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Model-based Evaluation Environment for Sustainability

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Abstract

Nowadays, many companies are using enterprise models within an enterprise planning system to develop their business strategy. In order to follow a holistic sustainability approach, environmental, economic and social aspects have to be integrated into these models on a strategic, tactical and operational level. This results in an increased model complexity and requires mechanisms to ensure consistency and efficient model management. Furthermore, the user is confronted with a variety of data and is not able to perform model validation and verification as well as using the enterprise model as a tool for operational support. This paper presents an approach of a model-based evaluation environment by extending enterprise models with sustainability artefacts, to empower the users within their decision-making towards a sustainable enterprise orientation. A framework for contextual enterprise modelling is applied to provide configurable individual model evaluation and application views.

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1. Introduction

Enterprise planning and development are very complex and comprehensive tasks. Especially in the context of sustainability, additional legislative and stakeholder requirement considerations make it much more challenging to manage these tasks effectively than it used to be some years ago. Based on the triple bottom line approach to sustainability [1] economic, environmental and social aspects need to be considered. The firm's overall objectives thus become multidimensional and have to be broken down to the single departments and business fields. To ensure a systematic embedding of the individual business strategies, objectives and their monitoring within all levels, enterprise models are particularly suitable as an instrument within enterprise planning to combine these three elements into one holistic approach. Tools for defining and visualizing performance indicators are no longer sufficient to capture the complex requirements of a comprehensive sustainability approach to enterprise planning. Moreover, a solution for enterprise sustainability management (ESuM) and its evaluation is

required to balance economic, environmental and social dimensions, thus ensuring an improved level of decision making. Today, there exist a number of methods and systems which provide an insight into the effects of substance, material and energy flows and balances on the environment. Enterprises use these to fulfil mandatory reporting requirements necessitated by the legal and market environment as well as own corporate objectives. These requirements push firms towards ensuring quality improvement, managing production cycle reductions and to consider thresholds for energy consumption and carbon footprints [2].

However, all these methods focus on the production processes and are limited to the evaluation of quantitative aspects of sustainability [3]. Drawing conclusions from these aspects for the overall corporate is neither representative of the actual state of progress nor would this lead to the identification of potential levers for improvement. In order to make decisions for the whole enterprise and to act on its individual sustainability targets, a lot more information about

interdependencies between processes is needed to ensure that also qualitative aspects are taken into account.

This paper presents a model-based approach, which allows connecting enterprise planning and operational controlling. Based on an integrated enterprise model the demands of managerial planning and operational controlling are depicted in a model-based evaluation environment. The presented approach is a further development of the multi-perspective modeling within the Collaborative Research Centre SFB 1026 – “Shaping Global Manufacturing Sustainable Value Creation” [4], [5]. It illustrates how planning objectives, indicators and visualization components can interact based on an integrated enterprise model and how the different dimensions and stakeholders are supported by individual evaluations.

2. Sustainability aspects for enterprise planning

Today, enterprises are forced to align their own objectives with the needs of all their stakeholders in order to generate profits. Particularly in a time characterized by globalization, shorter product life cycles, decreasing prices, new technologies and increasing sustainability demands, enterprises need an efficient and customer-oriented way of their planning activities. In this context, many companies use enterprise processes as a common backbone for the different management disciplines with the objective of developing holistic strategies that can be implemented fast and consistently at all levels of the enterprise [6]. Subsequently, enterprise processes can be measured, evaluated, controlled and aligned to the needs of customers. Enterprise planning is concerned with the future state of structures, processes and events and is thus an essential task of the management and controlling. It can only work efficiently if all data, actions and facts which are relevant for the decision-making and thus for the control are taken into account. Every business activity requires planning and allows identifying potential impacts and consequences of individual decisions.

Enterprise planning is a management approach that supports the corporate management in their economic, environmental and social decision making. The challenges posed by adopting a sustainability approach to enterprise planning have not only increased the scope of planning environments, but also the complexity of internal tasks emphasizing the need for a closer coordination between the firm’s strategic, tactical and operational planning. Moreover, an enterprise which aims to adopt an integrated sustainability approach has to integrate long-term, medium-term and short-term targets into its planning process to meet the needs of its stakeholders [7].

The definitions of the different planning levels and their relations in terms of sustainability are shortly summarized in this section.

2.1. Strategic planning

Strategic planning covers a period of 5-10 years and aims at assuring the long-term competitiveness of the enterprise. The main goal is to define a set of strategies which will allow

the organization to achieve its mission statement and establish its desired position in the market. The strategic objectives defined at this stage can only be relevant and effective if the entire corporate knowledge is drawn upon and only if these accurately reflect the company’s overall mission. At this level of planning the vision of a sustainable development can be broken down into e.g. energy policy, environmental policy and social policy. A common goal in the industry is, for example, the reduction of production-related energy and resource consumption. The collection of information about the sustainability performance, for instance under the aspect of resource efficiency, should always be seen from a corporate perspective. The aim of such a sustainability performance evaluation is to establish how an enterprise can improve its operations on a local, regional and global level. An overall strategy that incorporates the demands of a holistic sustainability approach must be supported by high level management. Moreover, the implementation of formulated policies and strategies is only possible if tangible objectives are derived and suitable indicators are available for each department and business area [8].

2.2. Tactical planning

Within the tactical enterprise planning, medium-term strategies are defined with a period of up to 5 years. The task of the tactical planning is to “translate” the firm’s overall strategy into a multi-period program, capacity and financial planning, the elaboration of concrete operational objectives at the level of the enterprise as a whole and its sub-areas as well as the definition of resources and measures to achieve. An instance of a tactical objective, derived from the vision of a lower consumption of energy and resources, could be to reduce energy demand by 20% within the next 5 years based on the financial year 2012/2013. At this level, planning objectives are already quantitatively oriented and should be coordinated horizontally as well as vertically [9]. Enterprise models are well suited to support the planner to cope with the increasing complexity caused by the additional demands of an extensive sustainability approach. The enterprise model considers the business processes holistically and can be used as an instrument to ensure that the derived objectives are coordinated horizontally and vertically on the level of the overall enterprise as well as on the level of enterprise units. Furthermore, the tactical planning sets out a course of action of how the enterprise aims to achieve its strategic objectives. To lower its energy consumption, for instance, the company has to take measures which allow the operational level to control and monitor its actual situation e.g. by utilizing an energy cockpit, which would identify potential areas for improvement. Enterprise models and its processes are particularly helpful in understanding interdependencies and cause-and-effect relations for environmental and social demands.

2.3. Operational planning

The operational planning mostly covers a period of one year. The main task is the planning and control of the defined

objectives during the tactical planning phase. The operational planning sets out responsibilities, schedules and addresses processes and procedures that influence the desired outcome. For example, energy savings could be realized by shutting down machines and equipment if they are not used in operational processes (e.g. breaks, change of shift). The operational level has to identify where and when such shut downs are possible and who would be responsible for the realization. In addition to the tactical planning, the operational planning is also bounded by the conditions set out in the strategic planning process. The control of the degree of target attainment in particular is central to the operational planning process. Therefore, the measurements for different indicators have to be defined and realized in the operational business. The monitoring of sustainability aspects (like energy consumption, pollution and waste) is already very process-oriented, but only production processes are typically monitored and evaluated for optimizing the resource and material efficiency [10].

Creating a holistic sustainability reporting framework is not a new issue. Many companies worldwide have been participating in voluntary international initiatives to establish a common set of standards for sustainability reporting. For this approach, various types of reports with sustainability indicators have been taken into account. This does not only include sustainability reports, but also e.g. environmental reports (e.g. ISO 14031 for Environmental Management [11]) or corporate social responsibility (CSR) reports (e.g. Social Accountability 8000 [12]). The indicators considered were divided into the three categories economic, environmental and social according to the triple bottom line. The selection method of indicators for this approach was similar to the approach of the Global Reporting Initiative (GRI) [13]. Accordingly, the indicators within a sustainability report should deal with important issues, which are either relevant in the economic, environmental or social sphere or which have an influence on the decisions of stakeholders. Furthermore, a mapping with the three described planning dimensions has been done. Exemplary important performance indicators for each group are shown in Table 1.

Table 1. Selected sustainability indicators

Category	Indicator name	Planning dimension
economic	costs for environmental management within organization	strategic
	return on Investment	tactical
	reject rate	operational
	Productivity	operational
	percentage of certified suppliers	strategic
environmental	raw material use	tactical/operational
	energy use	tactical/operational
	water use	tactical/operational
	emissions	strategic/tactical/ operational
	waste	operational
social	working days lost through sickness absence	tactical/operational

social	employee turnover	strategic/tactical
	qualification index	strategic/tactical
	employee participation in improvement process	tactical/operational
	percentage of females in executive positions	strategic/tactical

The following section presents an integrated approach of how enterprise planning can be supported by a model-based evaluation environment for sustainability based on objectives and indicators.

3. Model-based evaluation environment

3.1. Approach

The development of a comprehensive enterprise strategy which meets all given requirements from internal, external stakeholders and especially sustainability perspectives requires a sound information basis on which several evaluations can be performed. Since an enterprise consists of several different units and elements which are related to each other on several levels (active vs. passive or strong vs. weak relationship) it is necessary to consider all influences and possible side effects within the planning process.

A representation of an enterprise referring to aspects of structure, activities, process, information, resources, people, behavior, goals and constraints of a business, government, or other enterprise, is defined as enterprise model [14]. To create such an enterprise model, the integrated enterprise modeling (IEM) [15] is used, because it is fully object oriented and therefore facilitates the integration of sustainability aspects. In addition, the IEM is also conform to the international standard EN/ISO 19440 (constructs for enterprise modeling) [16] and is fully supported by the enterprise modelling tools MO²GO and Process Assistant (PA) [17], [18], [19].

The strategic vision of an enterprise is closely linked to the operational point of view. Here, MO²GO offers appropriate advanced views regarding mapping of decision chains from the strategic level to the execution of the operational levels, which reflect the interaction between them. This is achieved by integrating the GRAI GRID [20] technology. In order to elucidate also the relationship between indicators and objectives, the ECOGRAI [21] method is integrated as well. The elements of the views are connected with MO²GO classes, objects (product, order, resource and action) and attributes and can be evaluated over the entire business model (e.g. which processes are influenced by the objective and which degree of performance do these objectives have)

Within this approach specific (see Table 1) sustainability key performance indicators are integrated into an IEM-model by mapping them to their related objectives as well as enterprise objects (e.g. process steps, machines, products, buildings). Since many of these indicators are measured by specific sensors and systems (e.g. energy consumption) and most of them support an API, the data is not directly imported into the model but the source systems are linked via the API

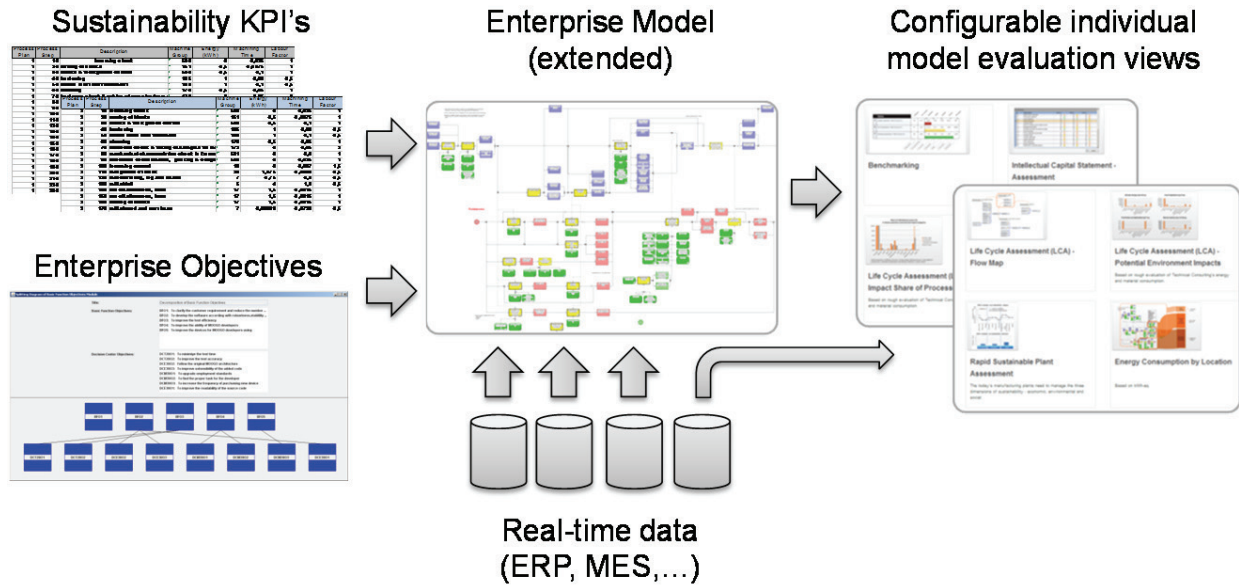


Fig. 1. Model-based evaluation environment (based on IEM)

address. This also facilitates the use of real-time data within the individual evaluation views, which allows a fast verification and validation of the business strategy implementation. A general overview of the described approach is presented in Fig. 1.

Based on this enriched integrated enterprise model, where all elements are related to each other, several evaluations can be performed to empower the users within their decision-making towards a sustainable enterprise orientation.

Integrating further aspects, information and data into the enterprise model results in an increased model complexity and requires mechanisms to ensure consistency and efficient model management. Furthermore, the user is confronted with a variety of data and is not able to perform model validation and verification as well as using the enterprise model as a tool for operational support. To reduce the model complexity and allow an efficient model management, a framework for contextual enterprise modelling is applied to provide configurable individual model application and evaluation views [22].

The framework for contextual enterprise modelling provides specific application and evaluation views by reducing the range of objects to those which are needed by the user and/or for his task. For instance, elements are not only hidden from view, but also re-arranged or presented in completely different ways, reducing the overall complexity and allowing an efficient modelling.

3.2. Application

The application of the presented approach can be divided into two different steps. In the first step, all relevant input data (like sustainability indicators, real-time data sources, enterprise objectives) are collected and mapped into the enterprise model. Therefore, this step can be described as building step.

The second step can be described as model evaluation or consuming step. Role specific model evaluation views can be configured and presented within the Process Assistant, a web-based process management tool. Therefore, a management cockpit was implemented in the PA, which summarizes all selected KPI's and enterprise information in a central system (Fig. 2.).

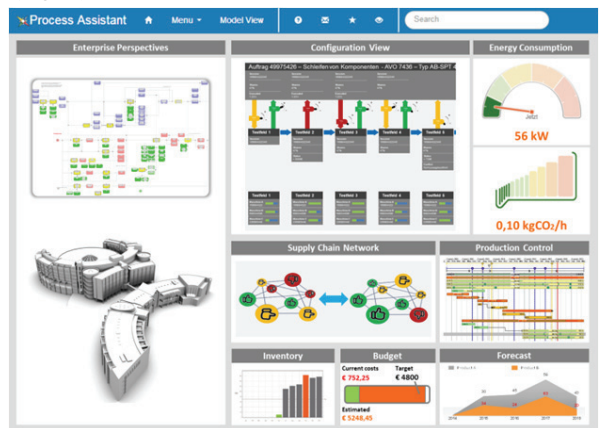


Fig. 2. Real-time management cockpit within the Process Assistant

The management cockpit supports the enterprise planning by delivering up-to-date (real-time) data which are necessary for reliable planning and controlling. It also represents a central enterprise information center.

4. Conclusion and Outlook

A key factor for successful enterprise management is the availability of evaluation tools for performance monitoring and tracking from a qualitative and quantitative point of view. In this paper, a model-based evaluation environment for

sustainability has been presented to provide such qualitative and quantitative views. Therefore, sustainability KPI's were integrated into enterprise models to enable a holistic sustainable enterprise planning and empower the users within their decision-making process. Furthermore, the mapping of sustainability indicators with their related enterprise objects allows identifying dependencies between enterprise decisions (e.g. changes within the product portfolio or lot sizes) and their effects on the sustainability KPI's. However, further steps in the field of sustainability evaluation are needed to extend the scope towards the complete supply chain in order to evaluate the whole value-creation network performance. In addition to supporting the enterprise planning, the application within the operational enterprise management on a daily basis needs to be examined.

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