TOPIC MAPS FOR REPRESENTING BALANCED SCORECARDS

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Abstract: Balanced Scorecard is a performance management tool that enables efficient business management. Information like cause-and-effect relations of the performance indicators improves the approach further. That is the reason why we consider Balanced Scorecards as a knowledge system. Topic Maps are a standard to represent knowledge in a digital way and they concentrate on the findability of information.
We propose a standard called Scorecard Maps that brings both systems together. The objects of a Scorecard Map are elaborated from the Balanced Scorecard approach. We realise a generality by not restricting the objects and by implementing several calculus for performance indicators.
The Scorecard Map can deal with a complete company although only a user specific view will be given. This means that only a Scorecard Map model is needed for the complete company.

Keywords: Balanced Scorecards, Topic Maps, XML, Knowledge representation.

1. MOTIVATION

In these days companies are influenced by quick changing technical progresses, business pressure of fast growing competitors or reduced product life cycles. That's why companies change their management from a conservative to a dynamical and flexible one. But a company's management cannot be flexible enough if it does not have the information which processes have to be improved or reengineered. This information must be expressed in key performance indicators. Otherwise it would be hard to find out whether the net gain raised or fell last year. These indicators are used to split between necessary and unnecessary information, compress the necessary information and represent all relevant parts of a company. In result somebody is able to use this compressed complex reality to manage a company. But how do these indicators looks like, how can somebody handle thousands of indicators in a big company and represent special needed information in special departments of a company without loosing information? How are the indicators related to each other?
In this paper we propose a solution by using the well known Balanced Scorecard system (BSC) and connect this system with topic maps, an ISO standard for the representation and interchange of knowledge. In part 2 and part 3 of this paper we give an overview about the special features of the BSC and Topic Maps and their advantages and disadvantages. In the main part 4 we propose a solution of how these 2 systems can be put together. We end up our paper with an example followed by conclusion and outlook.

2. BALANCED SCORECARDS

"If you can't measure it, you can't manage it" (Kaplan & Norton (1996), p. 21). With this sentence the Balanced Scorecard system inventors Robert S. Kaplan and David P. Norton made a statement which describes a common problem in the industry: you can not manage a company if you don't have performance indicators to manage and control your company. But what about indicators like the mental satisfaction or the motivation of your staff. Can you measure it?
With the BSC Kaplan and Norton represented a management tool for bringing the current state of the business and the strategy of the company together. It is a result of previous indicator systems. The DuPont-schema for instance was invented in 1919. It was adapted (i.e. ZVEI performance indicator system

(ZVEI (1989))) and used for decades. In sum all systems use key indicators to represent a company's business. But a BSC is more than a business system (Friedag & Schmidt (2004)). Kaplan & Norton (2004) emphasise this in their further development of Strategy Maps. Figure 1 shows an overall involvement in a company's strategy by managing the company with a BSC.

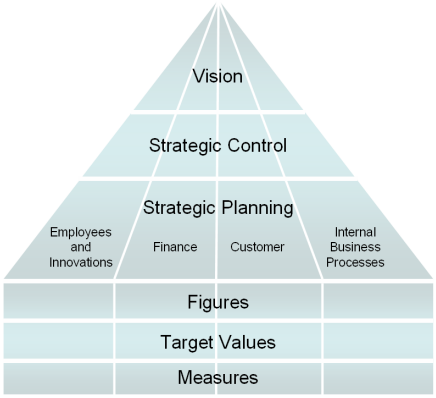

Fig. 1. The BSC Approach.

The company's vision describes where the company will go whereas the company's strategy characterises the way how the vision is reached. Strategy is divided into the planning and controlling processes. Planning is done in all perspectives of a company. Concrete targets are set. Strategic control is attached as the next step to check the targets and to depict the fulfilment of the vision. The fundament on which the strategies are built is measurement. Due to the complex structure of businesses, measures are depicted to describe the current state of the company in dependence of perspectives. The strategy is translated into target values for the measurements. On the other hand, aggregation from measures to business is used to reduce the convoluted numbers of measurements.
But what are these performance indicators and how can you measure it? Preißner (2002, translated) divides the functionality of indicators into four topics: operationalisation ("indicators should be able to reach your goal"), animation ("a frequent measurement gives you the possibility to recognize important changes"), demand ("it can be used as control input") and control ("it can be used to control the actual value"). Nonetheless – for our purpose in this paper - we understand an indicator as defined in Lachnit (1979). Figure 2 gives the classification we use for indicators.
Also indicators must be divided into absolute and relative performance indicators. One of the advantages of using absolute ones is that you can calculate new information by using arithmetic operators like addition, division, multiplication or subtraction. Absolute indicators can represent quantities, data on a value basis or information without a dimension. Relative indicators can be assumed as a part of a total volume, a relation between similar information or a comparison to a given basis. But for all indicators a measurement or a given calculus with measurable information must exist.
Several possibilities exist. The indicators can be handled as crisp data. This is the usual case in using indicator systems like the BSC. In this case an indicator has a known value at a certain point of time. The examples in Figure 2 are of this kind. But naturally the current state is not well known. Uncertainty can be distinguished into stochastic and fuzzy uncertainty. For a further differentiation see Zimmermann et al. (1993). Both modes are different to interpret but for both types a calculus exists. In a complex stochastic environment Markov Chain Monte Carlo simulation might be the only choice to get a better understanding of the BSC indicators, cf. Köppen & Lenz (2005). Using Fuzzy set theory in combination with the BSC is another possibility. Nissen (2006) describes a way for Fuzzy aspects within the BSC. Kaplan & Norton (1996) emphasise that more than a simple fuzzy variable is necessary to obtain a value from the BSC (Kaplan & Norton (1996), p. 255). It should be mentioned that both depictions which can be used as a variable or an indicator are not standing in contrast (cf. Dubois & Prade (2006), Köppen & Lenz (2006)).

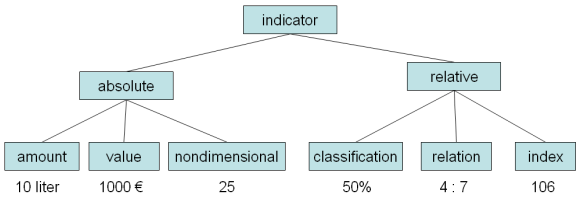

Figure 2. Classification of indicators.

We suggest that a performance indicator is described with all possible available information and the gain is reached by using the relationships. Here the calculus is dependent upon the variable descriptions.
But before you decide which indicators you use to build up your BSC and the corresponding perspectives you have to look onto the importance of the indicators. Kaplan and Norton divide indicators additionally into hard and softer objectives (depending on the possibility of how measurable objectives are, e.g. net gain versus a social status of an employee), short and long-term objectives (which gives the management the possibilities to predict the company's future, e.g. employee fluctuation or customer satisfaction) Kaplan and Norton also consider about cause and effect. The three main aspects are that:
1. all indicators which does not make sense are not valuable to be included in the BSC,
2. while building a BSC, a company should be differentiated between performance and result indicators and
3. all non-monetary values should influence monetary values.
Based on these indicators we are now able to build up a complete system of indicators which turns into or influences each other. Reichmann (1990, translated) describes this measurement as an essay of bringing different performance indicators together in a sensible

way so that indicator complete their information and result in a common goal. E.g. all indicators of the well known Du-Pont-Schema result into the common goal return on investment (ROI). One of the disadvantages of traditional indicator systems (e.g. the mentioned Du-Pont-Schema) is that a company's management concentrates on short-term periodically gains without regarding the financial future of their company. Additionally, non-monetary indicators like customer satisfaction will be excluded in traditional indicator systems. Omitting these values stand for loosing qualified information that can help the management to drive a company's strategy better.
Tackling against these disadvantages Kaplan and Norton published the BSC, the milestone for modern performance measurement. In sum the BSC seeks a measurement for one of the following four perspectives:
1. Financial Perspective to reflect the financial performance like the return on investment
2. Customer Perspective to sum all indicators of the customer/company relationships
3. Business Process Perspective to give an overview about key business processes
4. Learning and Growth Perspective which measures the company's learning curve
By splitting a company into four different views the management of a company gets the chance to have a quick overview over the main perspectives of their company and divide these into usable and unnecessary layers. The management can focus onto their strategic goal they are responsible for and are able to react before it is too late. They are able to connect qualitative performance indicators with one or all business indicators. Also the construction of an adequate equation system might not be impossible. But the BSC is not restricted to these four perspectives. A customization of the companiy's perspectives is advisable (Friedag & Schmidt (2004)). Nevertheless the relations between indicators should be elaborated and an approximation of the relations of these indicators should be considered. For this case multidimensional estimation like multivariate density estimation is an appropriate tool for modelling the relations of the business indicators.
Due to the fact that variables are described as crisp, stochastic or fuzzy data an arithmetically equation system can deliver unknown variables. That is the reason why we focus on such relations. Another possible way to model fuzzy relations in a BSC is described in Nissen (2006). But this leads to restrictions in the variable domains.

3. TOPIC MAPS

Topic Maps (TMs), also known as the ISO/IEC 13250:2000 standard, represent an idea of the Davenport Group (Pepper (2000)). This group first mentioned TMs as an essay of how to visualize knowledge via information technology. TMs can be described as a development of the semantic web which allows references to information objects. The roots of TMs can be found in the structures of how to process knowledge in information technology like classification, building up thesauri or creating indexes for quicker search. Knowledge in a TM is represented by topics; each topic has an association to another topic which fulfils its information. Additional information can be achieved by so called occurrences: they describe which other sources (e.g. pictures of a topic) can be used to fill up the information of a topic. So one of the key features of TMs is that description of information and resources are strictly separated.
With the modification of the TM standard in 2002 to ISO 13250:2002 the TopicMaps.org author group began to think about the usability of topic maps in the World Wide Web. This group used features of XML schemas and created the TM XML standard (XTM). By using a XML schema TMs got the chance not only to be visualized. Also different datasets and information sets respectively could be merged or used as input for new topic maps. By using XTM, additionally, TMs get the chance to describe topics in a better way, e.g. the possibility how to describe a role of a topic.
One main feature is the usage of the XML element scope: different views can be achieved without rewriting a topic map. So a user gets the feature to hide unnecessary information and concentrate on necessary ones. All these XTM items make a topic map a perfect tool to display BSCs in a company. Different company's departments can display their necessary information, fulfil their information e.g. by merging XTMs from sub companies or departments without loosing the company's strategy as the big picture in the background. Nonetheless information - quantitative and qualitative - can be calculated.

4. SCORECARD MAPS

In the previous section the concepts of Balanced Scorecards and Topic Maps were introduced. Both ideas can be combined and a standard format for describing the Balanced Scorecard with business indicators and strategies can be established. In this section we give you an idea of how to develop Scorecard Maps.
A business indicator can be seen as an object of a current value that was measured or computed, although there might be a difference between name and meaning of a business indicator. So a short description of what the underlying measurement or what the business indicator interpretation is should be part of the object business indicator. For global acting companies with no common language it might be of interest to use different languages for the name and for the description of the business indicator. The CEO of a Spanish speaking company can use exactly the same Scorecard Map as his colleagues in an English speaking country without misunderstanding. For the concept of these perspectives in a Balanced Scorecard the object can also be attributed by the corresponding perspective.
The relation between business indicators might be mathematically described by equations. To depict an equation in our Topic Map we use the object operator and the object business performance indicator. The object operator consists of a mathematically symbolic

and the definition of left and right hand side variables. In the case of the operations +, -, * and / the equations are separable. So it is possible to reformulate the equations and forward and backward calculations are possible. Furthermore the operators + and * are commutative and therefore the order of the right hand side variables (independent or input variables) is irrelevant.

Another object of the Scorecard is the representation of a user or a whole user group. As depicted in section two, there does not exist one Balanced Scorecard; there exists a view onto the Scorecard. We propose that a user group belongs to a certain level. This level corresponds to the strategy level and to the aggregation level of the business indicators. The object user group in the Topic Map is also attributed by a language dependent description. A user can belong to one or more user groups. The object user group is directly connected to the other main objects of the Scorecard Map.

The strategies are another important aspect of the Scorecard Maps. They are ordered in a hierarchy corresponding to the management hierarchy. The top management formulates the business vision and gives the top strategy. In a top down process this strategy is transferred to strategies of a lower level. In this level the scope is limited to the main objectives of the organisational unit. By using this top down process, clear details for the corresponding department will be represented without revealing another one their secret strategies.

Beside of these objects the relations between objects build up the topic map. E.g. in our scorecard map there exists relations between business indicators. These relations use the mathematical interpretation of equations. The operator defines how many business indicators are related in an equation.

Digital dashboards are the control centres for a business and represent a type of executive information system. They summarise the current state of the business by selected indicators. They should display accurate, consistent and timely data. Most of the time a dashboard is created in a portal-like environment with help of devices like charts, set of traffic lights, summaries and drill downs.

To distinguish between dashboards and scorecards, strategies should be related to the business indicators. This is a very complex and subjective process. Due to the fact that the business indicators are related via an equation system it is possible to derive intermediate targets of the given target values for business indicators.

A complete scorecard for a company can be a very complex and an unmanageable system. A reduction for certain user groups is necessary. This can be done in the Scorecard Map with the relation strategy and user group and on the same time with the relation business indicator and user group. While on the one hand not every strategy plays a role for a user on the other hand business performance indicators can also be restricted to a certain level, i.e. they are measured in a given organisational unit or are highly aggregated to compress information of similar objectives.

We now present our remarks on generating Scorecard maps and use for the design significant abstracts from XTM files.

4.1 Representation of Business Indicators

Business indicators of a Scorecard Map are topics. They are an instance of a specific perspective. A perspective is a topic that is described by a base name. Figure 3 shows the topic Finance.

```
<topic id="Finance">
 <baseName>
  <baseNameString>Finance</baseNameString>
 </baseName>
</topic>
```

Figure 3. Finance Perspective.

```
<topic id="AdditionOperator ">
 <baseName>
  <baseNameString>+</baseNameString>
 </baseName>
</topic>
```

Figure 4. Topic Addition

In a global acting company several languages might be spoken. We use different language topics to differentiate between various names for a unique business indicator. In our example we use English and German. In a representation it might be useful to abbreviate the variable names. This is done in our topic map using a topic abbreviation. Usually a variable is specified by values. To be general we implement different topics for stochastic and fuzzy variable modelling. As an example the Gaussian distribution is a topic and it can be parameterised by mean and standard deviation, which are also topics. The values are directly formulated in the topic that describes the variable, i.e. Profit. The Fuzzy membership functions can also be expressed with values. For a specific function like the triangular membership function (Figure 6) the values are specified again in the topic of the business indicator. But also topics are used for the values. Figure 5 shows the topic Gaussian distribution and in Figure 6 a triangular Fuzzy membership function is presented. There are no restrictions to the use of values for describing uncertainty within the topic map.

Crisp data for a variable is implemented by creating an instance of our topic real value and assigning a value similar to the other value assignment above.

4.2 Representation of Equations

An equation is an association between an arithmetic operator and business indicators. An equation has at least one input variable and one output variable. How many inputs and outputs exist depend upon the operator. The operator is a topic and to keep things simple we do not implement a validation rule for the inputs and outputs of an operator. The XML mapping of a plus operator is shown in Figure 4.

```
<topic id="RealValue">
 <baseName>
  <baseNameString>Real Value</baseNameString>
 </baseName>
</topic>

<topic id="GaussianDistribution">
 <baseName>
  <baseNameString>Gaussian Distribution</baseNameString>
 </baseName>
 <member>
  <topicRef xlink:href="#RealValue" />
  <baseNameString>Mean</baseNameString>
 </member>
 <member>
  <topicRef xlink:href="#RealValue" />
  <baseNameString>Standard Deviation</baseNameString>
 </member>
</topic>
```

Figure 5. Gaussian Distribution

The relationship is mapped into the XTM with an association and the variables of an equation are members of the indicators with a role corresponding to the operator. The operator itself is an instance of the topic operator. Figure 7 shows the relationship of Transaction volume = Profit + Costs.

```
<topic id="FuzzyTriangularMembership">
 <baseName>
  <baseNameString>Fuzzy Triangular Membership Function</baseNameString>
 </baseName>
 <member>
  <topicRef xlink:href="#RealValue" />
  <baseNameString>Lower Value</baseNameString>
 </member>
 <member>
  <topicRef xlink:href="#RealValue" />
  <baseNameString>Peak Value</baseNameString>
 </member>
 <member>
  <topicRef xlink:href="#RealValue" />
  <baseNameString>Upper Value</baseNameString>
 </member>
</topic>
```

Figure 6. Fuzzy Membership Function

4.3 Representation of User Groups, Strategies and the Relations between

The user management of a companywide BSC can be done in a standalone topic map. User should be grouped to access different indicators and create a customized view of the strategy and goals of the company. A user group is a simple topic. The user itself is a topic which is an instance of one or more user groups. Figure 8 gives an example of a user group and a user.

The linkage between business indicators or perspectives and the users is done in an association that is placed into the Scorecard Map. This link can be used to create views of the BSC for certain usage. All parts of the association are members of the topics. Figure 9 combines user group A with profit.

A strategy represents another topic in a BSC. A short description of the essentials of the strategy beside a representative name should be given. Due to the fact

```
<association id="TransactionVolumeEqualsProfitPlusCosts">
 <member>
  <roleSpec>
   <topicRef xlink:href="#input" />
  </roleSpec>
  <topicRef xlink:href="#Profit" />
 </member>
 <member>
  <roleSpec>
   <topicRef xlink:href="#input" />
  </roleSpec>
  <topicRef xlink:href="#Costs" />
 </member>
 <instanceOf>
  <topicRef xlink:href="#AdditionOperator" />
 </instanceOf>
 <member>
  <roleSpec>
   <topicRef xlink:href="#output" />
  </roleSpec>
  <topicRef xlink:href="#LoyalityCustomer" />
 </member>
</association>
```

Figure 7. Association of Transaction Volume = Profit + Costs

that the company strategy should be known to each employee and user of the BSC there is no relation between a specific user or group and the strategy. But an association between a strategy and the key indicators should be taken into account. In the topic map this is again an association. Figure 10 is an example of a strategy and the relationship to the indicator profit. Here the explanation and description of the strategy is done in a separate HTML file (ProfitStrategy.htm) which is linked.

```
<topic id="UserGroupA">
 <baseName>
  <baseNameString>User Group A</baseNameString>
 </baseName>
</topic>

<topic id="User1">
 <instanceOf>
  <topicRef xlink:href="#UserGroupA" />
 </instanceOf>
 <baseName>
  <baseNameString>Mr. X</baseNameString>
 </baseName>
</topic>
```

Figure 8: User Group and User in XTM Representation

```
<association id="ProfitUserGroupA">
 <member>
  <topicRef xlink:href="#Profit" />
 </member>
 <member>
  <topicRef xlink:href="#UserGroupA" />
 </member>
</association>
```

Figure 9: Association of User Group A and Profit

```
<topic id="ProfitStrategy">
 <baseName>
  <baseNameString>ProfitRaising</baseNameString>
 </baseName>
 <subjectIdentity>
  <subjectIndicatorRef xlink:href="http://localhost/ProfitStrategy.htm" />
 </subjectIdentity>
</topic>

<association id="ProfitUserGroupA">
 <member>
  <topicRef xlink:href="#Profit" />
 </member>
 <member>
  <topicRef xlink:href="#UserGroupA" />
 </member>
</association>
```

Figure 10: Strategy and Relationship to Business Indicators within XTM

5. A SCORECARD MAP EXAMPLE

In this section we want to give an example for a Balanced Scorecard mapped into a Scorecard Map.
In our BSC example we have 25 business performance indicators that comprise the BSC. To keep things simple we leave out different users or user groups. In this case the Balanced Scorecard can be interpreted as a view from a specific management level. For all indicators a German and an English name exist. Descriptions can also be added but are left out for simplifications. The four classic perspectives are used. Our Scorecard shows all indicators used and the relationships between these indicators. The selected name domain is English and the operators "+" and "*" are constituted with a symbol different from the indicator topics. We also distinguished between indicators and constants that we need for simple equations like reciprocal. The different perspectives are drawn with a dotted environment. An auxiliary variable is used for a more complex relationship between four business indicators. But a perspective is not directly attached.

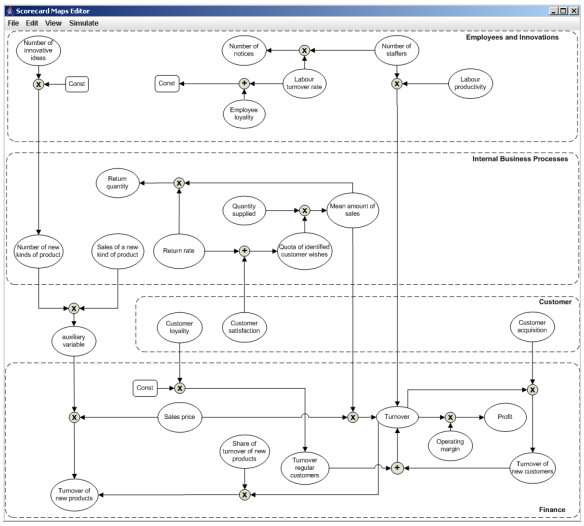

Figure 11: Strategy and Relationship to Business Indicators within XTM

6 CONCLUSION AND OUTLOOK

In this paper we represented an idea of how to lift Balanced Scorecards to a next level called Scorecard Maps. In the past decades the executive management concentrated only on representing their company with inflexible indicators like gains and money losses to calculate their return on investment. They only gave you the chance to get a view what happened in the past with your company. With the release of BSCs the management got the chance to predict the future of a company. A solution of how to calculate non-monetary values like employee satisfaction is now possible. Additionally BSCs give you the chance to identify drivers in your company which bring your company to success. But in a fast growing economy several problems are not solved. For example there is no quick solution of merging different strategies like for companies which has been bought up by another one.
With our paper we gave you the idea to concatenate Topic Maps with Balanced Scorecards to so called Scorecard Maps. By using the features of TMs a company is able to concatenate strategies from bought up companies or subsidiary companies without reengineering all processes. Additionally, a company will have a tool to represent strategies only to these scopes the strategies are important for without loosing features of a classical BSC. All drivers and indicators can be still calculated. For future work we follow the goal to find a common standard process of how to merge different Scorecard Maps without reengineering processes. One main part of our future work will be an experiment of extracting business data to create just in time scorecard maps. Furthermore these should also be used by multivariate simulations. So an executive management will be able to predict a company's future in different scenarios.

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