Implementing the green transport strategy using Balanced Scorecard and Analytic Network Process

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Abstract—The paper presents a conceptual framework for supporting a green transport strategy implementation in industrial companies and supply chains. Balanced Scorecard and Analytic Network Process were used as the methodological basis. The framework contains five main steps – selection of green transport strategy, selection of Balanced Scorecard approach, specification of green transport strategy, prioritization of Balanced Scorecard measures, and evaluation of green transport strategy reaching. For each phase are defined fundamental principles and recommended tools. The verification of the designed conceptual framework was performed on a real supply chain of the European automotive industry.

Keywords—Analytic Network Process, automotive industry, Balanced Scorecard, green transport strategy.

I. INTRODUCTION

In recent decades, the performance of economic and non-economic activities has required them to be friendly with the environment [1], [2]. This proactive approach to addressing and eliminating the negative environmental impacts from transport processes is called Green Transport (GT).

Transport is one of the areas having considerable potential within the scope of the green strategy implementation, since it has significant negative impacts on the environment [3]. They include, primarily, the emissions of CO and CO\textsubscript{2} and other exhaust gases, noise, and, last but not least, congested transport infrastructure.

The current goals of GT are now focused on reducing the fuel consumption (which is closely linked to cutting CO\textsubscript{2} and other exhaust gases), reducing noise, reducing the transport costs, reducing traffic jams and, ultimately, on complying with the legislative restrictions. An active and effective solution of the issues of GT must be seen not only as a challenge, but especially as an opportunity offering the possibility of significant competitive advantage, improving the image of the company in the eyes of the customers, region, state and the general public.

The aim of the paper is to design conceptual framework for supporting a Green Transport Strategy (GTS) implementation in industrial companies and supply chains using Balanced Scorecard and Analytic Network Process.

II. METHODOLOGICAL BASIS

A. Balanced Scorecard

Full name of the tool is System Balanced Scorecard enterprise (BSC). It is a method of management that creates a link between strategy and operational activities with an emphasis on performance measurement developed by Kaplan and Norton [4].

By using the BSC, the strategy and vision of the company can be converted into performance measures that include both outcome measures and the drivers of these measures [5]. For a strategy to be successful, it needs to consider financial ambitions, processes to be improved, markets served and the people in the organization that implement the strategy [6]. The BSC uses all these perspectives by considering both internal and external aspects [7]. Every perspective should contain four different sections: objectives, measures, targets and initiatives. For employees to be able to act upon the organization’s vision, translating the strategy and mission of the company into objectives is the first step in the creation of each perspective.

Strategies like “an empowered organization” is hard to implement in practice and senior executives should therefore create understandable and actionable objectives, along with defined measures to keep track of the progress of reaching each goal [8]. Each measure should then be associated with a target (a short-term goal) that works as a milestone to assist in evaluating the progress of each objective. The last column in each perspective should be initiatives, describing actions that should be undertaken by the firm to reach each objective.

B. Analytic Network Process

The Analytic Network Process (ANP) is multistage decomposition method used to solve decision-making problems involving more than one criterion of optimality developed by Saaty [9]. The basic idea is to create a decision-making network and the subsequent evaluation of importance of the individual links among the interconnected elements. These evaluations are represented by weights, which are
determined on the basis of pair comparison or by normalizing direct measurements. The ANP does not limit human understanding and experience to force decision-making into a highly technical model that is unnatural and contrived. It is in essence a formalization of how people usually think, and it helps the decision-maker keep track of the process as the complexity of the problem and the diversity of its factors increase [10].

III. CONCEPTUAL FRAMEWORK DESIGN

Designed conceptual framework includes the following steps: Selection of green transport strategy, Selection of Balanced Scorecard approach, Specification of green transport strategy, Prioritization of Balanced Scorecard measures, and Evaluation of green transport strategy reaching.

A. Selection of Green Transport Strategy

The key step of the conceptual framework is selection of an appropriate green transport strategy. For that purpose, authors of the paper offer GTS matrix, which is shown in Fig. 1.

<table>
<thead>
<tr>
<th>Green effect</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Ideal</td>
<td>I. Ecological</td>
</tr>
<tr>
<td>II. Economic</td>
<td>II. Ineffective</td>
</tr>
</tbody>
</table>

Fig. 1 Green transport strategy matrix

The GTS matrix is based on the following criteria: (1) Expected green effect after the GTS implementation – low or high; (2) Estimated cost of the GTS implementation – low or high; (3) Responsibility to decide on the GTS implementation in the given company: I. In the responsibility of the implementers or II. Limited responsibility of the implementers (e.g. within the responsibility of another company department or corporation).

The result are four main GTSs: (1) Ideal – high green effect can be achieved at low costs or even cost savings; (2) Economic – only a limited green effect can be achieved at low costs or even cost savings; (3) Ecological – incurring high costs will achieve a high green effect; (4) Ineffective – incurring high costs brings only a limited green effect.

Ideal GTS is generally used in companies and supply chains, which start with green politics. Economic and Ecological GTSs are implemented when Ideal GTS is depleted. Ineffective GTS should not be used at all. At the same time, green initiatives within the direct responsibility of the implementers are preferred in frame of the selected main GTS.

B. Selection of Balanced Scorecard Approach

According to Butler et al. options for incorporating sustainability/green into the BSC include: (1) Adding a fifth perspective to the BSC; (2) Developing a separate sustainable/green BSC; (3) Integrating the measures throughout the four perspectives [11].

Adding a fifth perspective to the BSC may be the simplest approach. For example, Kurien and Qureshi propose Environment perspective with three indexes: environment, social, and economic [12]. It could provide more visibility but not necessarily increased importance to the sustainability/green ability aspects of corporate management. Isolating sustainability/green measures in a separate perspective might weaken environmental initiatives by not providing clear ties to the other perspectives and to corporate strategies.

The strength of developing a separate sustainable/green BSC is the fact that a sustainable/green BSC can be used to implement a sustainability/green strategy [13]. However, the free-standing nature may fail to help the company tie sustainability directly into corporate strategy. There are two possibilities: (a) to use four original perspectives with completely new sustainability/green measures (see e.g. [14]) or (b) to develop new sustainable/green perspectives. For instance, Hsu et al. propose perspectives as follows: Sustainability, Stakeholders, Internal business processes, and Learning and growth [15].

Integrating new measures throughout the existing four perspectives has the advantage of allowing the measures to be seen as fundamental to day-to-day operations. Integration indicates that management recognizes there are cause and effect linkages between corporate strategies and sustainability/green efforts.

Authors of the paper suggest to use the second approach with four original perspectives for GTS implementation on the company/supply chain transport level and the third approach for company/supply chain level. Designed Green Transport Balanced Scorecard (GTBSC) is shown in Fig. 2.

There are two basic differences in comparison with traditional BSC: (1) Only green measures are taken into consideration; (2) In addition to target values there are threshold and real values. Thresholds represent minimum accepted values of the measures. Realities describe real values of the measures.
C. Specification of Green Transport Strategy

Specific green objectives, measures, thresholds, targets, and initiatives are determined in this step according to the selected GTS and the contemporary green transport level in the given company/supply chain. Authors of the paper designed conceptual framework for assessing the green transport level in industrial companies and supply chains for that purpose. The framework contains 30 general green best practices (initiatives), which are divided into four areas: (1) Strategy – practices creating the basis of a successful application of other best practices or they have the character of supply chain structural changes; (2) Management – practices focused on planning and subsequent execution of transport; (3) Technology – technical innovations of the means of transport, equipment, ICT systems and packages; (4) Staff – practices whose motive power is represented by the people and their skills. [16].

D. Prioritization of Balanced Scorecard Measures

The task of this step is the creation of a system for measurement of the reaching the selected GTS. It is based on the assignment of weights to the four perspectives and their measures. Authors of the paper suggest the ANP method for that purpose, because there are significant dependences between the perspectives and also their measures.

Measures with the highest weight should be incorporated to the existing company/supply chain BSC to ensure the unity between a company/supply chain strategy and the GTS.

E. Evaluation of Green Transport Strategy Reaching

A real values of the selected measures are collected during this step. Using ANP method, level of the selected GTS reaching can be calculated. The evaluation of the results may include: (1) Comparison of the calculated value with the overall threshold and target values; (2) Inclusion of the calculated value into the pre-defined categories (unacceptable, bad, good, very good, excellent GTS reaching); (3) Analysis of the trend if the evaluation of the GTS reaching is performed repeatedly. If there is the unsatisfactory GTS reaching, it is desirable to focus on the perspectives and measures with the highest weight.

IV. CASE STUDY

The verification of the designed conceptual framework is performed on a real supply chain of the European automotive industry. The GTS implementing took place in a company which is incorporated in a multinational corporation. Given the sensitivity of the used data, this section presents only an illustrative case study.

A. Selection of Green Transport Strategy

GTS is related to inbound, internal, and outbound transport, which is planned and controlled by the company. The Ideal GTS is preferred in this case study.

B. Selection of Balanced Scorecard Approach

As the GTS is only a partial strategy of the company
(Company strategy → Green strategy → Green logistics strategy → GTS), the designed GTBSC appears as an appropriate tool for GTS implementation.

C. Specification of Green Transport Strategy

Specific green objectives, measures, threshold, target and real values, and initiatives for each perspective sums up Table 1. Evaluation of reaching the objectives and their measures is carried out on the annual basis. Threshold, target and real values of the measures F1, P1, L1, L2, and C2 are expressed as annual change in per cents. Only objectives and initiatives related to the Ideal GTS in the responsibility of the company were selected.

D. Prioritization of Balanced Scorecard Measures

A network structure, which expresses dependences among the perspectives and measures is shown in Fig. 3. Orientation of the arrows determines the type of the dependences. SuperDecision software was used for the application of the ANP method (see Fig. 4). The software was written by the ANP Team, working for the Creative Decisions Foundation. There are subnets at each measure, which are used for assignment of the threshold, target and real values.

Table 1 Specification of the selected GTS

<table>
<thead>
<tr>
<th>Perspectives</th>
<th>Objectives</th>
<th>Measures</th>
<th>Units</th>
<th>Thresholds</th>
<th>Targets</th>
<th>Realities</th>
<th>Initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial</td>
<td>Transport cost saving</td>
<td>F1: Transport costs / Produced cars</td>
<td>EUR/car</td>
<td>1%</td>
<td>3%</td>
<td>2.5%</td>
<td>4 - Efficient system of green transport monitoring indicators</td>
</tr>
<tr>
<td></td>
<td>High return on investments in green projects</td>
<td>F2: (Net project benefits / Project costs) * 100</td>
<td>%</td>
<td>0</td>
<td>20</td>
<td>5</td>
<td>6 - Logistics service providers with implemented green politics</td>
</tr>
<tr>
<td>Internal Business Processes</td>
<td>Decreasing the CO₂ emissions</td>
<td>P1: CO₂ emissions / Driving distance</td>
<td>g/km</td>
<td>1%</td>
<td>3%</td>
<td>4%</td>
<td>14 - High transport capacity utilisation</td>
</tr>
<tr>
<td>Learning and Growth</td>
<td>Increasing the green knowledge</td>
<td>L1: Green training hours / Number of logistics staff</td>
<td>hours</td>
<td>25%</td>
<td>50%</td>
<td>30%</td>
<td>27 - Eco-efficient motivation system for company logistics staff</td>
</tr>
<tr>
<td></td>
<td>Increasing the green innovativeness of logistics staff</td>
<td>L2: Number of successful green innovations / Number of logistics staff</td>
<td>pcs</td>
<td>0%</td>
<td>30%</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td>Customer</td>
<td>Increasing the green image of transport</td>
<td>C1: Number of positive evaluation in a survey</td>
<td>%</td>
<td>60</td>
<td>90</td>
<td>75</td>
<td>29 - Green training of company logistics staff</td>
</tr>
<tr>
<td></td>
<td>Reducing the local environmental impacts</td>
<td>C2: Number of arriving trucks / Produced cars</td>
<td>pcs</td>
<td>1%</td>
<td>4%</td>
<td>3%</td>
<td></td>
</tr>
</tbody>
</table>
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Fig. 3 Network structure of the designed GTBSC

Fig. 4 Network structure in SuperDecisions software
E. Evaluation of Green Transport Strategy Reaching

The main result of the evaluation step using the SuperDecision software is shown in Fig. 6. The present state of reaching the green objectives and GTS is 69%.

Table 2 System for evaluation of the GTS reaching

<table>
<thead>
<tr>
<th>Category</th>
<th>Interval</th>
<th>Corrections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>&gt; 1.00</td>
<td>Unneeded</td>
</tr>
<tr>
<td>Very good</td>
<td>0.75 – 1.00</td>
<td>Small</td>
</tr>
<tr>
<td>Good</td>
<td>0.49 – 0.74</td>
<td>Large</td>
</tr>
<tr>
<td>Bad</td>
<td>0.22 – 0.48</td>
<td>Principal change of GTS</td>
</tr>
<tr>
<td>Unacceptable</td>
<td>&lt; 0.22</td>
<td>Total change of GTS</td>
</tr>
</tbody>
</table>

Present state of the evaluated GTS implementation is good that is why large correction initiatives must be planned and realized.

V. Conclusion

The presented case study has demonstrated the viability of the designed conceptual framework for supporting a GTS implementation in industrial companies and supply chains. Future works will be oriented on adding the fuzzy approach to the framework.

REFERENCES