]	0.38

	Higher Customer Satisfaction	2	[1.38, 1.94]	0.323
	Royalty of customers	3	[1.633, 2.7]	0.199
	Brand name	4		0.098
			ASI:	0.968
Pillar	**Objectives and Purposes**	**Ranking**	**[Zmin - Zmax]**	**Weights (Barycenter)**
INTERNAL PROCESS	Quality Assurance	1	[1.2, 1.47]	0.421
	Inventory Control	2	[1.38, 2.13]	0.316
	Product mix	3	[2.00, 3.26]	0.187
	Flexibility	4		0.076
			ASI:	0.9705
Pillar	**Objectives and Purposes**	**Ranking**	**[Zmin - Zmax]**	**Weights (Barycenter)**
DEVELOPMENT-INNOVATION	Talent support and inspiration	1	[1.14, 1.25]	0.3506
	Recruitment	2	[1.26, 1.33]	0.254
	Research and development	3	[1.22, 1.27]	0.2194
	Staff Specialization	4		0.176
			ASI:	0.9941

The illustration of the proposed methodological frame for monitoring and management of the changing process will be implemented by using simulation data, which are based on the information close to the reality provided from the top management team. The working scenario is presented in table 4 with the achievements (r_{ij}) and the calculated degree of achievements (y_{ij}) in an interim milestone of the change process. The marginal achievement index Ri and the overall one R are estimated utilising the Weighted BSc value system.

Table 4: Simulation Data for the case examined for a n interim milestone of the change process.

No	**Ratios/ Indices**	**Initial Value r_{ij}^0**	**Target r_{ij}'**	**Achievements r_{ij}**	**% Achievements y_{ij}**	**Weights w_{ij}**	**$w_{ij}y_{ij}$**
1	Increase Profitability	8	12	9.716	0.429	0.373	0.160
2	Increase Market Share	10	14	12	0.50	0.275	0.138
3	Investments and Development	30	35	33.03	0.604	0.214	0.129
4	Return Of Investment	20	25	22.7	0.54	0.138	0.075
FINACIAL (Weight:0.176)						**R_1**	**0.5013**
No	**Ratios/ Indices**	**Initial Value r_{ij}^0**	**Target r_{ij}'**	**Achievements r_{ij}**	**% Achievements y_{ij}**	**Weights w_{ij}**	**$w_{ij}y_{ij}$**

1	Internal Customer Satisfaction	72	78	75.6	0.60	0.38	0.228
2	Increase Customer Satisfaction	5	3	4	0.50	0.323	0.1615
3	Royalty of customers	52	60	53.6	0.20	0.199	0.0398
4	Brand Name	160	200	170	0.25	0.098	0.0245
CUSTOMERS (Weight: 0.214)						**R_2**	**0,4538**
No	**Ratios/ Indices**	**Initial Value r_{ij}^0**	**Target r_{ij}'**	**Achievements r_{ij}**	**% Achievements y_{ij}**	**Weights w_{ij}**	**$w_{ij}y_{ij}$**
1	Quality Assurance	2	1	1.5	0.50	0.421	0.211
2	Inventory control	6	4	5	0.50	0.316	0.158
3	Product mix	12	20	14.66	0.333	0.187	0.062
4	Flexibility	50	80	70	0.667	0.076	0.051
INTERNAL PROCESS (Weight: 0.259)						**R_3**	**0.4813**
No	**Ratios/ Indices**	**Initial Value r_{ij}^0**	**Target r_{ij}'**	**Achievements r_{ij}**	**% Achievements y_{ij}**	**Weights w_{ij}**	**$w_{ij}y_{ij}$**
1	Talent support and inspiration	32	41	38.3	0.7	0.3506	0.2454
2	Recruitment	37	55	40.6	0.2	0.254	0.0508
3	Research and Development	7	11	8.796	0.449	0.2194	0.0985
4	Staff Specialization	36	40	37.0	0.25	0.176	0.044
INNOVATION AND DEVELOPMENT (Weight: 0.351)						**R_4**	**0.4387**
Weighted BSC Index						**R**	**0.464**

The analysis of the results presented in table 4 indicates the business situation regards to the desirable targets. The situation could be considered successful, failure or promising depending on the business plan, the evaluation point of time, the DM's expectations, the progress of the action plan and the conditions of the external environment. For the examined scenario the total achievement index R is estimated at 0.464, which was less than the expectations. This undesirable value of total achievements triggered the further investigation across the four pillars. The achievements regards to the most important pillar of innovation and development (R_4=0.4387) are considered lower to the desirable targets due to the low progress on the recruitment and staff specialization objectives. The low performance related to the customers royalty, the enhancement of the brand name and the product mix lead also to the low achievement indices for the customers and internal process pillars.

The proposed methodological approach is not limited to diagnosis but to support the identification of the actions to be taken to solve potential problems and eliminate the divergences from the initial planning. This process of diagnosis can support the enrichment and adaptation of an action plan in order to keep the track on the path of change. In the examined scenario the initial action plan was modified by: a) rewarding the frequent customers through a discount member card, b) motivating the staff to participate in training activities, c) exploiting the e-learning technology to improve their knowledge and expertise, d) running a campaign for the

recruitment of new trained and experienced staff and e) accelerating the program of production and promotion of the new products in the market.

One more crucial point for the utilisation of this structure value system is the capability to be used in a What if Analysis process. The potential improvement on specific objectives implementing the above actions could be quantified by this value system which provides an estimation on the achievement indices. Actions could have positive or negative impacts across the 16 objectives influenced by the level of interrelations among them. For example, the rewarding of frequent customers through a discount member card impacts mainly the customer's royalty and secondly the brand name without negative influence on the financial aspects as the cost of the action will be balanced by the sales increase. The implementation of this action is expected to create additional value to the achievement indices of customer's royalty and brand name with an increase to the values of 50% and 37.5%, respectively. The achievement index of customers pillar will be climbed to the value R_2= 0.526, while the total achievement index will increase to the value of R=0.506. Therefore, the whole process of the methodology aids the DM to track the business progress, identify areas that are requiring improvement and conclude to a set of actions which will harmonize the business expectations with the progress.

6. CONCLUSIONS

BSc framework constitutes the main stream for firms and organisations to organise monitor and review their changing progress in a systematic and systemic way. The utilisation of the WAP method to estimate the weights vectors on the BSc value system has the following advantages:

- The DM could be supported with a clear picture of the change process not only globally but also for every pillar individually taking into account the relevant importance.
- The preference attitudes of the DM according to the strategic priorities are incorporated into the BSc value system. This influences the measurement system to be used monitoring the change progress and the identification of the feedback actions to be taken in order to keep the change on the planned path.
- The DM could be efficiently participated in the decision making process due to the low demanding preference information required for weights estimation.
- The estimated weights are characterized by high level of robustness utilizing pairwise comparisons and linear programming techniques in a structure manner.

The experimentation of the proposed approach in a firm, where a significant change process is taken place, concludes to satisfactory results. This constitutes one of the reasons for further research in this field as well as the wider utilisation of the proposed methodological approach on different sectors. The future research will be focused on the identification of a methodological approach to support the modeling of the interrelations between the actions and the objectives so as to better support the decision making in the changing process. The identification of the interrelation level among the objectives in a structured manner and the modeling of the potential influence of the taken actions constitute points of future research.

REFERENCES

Bana e Costa, C.A., Vansnick, J.-C., 2008. A critical analysis of the eigenvalue method used to derive priorities in AHP. Eur. J. Oper. Res. 187, 1422–1428. doi:10.1016/j.ejor.2006.09.022

Bana e Costa, C.A., Vansnick, J.-C., 1994. MACBETH—An interactive path towards the construction of cardinal value functions. Int. Trans. Oper. Res. 1, 489–500.

Bhattacharya, A., Mohapatra, P., Kumar, V., Dey, P.K., Brady, M., Tiwari, M.K., Nudurupati, S.S., 2014. Green supply chain performance measurement using fuzzy ANP-based balanced scorecard: a collaborative decision-making approach. Prod. Plan. Control 25, 698–714. doi:10.1080/09537287.2013.798088

Butler, J.B., Henderson, S.C., Raiborn, C., 2011. Sustainability and the balanced scorecard: Integrating green measures into business reporting. Manag. Account. Q. 12, 1–10.

Cebeci, U., 2009. Fuzzy AHP-based decision support system for selecting ERP systems in textile industry by using balanced scorecard. Expert Syst. Appl. 36, 8900–8909. doi:10.1016/j.eswa.2008.11.046

Chenhall, R.H., Langfield-Smith, K., 2007. Multiple Perspectives of Performance Measures. Eur. Manag. J. 25, 266–282.

Delias, P., Doulamis, A., Matsatsinis, N., 2008. Simulating Agents as Balanced Scorecard Objectives. Proc. IEEE SMC Int. Conf. Distrib. Hum.-Mach. Syst. March 9-12, Athens, Greece, 121–126.

DeWayne, L.., 2004. Aligning the Balanced Scorecard and a Firm's Strategy Using the Analytic Hierarchy Process. Manag. Account. Q. 5, 1–10.

Feili, H.R., Farahani, N.V., Vesaghi, N., 2011. Integration of fuzzy analytic hierarchy process (FAHP) with balance score card (BSC) in order to evaluate the performance of information technology in industry. J. Math. Comput. Sci. 2, 271–283.

Ferreira, F.A.F., 2013. Measuring trade-offs among criteria in a balanced scorecard framework: possible contributions from the multiple criteria decision analysis research field. J. Bus. Econ. Manag. 14, 433–447. doi:10.3846/16111699.2011.631744

Figueira, J., Roy, B., 2002. Determining the weights of criteria in the ELECTRE type methods with a revised Simos' procedure. Eur. J. Oper. Res., EURO XVI: O.R. for Innovation and Quality of Life 139, 317–326.

Fishburn, P.C., 1970. Utility theory for decision making, Wiley, New York. ed.

Fletcher, H.D., Smith, D.B., 2004. Managing for Value: Developing a Performance Measurement System Integrating Economic Value Added and the Balanced Scorecard in Strategic Planning. J. Bus. Strateg. 21, 1–17.

Grigoroudis, E., Orfanoudaki, E., Zopounidis, C., 2012. Strategic performance measurement in a healthcare organisation: A multiple criteria approach based on balanced scorecard. Omega 40, 104–119.

Grigoroudis, E., Siskos, Y., 2002. Preference disaggregation for measuring and analysing customer satisfaction: The MUSA method. Eur. J. Oper. Res. 143, 148–170.

Hoque, Z., 2014. 20 years of studies on the balanced scorecard: Trends, accomplishments, gaps and opportunities for future research. Br. Account. Rev. 46, 33–59. doi:10.1016/j.bar.2013.10.003

Jacquet-Lagreze, E., Siskos, J., 1982. Assessing a set of additive utility functions for multicriteria decision-making, the UTA method. Eur. J. Oper. Res. 10, 151–164.

Johnson, B., 2014. Polarity Management: Identifying and Managing Unsolvable Problems, 60754th edition. ed. H R D Press, Amherst, Mass.

Kalender, Z.T., Vayvay, Ö., 2016. The Fifth Pillar of the Balanced Scorecard: Sustainability. Procedia - Soc. Behav. Sci., 12th International Strategic Management Conference, ISMC 2016, 28-30 October 2016, Antalya, Turkey 235, 76–83. doi:10.1016/j.sbspro.2016.11.027

Kaplan, R.S., Norton, D., 1996a. Using the Balanced Scorecard as a Strategic Management System. Harv. Bus. Rev. 74, 75–85.

Kaplan, R.S., Norton, D., 1993. Putting the Balanced Scorecard to Work. Harv. Bus. Rev. 71, 134–147.

Kaplan, R.S., Norton, D., 1992. The Balanced Scorecard: Measures that Drive Performance. Harv. Bus. Rev. 70, 71–79.

Kaplan, R.S., Norton, D.P., 2008a. Mastering the Management System. Spec. Issue HBS Centen. Harv. Bus. Rev. 86, 62–77.

Kaplan, R.S., Norton, D.P., 2008b. The Execution Premium: Linking Strategy to Operations for Competitive Advantage, 1st edition. ed. Harvard Business Review Press, Boston, Mass.

Kaplan, R.S., Norton, D.P., 2005. The balanced scorecard: measures that drive performance. Harvard Business School Publishing.

Kaplan, R.S., Norton, D.P., 1996b. The Balanced Scorecard: Translating Strategy into Action, 1 edition. ed. Harvard Business Review Press, Boston, Mass.

Karra, E.D., Papadopoulos, D.L., 2005. Measuring performance of Theagenion Hospital of Thessaloniki, Greece through a Balanced Scorecard. Oper. Res. 5, 289. doi:10.1007/BF02944314

Keeney, R.L., Raiffa, H., 1976. Decisions with Multiple Objectives: Preferences and Value Tradeoffs, John Wiley & Sons, New York. ed.

Kellert, S.H., 1993. In the Wake of Chaos: Unpredictable Order in Dynamical Systems. University of Chicago Press.

Kunz, R.E., Siebert, J., Mütterlein, J., 2016. Combining Value-focused Thinking and Balanced Scorecard to Improve Decision-making in Strategic Management. J. Multi-Criteria Decis. Anal. 23, 225–241. doi:10.1002/mcda.1572

Laitinen, E.K., 2002. A dynamic performance measurement system: evidence from small Finnish technology companies. Scand. J. Manag. 18, 65–99.

Lee, A.H.I., Chen, W.-C., Chang, C.-J., 2008. A fuzzy AHP and BSC approach for evaluating performance of IT department in the manufacturing industry in Taiwan. Expert Syst. Appl. 34, 96–107. doi:10.1016/j.eswa.2006.08.022

Leung, L.C., Lam, K.C., Cao, D., 2006. Implementing the Balanced Scorecard Using the Analytic Hierarchy Process & the Analytic Network Process. J. Oper. Res. Soc. 57, 682–691. doi:10.2307/4102352

Montanari, A., Young, G., Savenije, H.H.G., Hughes, D., Wagener, T., Ren, L.L., Koutsoyiannis, D., Cudennec, C., Toth, E., Grimaldi, S., Blöschl, G., Sivapalan, M., Beven, K., Gupta, H., Hipsey, M., Schaefli, B., Arheimer, B., Boegh, E., Schymanski, S.J., Baldassarre, G.D., Yu, B., Hubert, P., Huang, Y., Schumann, A., Post, D.A., Srinivasan, V., Harman, C., Thompson, S., Rogger, M., Viglione, A., McMillan, H., Characklis, G., Pang, Z., Belyaev, V., 2013. "Panta Rhei—Everything Flows": Change in hydrology and society—The IAHS Scientific Decade 2013–2022. Hydrol. Sci. J. 58, 1256–1275. doi:10.1080/02626667.2013.809088

Niven, P.R., 2006. Balanced scorecard step-by-step: maximizing performance and maintaining results, 2nd ed. ed. Wiley, Hoboken, N.J.

Norreklit, H., 2000. The balance on the balanced scorecard: a critical analysis of some of its assumptions. Manag. Account. Res. 11, 65–88.

Pérez, C.Á., Montequín, V.R., Fernández, F.O., Balsera, J.V., 2017. Integration of Balanced Scorecard (BSC), Strategy Map, and Fuzzy Analytic Hierarchy Process (FAHP) for a Sustainability Business Framework: A Case Study of a Spanish Software Factory in the Financial Sector. Sustainability 9, 527. doi:10.3390/su9040527

Rabbani, A., Zamani, M., Yazdani-Chamzini, A., Zavadskas, E.K., 2014. Proposing a new integrated model based on sustainability balanced scorecard (SBSC) and MCDM approaches by using linguistic variables for the performance evaluation of oil producing companies. Expert Syst. Appl. 41, 7316–7327. doi:10.1016/j.eswa.2014.05.023

Reisinger, H., Cravens, K.S., Tell, N., 2003. Prioritizing Performance Measures Within the Balanced Scorecard Framework. MIR Manag. Int. Rev. 43, 429–437. doi:10.2307/40835943

Roy, B., 1990. The Outranking approach and the foundations of ELECTRE methods. Read. Mult. Criteria Decis. Aid Bana e Costa (Ed.), Springer, Berlin, 155–183.

Roy, B., 1985. Méthodologie multicritere d'Aide à la Decision, Economica, Paris. ed.

Saaty, T.L., 1996. Decision making with dependence and feedback: the analytic network process.

Saaty, T.L., 1980. The Analytic Hierarchy Process, McGraw-Hill International, New York. ed.

Santos, M.A.R. dos, Salomon, V.A.P., Marins, F.A.S., 2015. Analytic Network Process and Balanced Scorecard Applied to the Performance Evaluation of Public Health Systems. Pesqui. Oper. 35, 353–361. doi:10.1590/0101-7438.2015.035.02.0353

Simos, J., 1990a. Evaluer l'impact sur l'environnement: Une approche originale par l'analyse multicritère et la négociation, Presses Polytechniques et Universitaires Romandes, Lausanne. ed.

Simos, J., 1990b. L'évaluation environnementale: Un processus cognitif négocié. Thèse de doctorat,. DGF EPFL, Lausanne.

Siskos, E., Tsotsolas, N., 2015. Elicitation of criteria importance weights through the Simos method: A robustness concern. Eur. J. Oper. Res. 246, 543–553. doi:10.1016/j.ejor.2015.04.037

Siskos, Y., Spyridakos, A., 1999. Intelligent multicriteria decision support: Overview and perspectives. Eur. J. Oper. Res. 113, 236–246.

Spyridakos, A., Tsotsolas, N., Yannacopoulos, D., Siskos, E., 2015. Estimating criteria weights exploiting priorities of the criteria and techniques of robustness analysis. Proceeding 4th Int. Symp. 26th Natl. Conf. Oper. Res. June 4-6, Chania-Greece, 225–229.

Tavana, M., Mousavi, N., Golara, S., 2013. A fuzzy-QFD approach to balanced scorecard using an analytic network process. Int. J. Inf. Decis. Sci. 5, 331–363.

Tsotsolas, N., Spyridakos, A., Siskos, E., Salmon, I., 2016. Criteria weights assessment through prioritizations (WAP) using linear programming techniques and visualizations. Oper. Res. 1–16. doi:10.1007/s12351-016-0280-7

Yu, L., Perera, S., Crowe, S., 2008. Effectiveness of the balanced scorecard: The impact of strategy and causal links. J. Appl. Manag. Account. Res. 6, 37.

Yüksel, \.Ihsan, Dağdeviren, M., 2010. Using the Fuzzy Analytic Network Process (ANP) for Balanced Scorecard (BSC): A Case Study for a Manufacturing Firm. Expert Syst Appl 37, 1270–1278. doi:10.1016/j.eswa.2009.06.002