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Model Of Improving Environmental Management System By Multi - Software

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Abstract*:This paper is based on doctoral dissertation which is oriented on improving environmental management system using multi – software. In this doctoral dissertation will be used key results of master thesis which is oriented on quantification environmental aspects and impacts by artificial neural network in organizations. This paper recommend improving environmental management system in organization using Balanced scorecard model and MCDM method - AHP (Analytic hierarchy process) based on group decision. BSC would be spread with elements of Environmental management system and used in area of strategic management system in organization and AHP* would be used in area of checking results getting by quantification environmental aspects and impacts.

Keywords: *artificial neural network, balanced scorecard, aspects, impacts, quantification, Analytic hierarchy process*

1. INTRODUCTION

The aim of this research is to improve environmental management on upper level. This can be done by application of scientific methods and software systems that will created unique model of management. The research subject in proposed doctorial dissertation is research of possibilities of regulation environmental protection by implementation of Balanced Scorecard policy in parallel with evaluation significance of environmental aspects by application of neural networks. Those networks are created by proposed data of certified organization and verification of results will be done with AHP method. In fact on basis of detailed analysis we can verify application of proposed Balanced Scorecard concept that introduces dimension of environmental protection. Like that we can choose the most important concept, which will be introduced in business system what will prove on ecological and economic utility of their implementation. Also we will verify possibility to value entrance elements of Balanced Scorecard concept by AHP model based on group decision with help of experts from these fields. In chosen Balanced scorecard concept the key place will be focused on environmental protection which importance will be noted by application on neural networks and additionally verified by application of AHP model based on group decision.

2. KEY RESULTS OF MASTER THESIS (*ICT implementation on modeling the quantification of environmental aspects)*

Most of key requirements of standard ISO 14001 /1/ are based on knowledge of significant environmental aspects while other requirements of standard stand in certain correlation with them although they do not entirely dependent on them. Through analysis of 4.3.1 Environmental aspects and part of aspects' significance and environmental impacts evaluation in standard ISO 14004 /2/, too much freedom of choice left for organizations can be observed:

- Metodology of evaluation
- significance criterion
- criteria ranking
- limited values of significance

In accordance with this, certification bodies do not enter into evaluation methodology selected by organization either. They only analyze final results and evaluate way of monitoring and rehabilitation of significant aspects consequences.

Namely, based on the available data from three certified organizations (A, B and C) in SCG territory that are related to the chosen mathematical model and evaluations of environmental aspects, worrying declination in number of significant impacts can be seen dependent on the applied verified model and which can not be justified by different activities of organizations. Comparative analysis was realized through programming in JAVA programming language, software package JDK 1.2.2. (Java Development Kit) in available text editor JCreator:

- Comparison I (organization A and organization B)
- Comparison II (A and C) - table 1
- Comparison III (organization B and organizationC)

Table 1/3/

	C	A	
VOLUME OF IMPACTS	1	1,2	C (significant) A (insignificant) 84
	2	3	
	3	4	
	4	5, 6	
	5	7, 8	
PROBABILITY	1	1, 2	A (significant) C (insignificant) 0
	2	3, 4	
IMPACT SEVERITY	1	1	
	2	2	
	3	3	
INFLUENCE ON PUBLIC OPINION	1	1	
	2		
	3		

We can see that with mathematical model organization C 84 impacts are evaluated as significant while with mathematical model organization A same impacts are evaluated as insignificant.

As to overcome stated non-uniformities of certain methodologies and yet to adopt their specificities and gained results, we approached production of program for evaluation of environmental impacts through application of neural network.

Tending was to establish a model with as less as possible subjectivity in individual evaluation so as to avoid possible manipulations with results.

2.1 Feed forward backpropagation neural network

Feed forward Back-propagation neural network is most commonly applied in practice as for its simplicity as for the wide spectrum of problems it can solve.

Considering that input data available in certain problem are grouped, and that exact

response is known for every input, feed-forward back-propagation is the simplest and best solution in choice of network.

Feed forward back-propagation neural network is a network with two or more layers, therefore it has at least 1 hidden layer and most commonly networks with completely linked layers are used /Figure 1/.

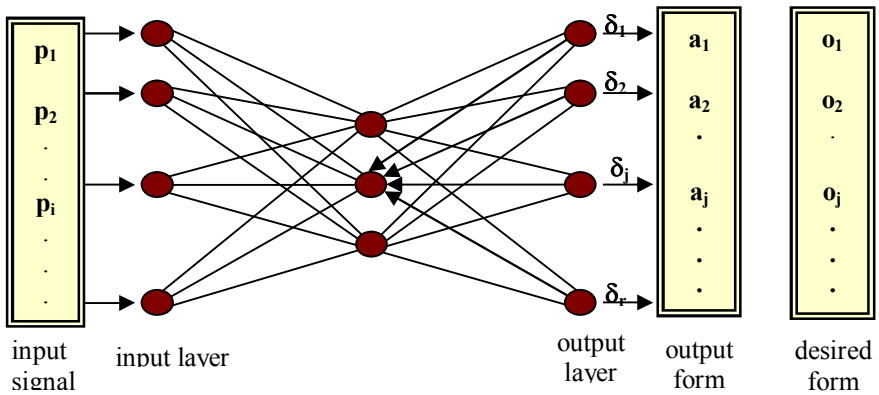

Figure 1 Two propagation steps of back-propagation neural network

Authors of master thesis had an idea to train feed forward back propagation neural network for objective evaluation environmental aspects and impacts in every organization independently of their activeness.

Taking into account that in that period was a very small number of certified organizations in the territory of Serbia and Montenegro in accordance with the standard ISO 14000 (28 totally) the first idea was to create a neural network on the basis of due diligence from all the organizations, which would be trained to evaluate significance of the impact in the new organization on the basis of such a great number of input – output information and different mathematic models.

The data sought from the organizations were related to the register of all identified aspects and impacts on environment and to their evaluation of significance according to their own mathematic models.

Organizations independently created and adjusted mathematic models for evaluation of significance of impact and aspects on environment to their criteria for meeting requirements of ISO 14001 standards.

However, due to impossibility of cooperation with a larger number of organizations, data from 4 organizations were collected, so the training of neural network was performed on the basis of data from 3 organizations (A, B, C) and data from the fourth organization (D) were used for simulation of the model. As quite a number of different data is in question (2184 impacts totally), pursuant to the recommendation of standards we approached the classification according to the medium on which the observed impacts have effect as it shown on Figure 2.

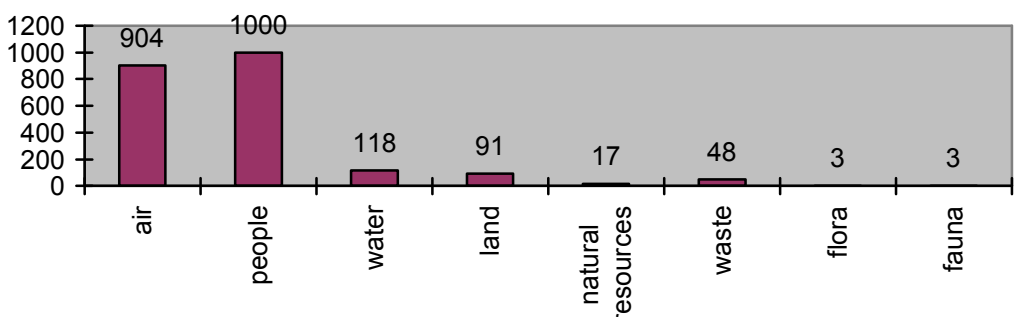

Figure 2 /3/ Diagram of impacts number division according to the mediums of effect

Training of neural network was made for medium air, people, water and land but not for flora, fauna, waste and natural resources because the number of data in relation to flora, fauna and natural resources is very small and as regards waste it is obtained from only one organization. Therefore, these impacts were not further considered, due to impossibility to obtain real results.

Back propagation neural network for medium air (trained in software package Matlab) is given on Figure 3a and its convergence diagram which defines speed and accuracy of training on Figure 3b

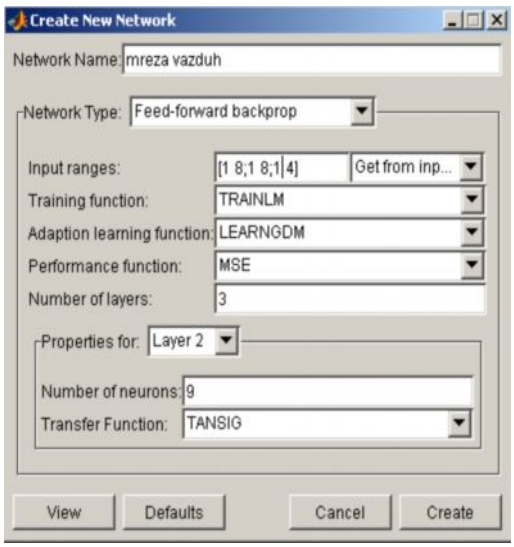

Figure 3 a /3/ Performances of neural network

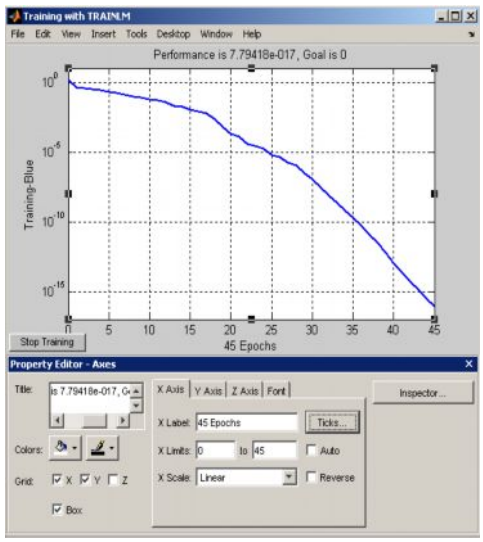

Figure 3 b /3/ Convergence of neural network

After results derived in this way, with relatively fast convergence and high accuracy, model was tested with data from organization D and produced results that have completely coincided with mathematical model of organization D chosen from the four available models (models of organization A, B, C and D) to serve as referent one. Appearance of the basic window in Matlab with results of network training and simulation for medium air is given in the Figure 4.

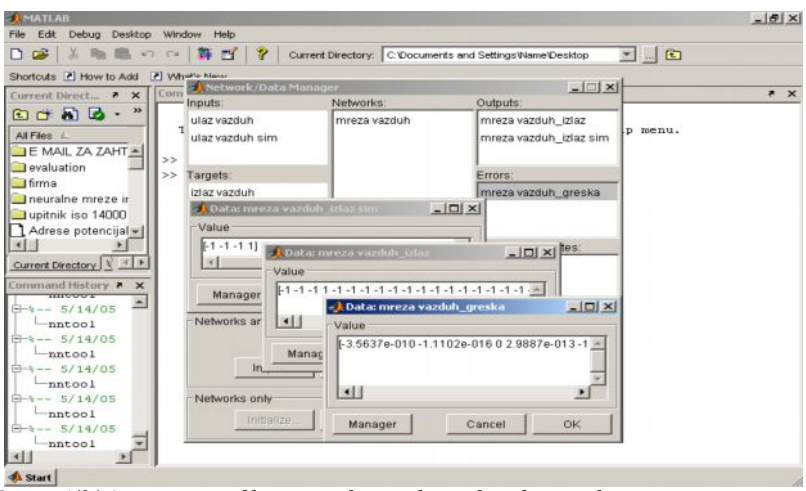

Figure 4/3/ Appearance of basic window with results of network trainin

Analogously with the previously defined procedure we approached the neural network creation and training for medium people, water and land.

When we trained artificial back propagation neural network and test it with data from organization D we get good results but not totally same.

Difference in results which is obtained by application of these two different models for medium people is impact for 11 and 17.

However, by analysis of the mathematic model of organization D it can be seen that impacts 11 and 17 belong to the limiting value which is not included as significant for the given model while neural network acquires these data as significant.

Therefore, it can be realized that neural network, as regards influence on health, is more sensitive about significance of impact than mathematical model of organization D, although the limiting values for each model as well as the neural network can be deemed as critical points due to inexistence of recommendations of standards or exact analysis for their determination.

aking into account a small training sample the results, which are obtained for medium water and land, showed certain deviation in relation to the model of organization D.

Comparative analysis of available mathematical models and obtained results through application of neural network has ascertained that the chosen back-propagation neural network had given satisfying results for sufficiently large training sample as it was for medium air and people.

The evident fact is, that evaluation like this that itself has incorporated specificities of available models from practice, has the highest character of objectivity and does not leave enough space for manipulations in the part of forming register of significant impacts and its efficiency and objectivity could be significantly improved through additional training of neural network with innovated data.

3. BALANCED SCORECARD

To improve environmental management system to the upper level in organization we try to find possibility for involving those problems in every day life of employees and whole management. Following this way we can obtain core orientation of management of organization on environmental protection. Balanced scorecard in this direction can gives important support.

BSC is the best solution for implementation strategy in the company and their principal duty is to transform the mission, vision and strategy of the company into the clear system for measuring the efficiency-output (Figure 5) shown with the line Top-Down. So that the strategy should be transferred into clearly set up goals (objectives) according to all the perspectives, and then, for all of them to define the parameters (measures), target values and the activities in order to achieve these goals. But, very important part of BSC can also be seen in Bottom up line where the degree of realization of set up goals is measured through the activities directed towards the final values of the measuring parameters.

In that way the action in Company is constantly urged towards permanent improvements through PDCA cycle because, nowadays in very changeable surroundings, it is not possible to define the strategy once and to apply it without its checking and improvements.

Each perspective contains parameters as follow:

- Objectives – What is necessary to do for achieve success?
- Measures – Which parameters will we choose and measure to approve our success?
- Targets – Which quantitative values will we take to determining success of measurement?
- Initiatives (Activities) – What is it necessary to do to achieve our targets?

We have chosen QPR software as support Balanced scorecard for this research.

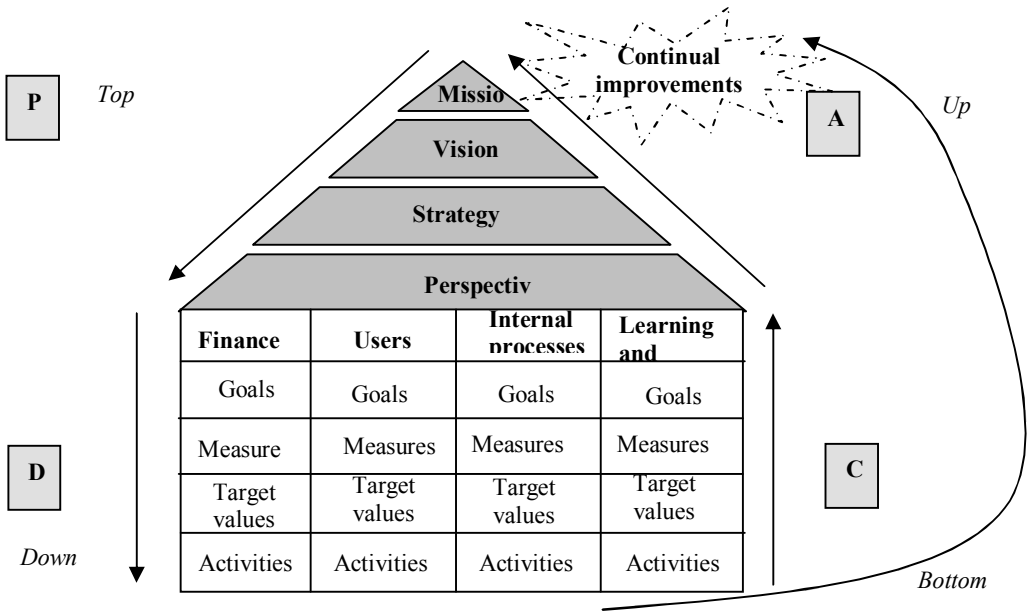

Figure 5. /4, 5/ Transfer of mission, vision and strategy through implementation of BSC

3.1 Strategic map

The concept of BSC is most seen through strategic map that characterized with explicative research with strategic assumptions in architecture measures what makes from BSC very important strategic tool. To define strategy through map, we need first to define strategic objectives that will bring knowledge of strategy and than connect them in cause-consequent chain of hypothesis and like that to link knowledge of whole strategy. After creation strategic map of objectives through perspectives it is necessary to perform it a move down to the level of causative relations of indicators (measures) /Figure 6/.

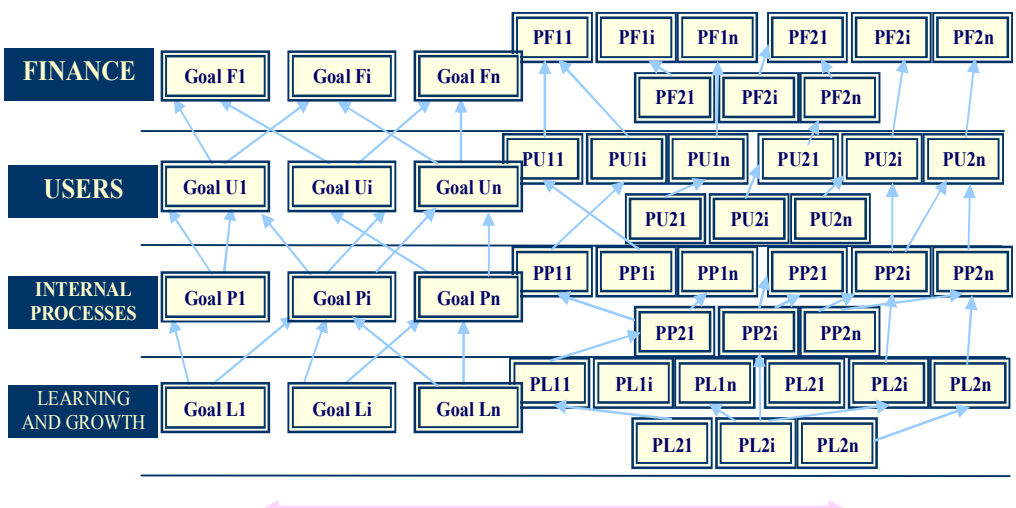

Figure 6 /4/, /5/, /6/ Causative relations of goals and measures of organizations

After translating strategy into measures, that process must be analyzed backward if we want to evaluate successful of implementing strategy.

Choice of proper indicators is of great importance in implementation BSC. On one hand, they must comprise all key processes of the organization, and on the other hand, one must see that their number is not too big because in that case image of the organization becomes unclear and complicated to follow. There is a recommendation that for 4 standard perspectives should be chosen about from 20 to 25 indicators (measures). If we want achieve that number it is necessary to limit number of perspectives objectives on about three to four.

3.2 Cascading balanced scorecard

To successfully implement any strategy it must be understood and acted on by every level of the firm /7/. Cascading the Scorecard means driving it down into the organization and giving all employees the opportunity to demonstrate how their day-to-day activities contribute to the company's strategy. All organizational levels distinguish their value creating activities by developing Scorecards that link to the high-level corporate objectives.

So, after creating corporative BSC it is necessary to create BSC model for lower level (as it represent on Figure 7). On that way activities of all levels could be connect with corporative objectives.

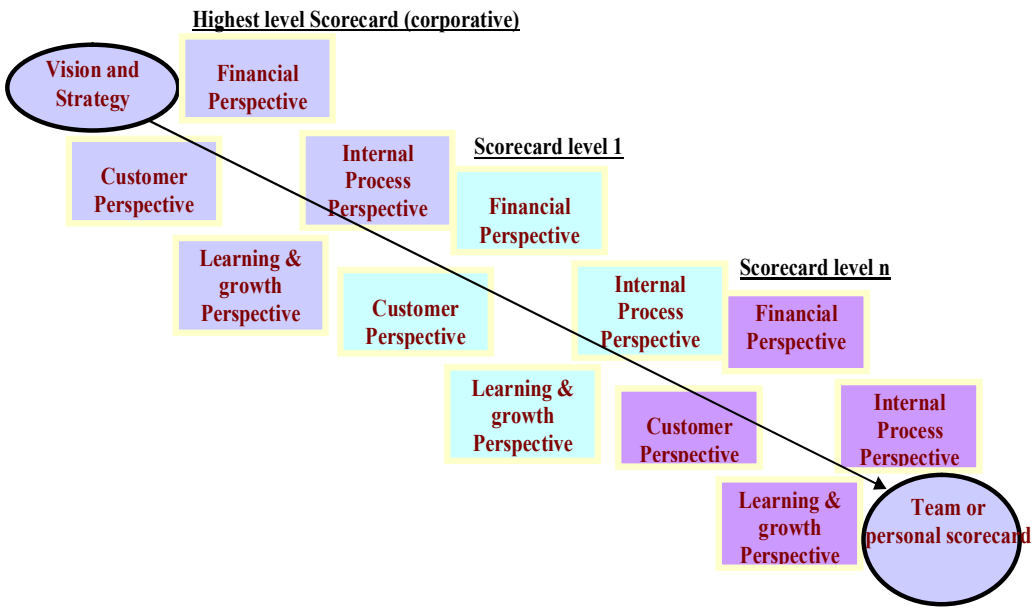

Figure 7 Cascading Balanced Scorecard

bjectives in corporative BSC represent four key strategies in organization according perspectives. Lower levels in organization have to analyze corporative objectives and how they can influence on it and according that they should define their own objectives and measures. Cascading scorecard down into organization could be finished with personal or team scorecard.

3.3 Comparative analysis BSC models in profit and non-profit organizations

BSC was originally oriented on profit organization but later it was modified for public and non profit organization.

Public and non profit organization is oriented on client's satisfaction, according mission. They are not oriented on profit and

according that original BSC have to be transformed. So financial perspectives shouldn't be an objective (in public organizations) like in profit oriented organization. In these organizations financial perspective represented budget. That is represented on figure 8.

With profit organizations during the choice of indicators the most important is to focus on financial perspective because it is the most important goal to all stakeholders.

According that Kaplan and Norton claim:

"Cause - effect chain of all BSC measures should be linked with finance."

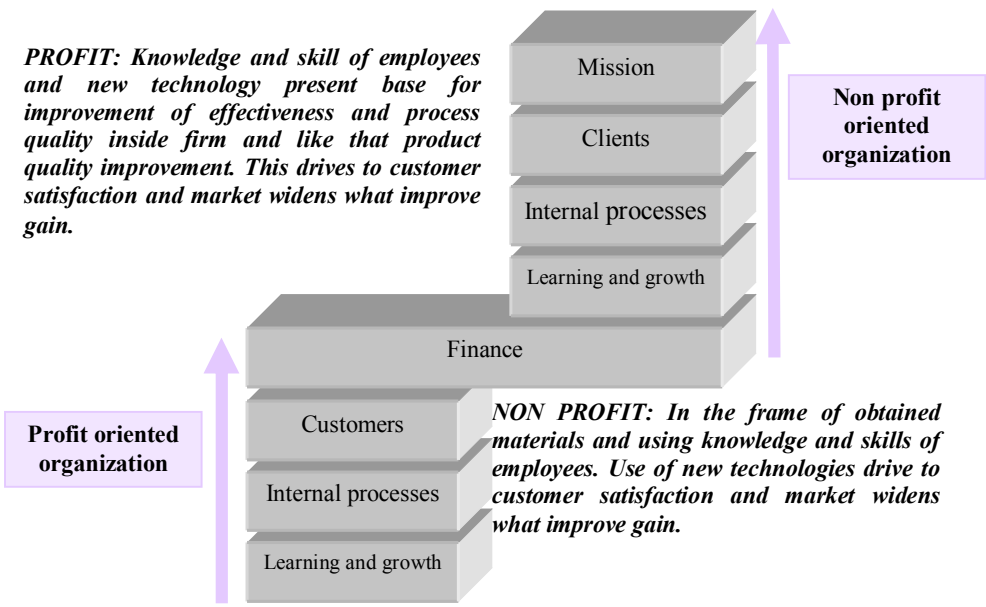

Figure 8 /8/, /9/, /10/, Causative relations between perspectives in profit and non-profit (public) organizations

With non profit organization focus is on customer satisfaction because that is the the mission of all non-profit organization. Financial perspective is only suggestion for customer satisfaction. So, in these organizations choice of indicators should be managed to link on customer perspective.

According that previous Kaplan and Norton claim could be transform like:

"Cause-effect chain of all BSC measures has to be linked to client perspective."

These differences have a very important role in process of including EMS into BSC.

3.4 Approaches of integration EMS into BSC

Ecological and social aspects could be integrated into BSC on three ways /11/: First, ecological and social aspects could be integrated into four exist perspectives. Second, it is possible to create new (fifth and/or sixth perspectives) which obtained these elements. Third it is possible to create special sustainability scorecard.

3.4.1Integration of environmental and social aspects into 4 perspectives

Environmental and social aspects should be included in the frame of 4 already existing perspectives through strategic elements, objectives and measures. Using this method, environmental and social aspects become an integral part of standard BSC and they will be automatically integrated inside the

cause-effect chain that has the financial perspective at the top of its hierarchy.

3.4.2 Appending new environmental/social perspectives

Environmental and social aspects are not completely integrated in market changes in the previous model. The reason for this is because these aspects are not market oriented. Moreover, from the point of many organizations, environmental and social aspects are a peripheral concern.

The creation of new perspectives creates a more clear picture about the integration of environmental and social aspects in the standard structure of BSC that is primarily market oriented. Elements of added perspectives should be connected with all other perspectives and not only with the financial perspective.

3.4.3 Creation of induced environmental/ social scorecard

The third approach of environmental and social aspects integration inside BSC is based on the creation of a special environmental/social scorecard. Furthermore, in this part we include creation of sustainable scorecard parallel with a conventional scorecard. Sustainable environmental/social scorecard is not independent from traditional BSC and to a give specific point to this aspect; it should have to be connected with a traditional BSC (Figure 9).

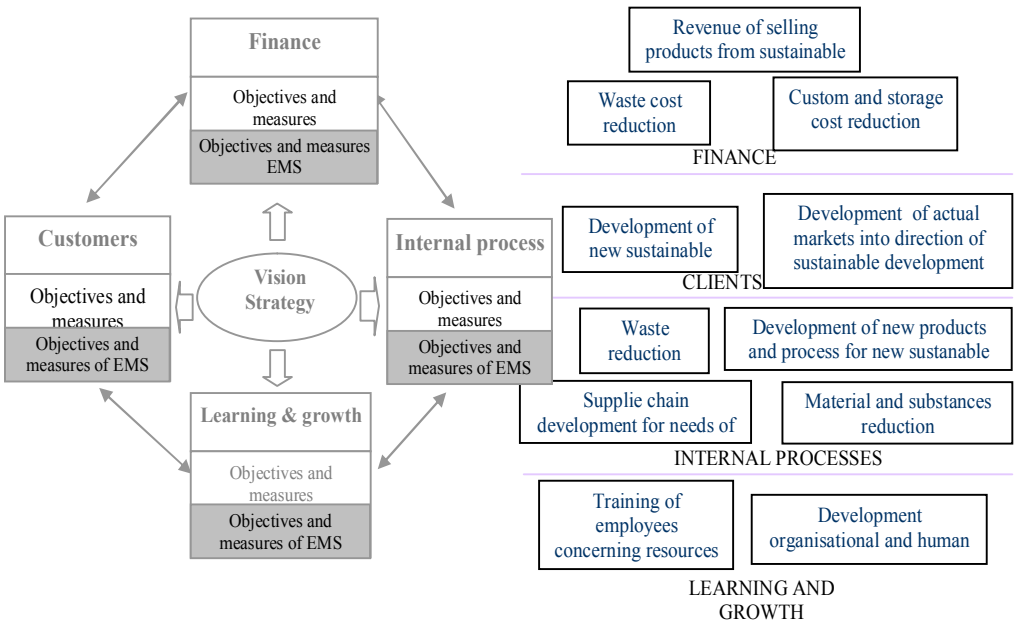

Figure 9 Creation of induced environmental/ social scorecard

If we observe the division of SBSC we can conclude that most organisations adopt the first possibility, moreover we can see the integration of environmental aspects into already existing perspectives. In this case the sustainable aspects could be found in all four perspectives. For example the customer perspective could include external stakeholders as a transactor, customers, loan organisations, government, enviromental organisations, stakeholders, ,... On the other side the financial perspective could include complaints and costs concerning environmental protection. Other perspectives could include environmental and

social aspects.

It is important to mention that environmental and social aspects could be included inside the 4 already existing perspectives of conventional BSC while at the same time it could be created as an additional perspective. Those two types do not exclude each other.

The choice of how to include those aspects depends on the definition of strategic environmental and social aspects during the process of defining the SBSC.

On the other hand, the creation of special environmental scorecard would completely include all elements of EMS throughout the full management system but in this way there is the possibility of creating a parallel system which could be neglected during the business. With good linkage with BSC an organization could reach good results concerning EMS organization.

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The actions relating to environmental protection have to include identified environmental aspects of organisation. It is not a rare case that an organisation during the choice of this small number of actions, choose ones that are easy to measure, and in this way they could eliminate actions that are strategically important but that are not easy for quantification (environmental and social).

After selection of indicators, the organisation has to analyze the cause-effect links of indicators. The majority of authors /11/, /13/,... consider cause-effect links of SBSC as in Figure 10, where everything is oriented around financial gain.

Figure 10 Causative relations SBSC-a

Therefore, the essential point is that a strategic map is established so that investment in environmental protection drives to financial gain and that all investment in environmental protection that does not reach financial gain is not retained.

SBSC created like this is easy to involve in already existing BSC because the disposition of perspectives is identical and the strategy is of course oriented to the financial gain of the organisation.

The concept of BSC for non-profit organisations is oriented to reach the defined mission of the organisation in the context of its disposable budget and in this sense customer perspective is most important. Is it possible to reach a better effect for environmental protection of organisations if they define their budget like non profit organisations and create a SBSC map starting with the financial perspective, through learning and development, internal processes, till stakeholders satisfaction that also leads to financial gain (Figure 11)?

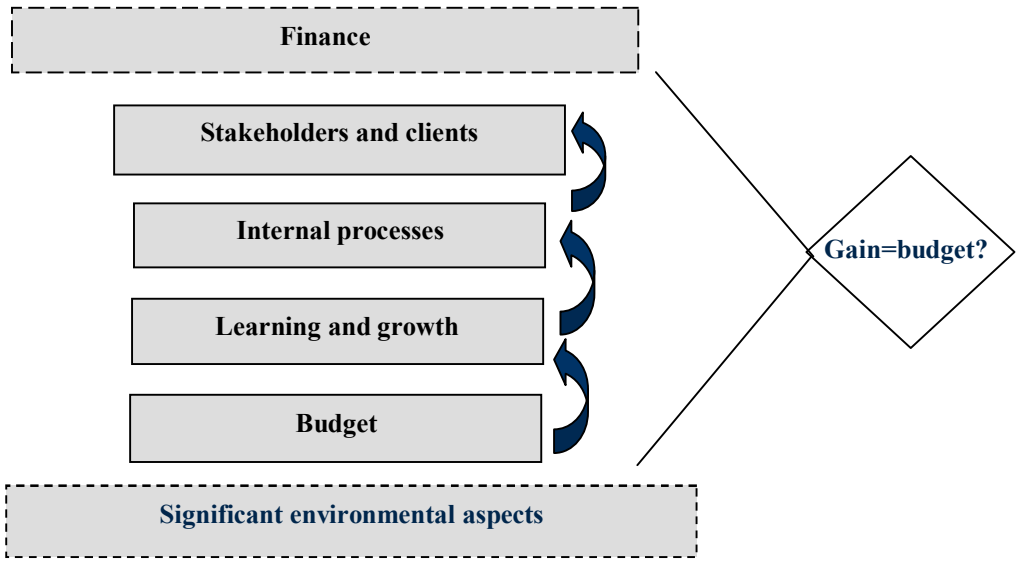

Figure 11 /12/ Causative relations SBSC base on non profit BSC

To avoid the budget assigned for environmental protection being treated as a cost, it is important to join this correlation also with financial perspectives and consider possible advantages from stakeholder satisfaction relating to this case.

This model of SBSC is not easy to implement inside an already existing BSC because of quite different strategic concepts and dispersion of perspectives. Therefore, the strategic map of SBSC defined like this does not induct connection as a standard BSC, but it could assure a better realtionship concerning environment than a system that is only oriented to financial gain. Budget definition is done upon the identification of important environment aspects. This model of SBSC is appropriate until the budget and financial gain reach quite main level after what the cause - effect relation of objectives could be oriented to financial perspective and realized complete fusion with BSC of organisation. Furthermore, the system could exist independently and connect some environmental activities with the management system, but as an independent part. Its aim is usually measurement of performance and improvement.

SBSC is a tool that gives a good chance for the integration of environmental and social objectives and actions into an existing management system. SBSC does not present a substitute for other systems such as ISO 14000, but in any case it does help the promotion of methods of sustainable development inside the organisation's processes and connect them with a traditional management system.

4. ANALYTHIC HIERARCHY PROCESS (AHP)

Methods of multi-criteria analysis and optimization (MCDM methods) are used in all areas of decision-making.

AHP is multi criterion method that is based on decomposition of complicate problems on different levels with defined objective on the top as a first level. The next levels are criterions and sub criterions and last one are alternatives. So, the base of AHP levels is consisted of three basic levels (objective, criterions, and alternatives) but it is possible to decompose this structure by forming new levels. This approach of decomposition is possible realize till necessary detailed level. In the figure 12 it is presented 4 levels AHP; but still we have to consider that it could not be completed, it means that one criterion will not be in common for all alternatives (k1, A1, A2).

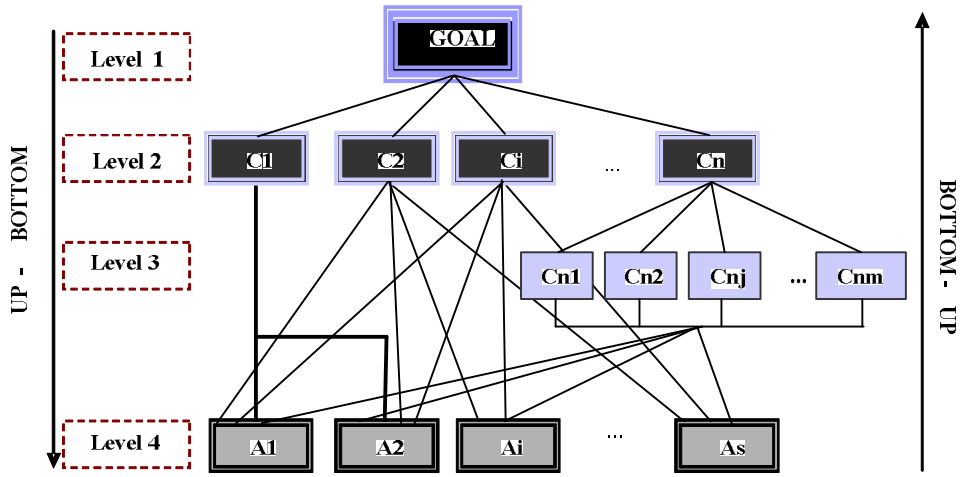

Figure 12 Example of hierarchy in AHP

In AHP approach objectives are defined in first level, than criterions; sub criterions and at the end alternatives. So the procedure of definition is from top to bottom (UP BOTTOM). AHP allows quantity by levels in both directions (UP BOTOOM) and (BOTTOM UP) but in the practice we have usually quantify from top to bottom; more precisely quantify of approach relating to aim; sub criterion, criterion and alternatives. Final results of AHP are list of importance alternatives relating to aim. So, reachment of results is in contrast way relating defined exercise (BOTTOM UP).

AHP is based on the following 4 principles /14/, /15/, /17/:

- **Decomposition** – Complex problem is being decomposed into hierarchy where every level comprise many elements that are further decomposed
- **Priority** – implies comparison and evaluation of paired elements from the same level in relation to the element of a higher level
- **Synthesis** – Integration of evaluations per all levels in order to eventually get a list of priority elements of the last level (alternatives)
- Sensitivity analysis – **Stability of the final result is being additionally verified by testing the best choice by question "what – if" through hierarchical levels**

Procedure of grading of problem hierarchy elements (goal, criterions and under criterions) could be make grading of elements in pairs that belong to the same level in relation to the element from the previous level. Comparisons in pairs are performed by grading according to Saaty scale given in Table 2, which is considered a standard in application of AHP.

Table 2 /16/

Scale of comparison (Saaty)	
1	Same significance
3	Weak dominance
5	Strong dominance
7	Very strong dominance
9	Absolute dominance
2,4,6,8	Inter-values used to represent a compromise between grades

Grading of hierarchy element could be done by Data Grid recommended for usage when there is a great number of elements from one level whose values vary according to some law (formula) or if you make free quantification. Data grid is most acceptable when some problem have in one level more then 9 elements. Data Grid combines the strength of paired comparison with possibility of grading hundreds or even thousands of alternatives. This is very important for quantification environmental aspects because their number is often above 9.

Last phase in AHP methodology is the synthesis of results, which implies final determination of priorities of alternatives in relation to positioned goal. It is also very important to determine a level of inconsistence of results that is automatically derived by this software package upon activation of synthesis. Level of inconsistency according to this methodology should range between 0 and 0.1.
Expert Choice is software for support of AHP that is entirely based on its mathematical basis and the most commonly used one.

4.1 Group decision

The greatest advantage of AHP method is viewed in possibility of not only individual decision give possibility to group decision that is more and more applied. Previously explained procedure that is related to individual noting present's core of group noting with whom there exist greater numbers of decision makers with basic difference in synthesis approach of final decision.

We can distinguish two different cases /14/:

- **Group synthesis with complete information** for which it is characteristic that whole members of groups are realized quantity in pairs. In this case problem resolve could be realized in two ways. The first one is that AHP method is introduces for each member of group and at the end we have synthesis of results and the second one is that the synthesis of all results are realized and then that we have implementation of AHP methodology like in the case of individual noting.
- **Group synthesis with not complete information** is when all members group are not or do not want to formulate about quantity of pair. In this case we have synthesis of reached results for group members that formulate in comparative approach, and than we have AHP results synthesis also like one of decision maker. During this noting it is important that in each position and in each matrices of decision making there exist at least one quantity. If this is not a case, than the AHP is unemployed.

4.2 AHP in implementation Balanced scorecard

Except, important role of AHP on the basis of group decision that could be applied for noting important aspects and influence on environmental protection, it could also very efficacies for choose of important measures during BSC more precisely SBSC creation.

According to the recommendation by Kaplan and Norton, typical BSC should contain 20 – 25 measures. Practice indicates that during BSC implementation there is always an excessive number of required measures and therefore AHP based on the group decision-making can be very successfully applied in this problem.

Application of AHP in Balanced scorecard is represented in Figure 13.

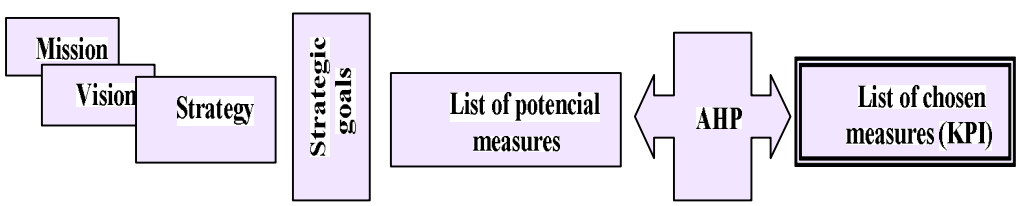

Figure 13 /18/ Role of AHP in BSC implementation

Therefore, according to AHP methodology, primarily it is necessary to define a hierarchical structure of the problem. As different alternatives are created for every perspective (in this case measures), and managerial teams that participate in evaluation of the model too, therefore it is necessary to define a separate AHP model for every perspective. Layout of AHP model for KPI choice in BSC implementation is represented in Figure 14.

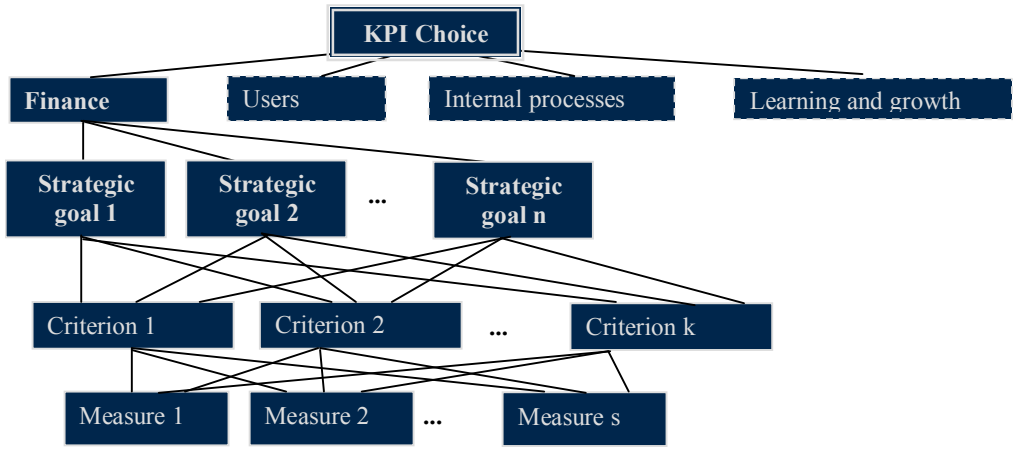

Figure 14 Choice of measures in BSC through application of AHP

In order to provide the most possible objective evaluation by experts from managerial team, introduction of one more additional level in hierarchical structure of AHP has been suggested, that would represent additional criteria in selection of right measures. Criteria relevant for evaluation of measures in relation to goals of perspectives are (19):

- Relation to strategic goals
- Simplicity and clearness
- Organizational correlation
- Lead –lag indicators
- Availability (accessibility) of data

Considering previous sub-criteria, managerial team can simpler perform both proposal of measures and their evaluation.
So, in this doctoral thesis AHP group decision model would be used in two different areas:

1. When we want to analyze did artificial neural network gave us a good results in area of quantification environmental aspects and impacts in organization.
2. When we want to choose proper measures in BSC models which we will create in some organization.

5. CONCLUSION

General research on management system and especially in part of environmental protection with application of tools of artificial intelligence and of other software systems in the world but especially in our country are not enough exploited.

In this paper is presented idea of doctoral thesis "Model of improving Environmental Management System by multi – software" with theoretical and literature researches. Choose of BSC model that including Environmental management system and validation model of doctoral dissertation will be done after implementation in some organization that already have particularly or completely implementing classical BSC model.

This doctorial dissertation will present contribution to researches in this direction on the one side and on the other side present important practical application for environmental protection support in our country and off course natural sequel in field of environmental managements system in master work »*ICT implementation on modeling the quantification of environmental aspects* «, as unique approach in our country.

In this way we can create one unique model for environmental management system with special accent on objectivity and objectively quantification of aspects of environmental protection which will be useful for all organization regardless the sector.

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