Process Model and Collaborative Mechanisms for Agile Energy and Ecology Management in Industry

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Abstract – **In this paper, we present the process model of activities relevant for achieving energy and ecology efficiency goals in industry. Being highly complex, multidisciplinary, and heterogeneous, such a process requires intensive use of information technologies in order to be efficiently and effectively executed in dynamic business environments. Next, we propose a set of selected collaborative information system's mechanisms that may be applied in the supporting information technology infrastructure.**

Keywords Ð **Collaborative information systems, energy efficiency, ecology efficiency, agile methodology**

I. INTRODUCTION

Advancements in the Information Technology (IT) are rapidly becoming leading force in human society development. As a consequence, the mutual impact is more and more evident where IT not only changes the way humans live and work (including businesses, social life, government, entertainment, etc.) but it also suffers tremendous pressure to deliver human-oriented value that is actually needed [10].

When the businesses slowed down, the cost cutting became imperative, and energy cost and energy performance suddenly attracted more interest again from the management. Although energy and ecology (EE) efficiency and energy conservation are common terms now days, successful implementation of an EE management program in a real industrial environment is still high risk venture for a team assigned to do that. The complexity arises from the need to tie together people, procedures and technologies in order to achieve consistent and sustainable performance improvement.

In this paper we identify process model for EE management in industry. Our motivating factor in this work is to provide the supporting information technologies (IT) infrastructure. We envision the Energy and Ecology Efficiency Management System (e3MS) as the intelligent information system, collecting information, processing and presenting it in a structured way and cooperate with users and other systems in problem solving, discovery, access, retrieval and manipulation of a wide variety of multimedia data and knowledge.

The problem understanding and acceptance level of EE efficiency aspects within an enterprise is called *motivation factor*. The motivation factor of the authority structures, informal groups and other influential actors in the company, is identified as the crucial success factor for EE efficiency management.

The collaborative IT mechanisms promise high levels of the EE efficiency motivation factor by effective interaction, information exchange and knowledge sharing between all relevant actors within the enterprise, independent of their function, education degree and physical location.

Agile development combines creative teamwork with an intense focus on effectiveness and maneuverability [6]. Particularly, the agile development methodologies bring-in high value when applied vertically [4], including strategic level [5]. Adoption of the agile methodologies for initiation and management of the EE efficiency process, which is a very complex activity spanning whole organization, may deliver significant benefits, such as: 1) reduced risks in implementing EE efficiency projects; 2) significantly reduced overhead costs; and 3) improved project success rate. To the best of our knowledge, the agile methodology, in spite of the significant practical results in several other application domains, has not jet been applied to the EE efficiency management in industry.

In this paper, we propose mechanisms of collaborative information systems as component of the supporting IT infrastructure for adoption of agile methodologies in the EE management application domain. In Section 2 we give brief introduction into collaborative information systems, agile methodologies, and EE management. In Section 3 we present a process model, based on agile methodologies, for strategic EE management in industry. Section 4 describes mechanisms of the collaborative information systems with respect to the developed model. In Section 5 we discuss presented results in the context of related work. Finally, Section 6 concludes the paper and indicates further research directions.

II. BACKGROUND

Collaborative systems have gained considerable attention in recent years as they provide many advantages such as effective customer-supplier relations, knowledge sharing, improved problem solving capabilities and increased

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efficiency of product development [3]. More and more organizations realize that in order to effectively manage innovation, knowledge generation and sharing are of the crucial importance. There is a continuing pressure to generate new knowledge through collaborative means and manage these actions in a way that will provide innovative and productive actions for the organizations, as the main driving factor of the organizational competitiveness.

To be effective, the collaborative groupware must support actual work practices as the participants construct them, rather than simply officially sanctioned and well documented practices. The groupware provides the technological capabilities to communicate across time and place. The type of groupware adopted in any organization is important and can provide many of the advantages depending on the level the best practices are adopted.

Agile development combines creative teamwork with an intense focus on effectiveness and maneuverability [6]. Agile models are more effective than traditional models because they are just barely good enough, they do not have to be perfect and present a practice-based methodology for effective modeling and documentation of software-based systems. Agile modeling approach can be applied to requirements, analysis, architecture, and design [1]. An important aspect of agile methodology is that it is not a complete development process. Agile methodology's focus is on effective modeling and documentation. For example, in the software development domain, it doesn't include programming activities, although it will tell you to prove your models with code. It doesn't include testing activities, although it will tell you to consider testability as you model. It doesn't cover project management, system deployment, system operations, system support, or a myriad of other issues [6].

One of the most useful lessons that a *EE management practitioner* can learn from working with the people, is the range and breadth of issues that they didn't know, didn't understand or were not confident about, which in turn hindered them to implement EE management programs. These issues ranged from simple technical details about some calculation, to missing the whole concept or context for energy management. Energy management has of course strong technical component, but *if the focus is on technical aspects only, the results will be limited*. *EE management needs to focus on people* because technical expertise and sophisticated equipment will fail to produce results unless people are committed and receptive to the changes recommended for performance improvement. Working with people of diverse background unified by a common goal, always presents a challenge to find the most effective way to help them understand and implement EE management system procedures and techniques.

Energy management can be defined as: Controlling energy flows, in a systematic manner, and according to a plan prepared in advance, with the objective of achieving company's goals at the lowest possible energy cost. It is a continuous process that integrates the entire sequence of events, starting with a commitment to energy conservation from end-user to top management, and proceeding to improved operation and maintenance procedures, quality control, financing and construction of energy conservation equipment, monitoring and follow-up.

Energy auditing is study of a facility, that has to determine one or all of the following: a) to determine how and where energy is being used or converted from one form to another, i.e. to establish a base line energy consumption; b) to identify opportunities to reduce energy usage, and define energy conservation measures; c) to evaluate the economics and technical practicability of implementing these measures, and recommend feasible energy efficiency improvement projects; d) to formulate prioritized recommendations for implementing improvement projects with the aim to cut the energy costs. In practice, energy audit of an industrial plant is often reduced only to checking the efficiency of the main utilities, like boilers, chillers or air compressors. It is obvious that such most simplified form of energy audit can yield only partial results, and cannot bring full benefits of a comprehensive energy management program.

Energy efficiency improvement projects are key practical solution to the problems of energy wastage, identified during an energy audit, and presented with full technical and financial evaluation.

III. Process Model for Strategic Energy and Ecology Management in Industry

The process model comprises several different significant management aspects of the energy and ecology management in industry. In such a case, agile methodology is very promising approach to achieve high efficiency of the resources invested in the project. The methodology favorites iterative steps integrating information technologies, knowledge management, EE efficiency technologies, as well as business process management and project management knowledge body. Following the methodology, work at the project is focused on the particular practical problems that are selected with respect to solutions with the greatest potential to deliver strategic value.

Model of the EE management process in industry is given in Fig. 1 in a form of the State/Activity Model UML diagram. The process starts with the strategic decision for continuous improvement of EE efficiency in the enterprise. After the decision is made, the collaborative process starts to continuously accumulate information about EE efficiency, where all players from the enterprise relevant to EE efficiency are involved. Using the growing body of collective knowledge and information, strategic decision makers can get first insight, begin learning about, and achieve common ground agreement regarding the current state in order to be able to make informed decisions. They exercise the accumulated knowledge by setting EE efficiency goals according to the existing business strategy. At the operation management level, the analysis and reporting activity is initiated, while activity for identification of the set of possible corrective actions is initiated in parallel at the strategy level. Then, decision makers assign priorities to the set of possible

corrective actions. Using the collected knowledge, decision makers are able to select a single, most promising action from the set of actions. Note that the same candidate action may be assigned different levels of priority in different iterations of the management process. Then, the request for proposals is issued regarding the selected action, and one or more project proposals are collected. If detailed project proposal exists and proposal is validated, the project implementation is launched and the process iteratively continues back to the collaborative process of gathering information. If the proposal is not validated, then we validate project through prototype implementation. In the case project proposal doesn't exist, the identified candidate solutions are inserted into the set of possible corrective actions, while the process iteratively goes back to analysis and reporting.

IV. COLLABORATION MECHANISMS

As is shown in Fig. 1, collaboration among actors in the system is of the crucial importance. Actors collaborating within the system are diverse, including human actors, such as strategic decision makers, managers, knowledge workers, engineers, etc., as well as software actors such as knowledge artifacts, processes, information, agents, etc. Collaboration facilitates the core process activities, such as decision-making, knowledge accumulation and usage, dissemination of the information to all relevant stakeholders, etc. As such, we identify collaboration as one of the most important success factors. Hence, we believe that investment in the IT support for the collaboration may significantly contribute to the enterprise strategic competitive advantage by improving process scalability, integration and flexibility, while delivering financially measurable benefits.

In the following, we propose several mechanisms of the collaborative information systems that may be effectively used in the supporting IT infrastructure for EE management in industry. For each of the proposed mechanisms, we briefly present features that are of the highest relevance for the EE management domain, only. Comprehensive discussion of the mechanisms is out of the scope of the paper.

- ***Work Group (WG)***: The work group is a first class object in the EE management system. In other words, the WG may engage in interaction with other first class objects in the system, such as users, actors, roles, processes, data, etc. Any user may create a WG. The creator has full access to the WG's resources, such as information artifacts, processes, and interactions with other members of the WG. Being a first class object, implies that the WG may be the creator of some other WG. We identify the following roles relevant to WG mechanism: *a) System Administrator* – administers the group from the aspect of a Provider, providing IT resources for the group. For example, the System Administrator may set storage and processing time limits for every group (or for the group of groups); *b) Content Administrator* – administers the content that is accumulated within the group boundaries. She has no author rights on the content. Instead, she has the right to do content administration (for example, statistics, content

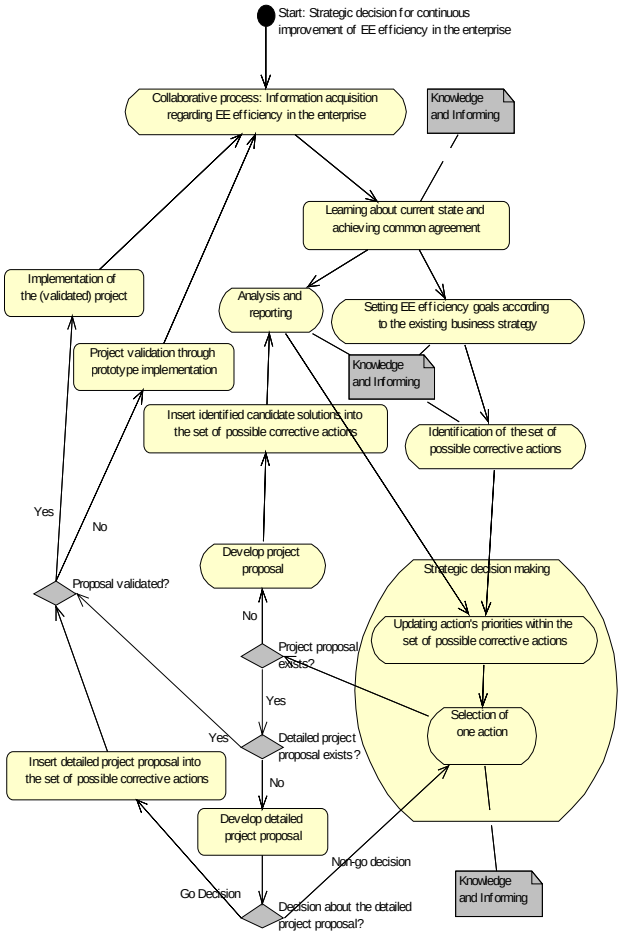

Fig. 1. Process model for EE management in industry

mining, fault-tolerance, back-up, etc.); *c) Workgroup Administrator* – is member of the WG that has privileges to organize activities within the group (for example, configuration of resource usage, WG's workflow, etc.); *d) Workgroup Member* – is any user participating in the WG. It is important to note that same user (or actor) may concurrently act in different roles within same or different WGs.

- ***Multi view:*** The Multi view mechanism is intended to support heterogeneous interactions between humans and the system. Namely, different users naturally assume different system's usage patterns, according to the user's knowledge, understanding, communication, and learning potential. It may include: *a)* Interface for accessing system resources; *b)* Multilanguage support; *c)* Interface for being aware of other system's elements.

- ***Indicators:*** We may identify the following types of indicators: *a) Activity Indicators* – number of active users, number of passive users, periodical review of the group's activity, level of interaction intensity, etc. The indicators may be assigned to a user, group or to any other system's element.

b) Social Indicators - for example, number of users interested in sharing the same system element; *c) LD ("likes-dislikes") Indicator* – an actor in the system may like/dislike some other system's element (other user or group, resource, time of the day, etc.).

- ***Forms:*** Forms are collaboratively developed, usually within a WG. These forms are then used to structure communication with actors outside the WG (questionnaires, surveys, reports, etc.). Also, the forms are used for knowledge and information acquisition.

- ***Reports:*** Collaborative, multi-user development of diverse reports. The forms may be used as report's templates.

V. Discussion And Related Work

In [7], the author is primarely concerned with user interaction aspect of software and Web site development. He is impressed with the Usage-Centered Design/Agile models when it comes to collaboration, but identifies the need for further techniques, including goal-oriented modeling, to achieve true user-centered design. In spite of different application domain, we have independently identified the same need. In this paper, we proposed the user-centered design process for EE efficiency management in industry and proposed supporting collaboration mechanisms. The agile methodology, based on collaboration and goal-oriented modeling, is the prime candidate for organizations and systems leanning towards Service Orinented Architecture (SOA)[8]. In fact, the SOA is target platform for implementation of the proposed methodology. Similar methodology, called Innovation Pipeline[5], is applied at the strategy level in the product development domain. The innovation pipeline methodology is based on two-stage pipeline process model while our methodology supports iterative process. Descriptive presentation of «stages» in the innovation pipeline fully supports formally modeled process as we propose in this paper.

In this paper, the State/Activity Model UML diagram is used for model specification of the EE management process in industry. For future research, we plan to integrate the goal-oriented requirements language (GRL) and the scenario-oriented notation Use Case Maps (UCM) [9] for process modeling purpose. GRL is designed to support goal-oriented and agent-oriented modeling and reasoning, providing guidance to the design process. UCM allows the behavioral aspects of the designed system to be visualized at varying levels of abstraction. The two notations complement each other enableing technical solutions to be described and evaluated with respect to corresponding contributions to the objectives of different stakeholders, while guiding the design towards viable solutions.

VI. Conclusion

In this paper, we developed process model facilitating application of agile methodologies to the strategic level of the EE management in industry. Also, we identified basic mechanisms of the collaborative EE management system.

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