

# Topic Map based Indicator System for Environmental Management Systems

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Environmental Management Systems, Balanced Scorecards, Environmental Policy, Environmental Objectives, Topic Maps

## Abstract

Try to reach a particular goal in an environmental management system should be associated with strategies, e.g. for environmental goals, or for environmental policies. Sustainable protection can be achieved so that public environmental departments get the possibility to have a better costs control about planning, doing and checking measurements, or organizations have the possibility to control influences onto its internal and external interrelated processes. But in reality in environmental management systems strategies are unclear, or miss totally. This paper describes how these systems can fill this gap, and derive strategies by linking the fundamentals of the management instrument “Balanced Scorecards” and the semantic network standard ISO/IEC 13250 for Topic Maps together.

## 1. Introduction

Strategies, e.g. for mission statements in environmental policy, or for environmental objectives are one of the most important tools for a successful enforcement of an environmental management system in organizations. They enable the coordination of intern and extern relations and react onto these influences. In most organizations there exist only loose or no strategies. The reasons for that can be the followed:

- unreadiness of the organizations administration to declare concrete strategies for the environmental management (also because of tactical or political reasons)
- inadequate knowledge of the top management about environmental management
- ignorance
- etc.

But also without these guidelines the top management has the duty to administrate the organization successfully. Because of the missing concrete strategies there does not exists a suitable tool

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to evaluate different measures. Therefore it is even more difficult to give reasons why one action alternative could be better than another one. Normally a strategy shows the direction of an organization and where it wants to go. Planned or implemented strategies can be estimated or evaluated with these directions so that success can be derived.

Despite of missing strategies there is still the necessity to plan different action, or to give an opinion about alternatives. One of the solutions could be the usage of a Balanced Scorecard (BSC). But also a BSC as one of the most distributed management tools worldwide is not able to identify successful actions if concrete strategies are missing. With this paper we show a concept of how associations can be extracted for organizations which do not have explicit strategies or long-running guidelines. All associations which influence each other in these organizations will be displayed and visualized. Nonetheless these circumstances make it possible to predict the corporate success and all actions, its corresponding cause and effects, and its action alternatives (Arndt 2007), Freese (2000).

## **2. Balanced Scorecards as an indicator system**

A clear measurable and controllable strategy is the base for success in an organization (Kaplan/Norton 1997) For an environmental management system the Balanced Scorecard represents one of the tools for the plan do check act processes in an organization (Kaplan/Norton 1997) Beside the financial control parameter which are influenced by the past (Wagner 2002) the Balanced Scorecard describes indicators which can be influenced and make future planning controllable (Kaplan/Norton 1997) They are also called performance drivers. These objectives and all its affected indicators are declared by the vision and strategy of the organization (Kaplan/Norton 1997). They can be characterized as long-termed and are influenced by the base of an organizations objective and strategic programs which has been specified by the normative and strategic management. All objectives of a Balanced Scorecard are viewed by four perspectives (Kaplan/Norton 1997, and Wagner 2002):

1. Financial Perspective
2. Customer Perspective
3. Business Process Perspective
4. Learning and Growth Perspective

All different perspectives contain a common structure. Beside they consist of the following dimensions (Göbel 1999):

- Strategic objectives: for all of the viewed perspectives the strategic objectives must be declared
- Measurand: in each perspective suitable indicators for the measurement of the objective have to be found. The measurand has to contain critical and promising factors (Wagner 2002)
- Target value: for the realization of strategic objectives indicators for the control of the objective must be derived from the found measurand

- Measurement: actions which are necessary for the objectives must be described

As shown above most of the organizations do not have explicit objectives for its environmental management like they should be contained in a Balanced Scorecard. For an effective and efficient assignment of an environmental management it is necessary to predict different actions and all its alternatives. Assessments of actions are done by relevant indicators which indirectly stand for representative objectives. By a bottom-up analysis of these indicators the possibility exists to generate objectives.

In the following chapter we explore the possibility to establish an objective and indicator system while using Topic Maps. With Topic Maps it is possible to represent cause and effects of indicators in organizations. An organization has the possibility to predict actions and administrate it without having clear objectives.

### 3. The Topic Map standard

The idea of how to represent a semantic network as a model (Widhalm/Mück 2002) is based onto the idea of the Davenport Group (Pepper 2000). Primary topic maps have been developed to give users the possibility to work onto glossaries, indexes, or other lists (Smolink 2005) and to represent an idealized, adequate, simple, and idealized model of the reality (Rosemann 1996). In 2001 topic maps have been accepted as standard ISO 13250:2000 (ISO 1999) by the International Standard Organization (ISO). At the end of 2001 it has been upgraded to ISO 13250:2003 (ISO 2002) which is based onto the web based eXtensible Markup Language (XML) That's why this standard is also named as eXtensible Topic Map (XTM). In sum topic maps are able to represent a complex structures of knowledge bases and give users the possibility to edit its structures. ISO 13250:2003 specifies the following elements of a topic map (Widhalm/ Mück 2002):

- Topics: Topics represent the main elements in a topic map. Compared to Smolnik (2005) topics generate all subjects of the real world, or can be better described as representatives of subjects (XTM 2001). That means that - in a consistent topic map - one subject is illustrated by one topic. If a subject is referenced by more than one topic these topics can be merged to one (XTM 2001). Additionally each topic can possess different properties. E.g. a name can be mentioned in "topic names", relevant information objects can be described in "topic occurrences" and associations and its roles to other topics can be mentioned in "associations".
- Topic Names: Each topics is associated with a unique name represented as "baseName". Restrictions like the usage of one "display name", or one "sort name" have been skipped in the new standard 13250:2003.
- Topic Occurrences: Occurrences in topic maps are useful to display relations to other information objects via an Uniform Resource Identifier (URI). Additionally external resources like images, books, videos, or audio streams can be integrated.
- Subject Descriptor: It is possible that a topic with different content is distributed over two topic maps. With a subject descriptor it is possible to merge these two topics to one.

- Associations: Compared to Widhalm/Mück (2002) associations can be described as multi-directional relations where the state of these relations differs between symmetric, transitive, or reflexive. Compared to the concept of topic maps associations' are also described in topics; additionally association types, or class hierarchies can be added.
- Scopes: Using topic names results in the fact that names can reflect different meanings. To avoid this fact ISO 13250:2003 provides the usage of scopes. A scope describes in which context a topic is valid or not (Pepper/Gronmo 2002). The usage on no scope in a topic means that a topic is valid in every context.

#### **4. A Topic Map based Balanced Scorecard of an environmental management system on the example of an environmental township organization**

Even if there are no explicit environmental strategies and goal demands in an environmental management system, there still exist general conditions which limit action alternatives. These limits must be regarded while modeling an indicator system. These limits could be e.g. the laws of the nature which can not be influenced. Also there are legal factors like laws for environmental organizations. Typically these factors are enlarged by an organization internally, or replaced by norms and regulations. All these circumstances restrict action alternatives resulting in a less amount of potential goals. Because of that action alternatives, which represent cause and effect associations, are important parts of a semantic web.

Action alternatives are strictly limited by valid general conditions. Possible alternatives are restricted by legal rules. Additionally the amount of left legal possibilities will be reduced by monetary, or social factors, or both. Nonetheless there exists the possibility that action, which is influenced by non-financial, or social force, can be realized, e.g. laws from the government.

For example compared to the municipal code of the region Saxony-Anhalt/Germany a township is responsible for public tasks. These task can be splitted into tasks by duty, or voluntary tasks. A third possibility can be seen in the fact that a the task should be realized by a country, or a region, and has been given into the hand of a township. With this example it is clear that action has a very limited margin. All duty actions must be done with high quality. Only the voluntary action accept a variation, often resulting in an action cut-off. All actions are legally binding. As example the regulations for child care, or fire prevention could be mentioned.

A second condition which binds an environmental management system will be described with the social structure. Also these conditions are closely related to legal rules. E.g. if there exists a high number of unemployed in a township the organization of a township should force the effort to approach manufacturing industry.

A third restriction for an environmental management system township organization can be seen in the budget. Typically this budget is restricted and must be regarded by individual activities. Of course the amount of money which will be spende can be redirected, but a lot of spending money positions are fixed. This often results in the fact that money will be saved on positions which are supposed to be spende for voluntary actions.

Beside these three restrictions there are additionally political influences. Also they can restrict (voluntary) action or initialize additional activities. For receiving an indicator system, which completely represents all cause and effects in an environmental management system and its corresponding derived goals it is necessary to acquire every described requirements. Afterwards all tasks can be associated with key performance indicators. The positive thing about using key performance indicators is the fact that they also represent restrictions.

The following figure visualizes different general conditions which should be regarded while deriving central control parameters. They will be represented schematically as Topic Map. To derive a better survey between each layer associations will not be labeled in the figure.

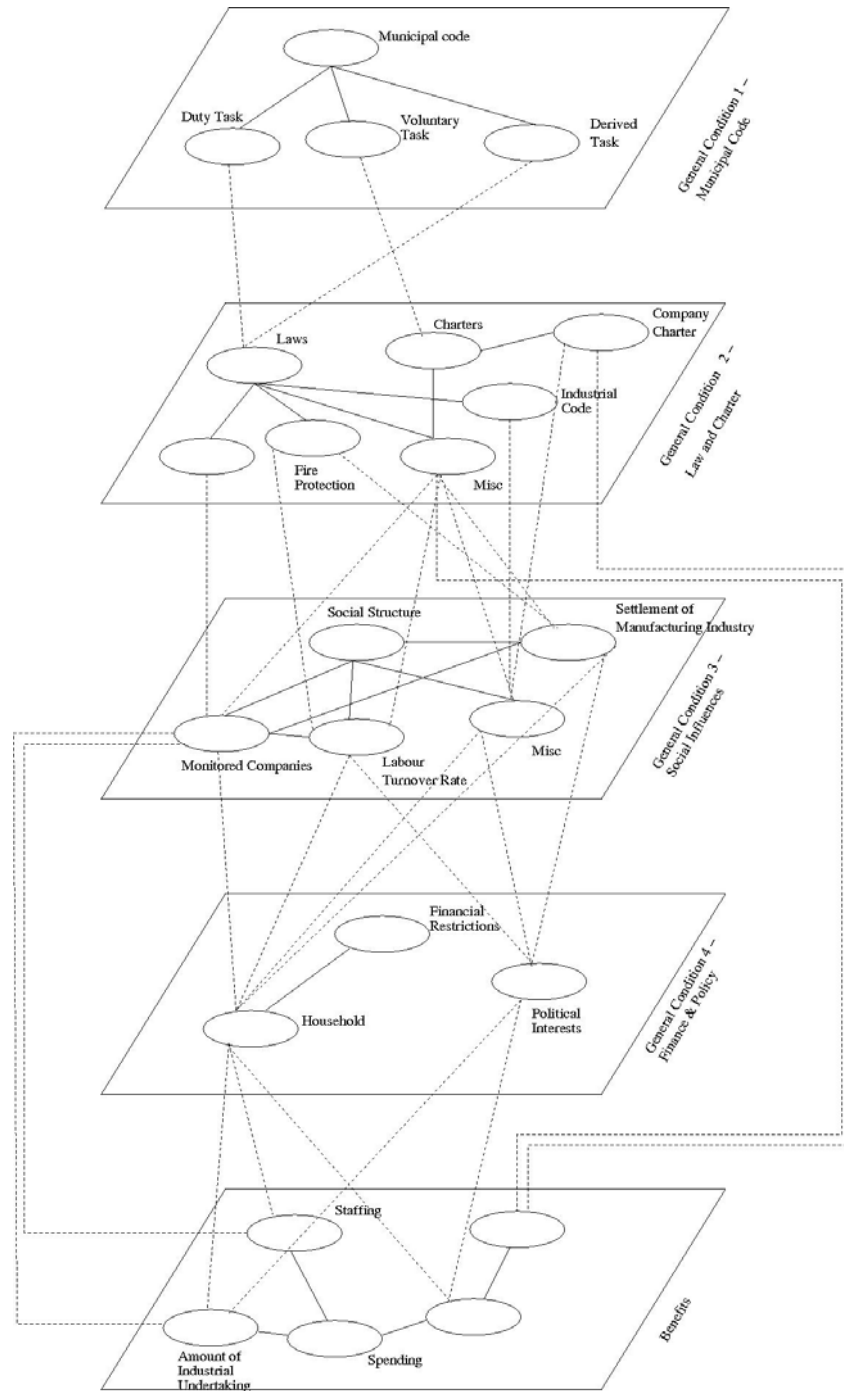


Figure 1: A topic map containing different layers for general conditions based on a township environmental management system

For a better illustration the indicator system was splitted into its layers. Associations between indicators are represented by lines drawn through, all other dotted lines mark associations between different indicators located in different layers.

With the top level figure 1 represents a topic map which reflects all legal rules of a municipal code which can influence an environmental management system. All associations between the topics in this represent the fact that a municipal code pass its tasks to its corresponding township. The next layer also reflects laws and charters. All laws which take influence on the first layer will be put in concrete terms by individual laws and charters followed by a description of how and in which circumstances this service can be realised. Each association between the first and the second layer describe allocations of special provisions of law to the derived tasks and limit these tasks. Each relation between topics in one layer also describes categorisations of its special provisions of law.

The following layer describes the influence of the social structure onto each action alternatives. Exemplarily some of these indicators are shown in the figure. These can be the amount of manufacturing companies which settled to a township, or the labour turnover rate. Each indicator can be identified by an acquisition. As mentioned in the figure each topic displays its influence onto the social structure, on the other site the cause and effect between the labour turnover rate and the rate of settlement of manufacturing industries can be identified. In our example every topic of the third layer displays only charters and laws which will influence the action from the social part of view. That's why only the second and the third layer have been connected. Regarding the fourth layer it includes all restrictions for general conditions which will be influenced by financial and political boundaries. The topic "Household" represent the available budget which restricts all other financial interests.

Additionally political interests might influence the general finance and political general conditions. E.g. there might be pre-election promises which have to be fulfilled. Nonetheless a change of the social structure can result in different political actions. That why this layer is associated with the third layer.

The last layer represents concrete indicators. Figure 1 only shows an example of how it could look like. For each indicator there also exist cause and effect associations. They can be influenced by the monetary and political indicators of the fourth layer, or influenced by other indicators from higher layers. Nonetheless - as shown in figure 1 - it is possible that indicators from higher layer influence indicators in the fifth layer. The complexity and variety of figure 1 shows how a small choice of tasks in an environmental management system can expand which results in a restriction of how these tasks can be fulfilled.

## 5. Summary

Even if there is a small number of indicators in an environmental management system, there might be the possibility that the representation of its model can expand to an unclear model because of all cause and effect associations. If indicators will be eliminate a model could be misunderstood, if to many indicators will be used the whole model will expand and become unclear. With transformation of the environmental management system first to a BSC and second to a topic map, it is possible to represent a complex environmental management system. With the usage of scopes it is possible to represent a clear complex model. Beside because of associations between all topics and the usage of operators it is possible to derive goals and strategies.

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