

IT-Supported Assurance of Environmental Law Compliance in Small and Medium Sized Enterprises

Heiko Thimm

School of Engineering

Pforzheim University

75175 Pforzheim, Germany

Email: heiko.thimm [AT] hs-pforzheim.de

Abstract—In Small and Medium Sized Enterprises (SMEs) the environmental compliance management practice is often based on relatively rudimentary work structures and IT solutions with inherent limitations for business process efficiency. Due to the growing complexity of environmental regulations and related corporate obligations - that when violated may result into severe fines – today more than ever firms are forced to improve their compliance management practice. In this article an SME-specific business process reference model for environmental compliance management is proposed which has been developed based on qualitative data. The model enables companies to obtain and continuously maintain a complete set of work flows for efficient IT-supported assurance of environmental law compliance. The software solution Compliance Center Professional (CCPro) is built on the principles of the model. An overview of CCPro is contained in the article in order to exemplify the compliance management work practice targeted in our research framework.

Keywords—Environmental Compliance, Environmental Management Information Systems, Business Process Efficiency, Small Medium Sized Enterprises, Green IT

I. INTRODUCTION

For organizations environmental compliance management is usually a challenging area of work that requires competences and expertise in many different disciplines including occupational safety, hazardous material management, fire protection, and transportation safety. The overall goal of the environmental compliance efforts is threefold and can roughly be described as follows. First, the organization needs to ensure that at all time it knows all the relevant legal regulations for environmental protection. Second, for all relevant regulations the organization has to determine and implement measures that are required in order to fulfill given requirements. Third, the organization needs to document all considerations, measures, and actions targeted on environmental protection. This documentation task has to be completed in a way that enables the organization at any time to proof the fulfillment of the previously described two obligations. For example, it is required to proof the compliance when an environmental audit is completed which normally involves external auditors from accredited independent agencies.

Should a company not comply with the obligation described above, the company faces sanctions ranging from fines, withdrawal of licenses and even permits to mandatory closures and shutdowns. It is for most companies a challenging

task to fulfil this obligation. A substantial part of the task complexity is caused by the enormous number of environmental protection regulations that exist today ranging from regional laws to worldwide laws. Furthermore, with a remarkably high frequency new regulations are announced and existing regulations are repealed or revised but nevertheless organizations are expected to accurately know all the relevant rules.

Given these complex obligations companies need to build up and maintain an effective work practice in order to reach environmental compliance. Not only for legal reasons companies target an effective environmental compliance management practice. Over the last decades public debates of corporate social and environmental responsibility have forced companies to increasingly invest in respective areas including especially the area of environmental compliance management. Furthermore, corporate environmental compliance endeavors can also be motivated by economic factors such as customer environmental compliance requirements for suppliers and insurance benefits of successful self-audits.

Big public enterprises in their annual corporate social responsibility reports frequently state impressive numbers about their investments into corporate social and environmental responsibility areas. However, the situation is different at Small and Medium Sized Enterprises (SME) where more often tight budget constraints and an attitude exists that is more focused on directly value adding business processes and less on support processes like environmental compliance management. There exists also evidence that at SME companies environmental compliance tasks are often perceived as a burden that is offering only little value to the company and thus is assigned a low organizational priority[1]. Furthermore, Fairman and Yapp [2] reported that especially at SME companies there often exists a lack of motivation for the introduction of organizational innovations such as business process management, the introduction of a quality management system or an environmental management system. Based on their studies they concluded that two main factors make it difficult for SMEs to comply with regulations and improve environmental health conditions (Fairman and Yapp[2], p. 44): "... the nature of SMEs themselves, and the nature of regulation with which they are expected to comply".

Given these findings it can be assumed that in SME companies there often exists an only rudimentarily developed

environmental compliance management work practice. Furthermore, it can be assumed that the typical SME compliance management operational practice does not involve effective use of IT to support the above described information management tasks. The argumentation for this assumption is that only when work areas are well organized - following for example a business process management approach[3][4]- then organizations can achieve in combination with well aligned use of IT a high level of operational efficiency. This dependency has been studied by many researches of the business information system area such as[5][6]. Some empirical evidence for the above described assumptions is available in an AMR research study[7] in which it is stated that spreadsheets – with inherent limitations of workflow management, data integration, data sharing, and auditing – are still widely used as environmental information system.

The research described in this article contains empirical evidence for the above stated assumption that with respect to their environmental compliance work practice many SME companies in comparison to big companies can still improve a lot. The given evidence is based on interviews with industry partners and a governmental environment protection agency in Germany. On the basis of this evidence it is the overall goal of our research to contribute a best business practice for a process-oriented development, implementation and use of IT for the assurance of environmental law compliance in SMEs. The best practice is developed in the form of a reference model for organizing compliance management work processes that especially reflect the key information management tasks described above. Based on the reference model and also based on the assumption that within a company's set of legal demands there does not exist any conflict a new software solution, Compliance Center Professional (CCPro), is being developed. CCPro is designed to efficiently assist company compliance managers in the management of administrative, dispositive and coordinating tasks. This management tool is designed to free up time for compliance managers to allocate to the study of new and amended laws and the assessment of such laws from a compliance management perspective. In addition, CCPro's cooperation-supporting-functionalities are designed to support and simplify cross-functional compliance management tasks and consensus-oriented group decision making. A brief overview of central concepts and functions of CCPro is contained in this work.

The remainder of the article is organized as follows. After a discussion of related work in Section 2 a brief introduction of the subject of environmental law compliance is given in Section 3. Section 4 addresses the current status of environmental law compliance management in SMEs. Section 5 contains a proposal for a process-oriented, holistic developmental approach to environmental law compliance management as it applies to companies. Section 6 provides a general overview on the use of IT in the implementation of the organizational approach and describes the basic functionality of the CCPro software solution. Final comments and an overview of the next project phases are contained in Section 7.

II. RELATED WORK

Over the last decade Environmental Management Information Systems (EMS) gained great attention in the research community[8][9][10][11]. EMS in addition to their core functionality for environmental monitoring and reporting obviously need to address compliance management duties of companies. However, most of the available research work is targeted on other aspects of EMS and not specifically on the use for environmental compliance management in SME companies.

Freundlieb and Teuteberg[12]like other researchers argue for an integrated systems approach for corporate environmental information management. They propose a meta reference model of compliance management that among others is composed of a strategy model, an IT architecture model, and a data model. The proposed meta model describes the modelling constructs of the various reference models as well as the possible interrelations among them. The reference data model follows a typical data warehouse approach where the EMS System is filled through a corresponding ETL process. The most refined part of the meta model is the data warehouse structure whereas the other parts of the model correspond to rather abstract models. Further differences to our work are that we target especially the needs of SME companies and that our reference model gives practical guidance for main operational compliance management processes. Several other research groups proposed reference process models for environmental compliance management tasks. The compliance process model of Henson and Heasman[13]focuses on the decision-making process to be performed within a company when a legislative requirement needs to be handled. On the basis of respective qualitative data Fairman and Yapp[2]adapted the Henson and Heasman model towards the specific demands of SME companies. For example, it was observed that SME companies do not make decisions whether to comply based upon economics, feasibility or market reasons like companies in general. Instead, SME companies base this decision upon what exactly is being required and this difference has been considered in the revised model.

Traditional Enterprise Resources Planning (ERP) Systems[14]are being deployed for several decades by companies around the globe. Some ERP vendors offer specific modules often referred to as "Environmental, Health and Safety" (EHS) that include functionality for environmental compliance management. However, it appears that those modules are primarily deployed by non SME companies with big compliance management headcounts and large budgets for add-on ERP development[15]. According to a recent study of the University of Michigan in corporation with SunGard Data Systems [16]today a new class of ERP systems is rapidly emerging that is referred to by Environmental ERP systems and those systems are expected to offer more extensive functionality for environmental compliance management. Based on empirical data they argue that such new environmental ERP systems have the power to not only support the implementation of the corporate environmental sustainability strategy they may even transform that strategy.

Several mostly government-lead projects have been conducted with the goal to deliver Recommendations and guidelines for SME companies for their endeavors to successfully introduce and use EMS. For example the Montreal-based Commission for Environmental Cooperation (CEC) with support from university researchers conducted a corresponding project. The outcome of this project also contains SME-specific recommendations for building up and maintaining an effective compliance management work practice. What is different to the work described in this article is that the recommendations in the following sections are based on a process-oriented view and they especially address operational-level information management and documentation tasks.

Our findings about the deficiencies of today's compliance management work practices in SME companies confirm results of several research studies that addressed the current status of SME environmental management activities in general (e.g. [17]). A review of the respective literature has been published by researchers of the Australian Edith Cowan[1] University.

III. ENVIRONMENTAL LAW COMPLIANCE - SIGNIFICANCE AND REGULATORY REQUIREMENTS PLACED ON COMPANIES

Environmental law is often described as the "totality of all statutory environmental protection activities, which serve to protect the environment from anthropogenic impact and the improvement of the overall environment" [18]. The relevant literature often refers to sub-practice areas, these include emission control, water protection, radiation protection, waste avoidance and disposal, chemical substance control, and soil and landscape conservation. In day-to-day operations, occupational safety, energy and transport are often included in the sub-practice areas. In addition to the segmentation of the sub-practice areas, horizontal segmentation of environmental law according to jurisdiction must also be taken into account. Horizontal segmentation differentiates between international environmental law which applies globally, European environmental law, and national environmental law. Overall, environmental law is comprised of more than 9000 acts and sub-ordinated regulations. The assumption is that the density of environmental law provisions will continue to grow in the future. In addition, it is worth noting that the environmental law sub-practice areas are also fraught with a large number of amendments and revisions. For years, new laws, directives or amendments to existing laws or previous amendments are being announced. Notices of the repeal of laws (i.e. repeal notices) are no longer the exception.

The density of provisions and the amendment dynamic presents organizations with a challenge in keeping up with current, more specifically relevant legislation. But this is exactly what companies are obligated to do. Companies are obligated to know and comply with the relevant laws and regulations (obligation to stay informed). Should a company not comply with this obligation (knowingly or unknowingly), the company faces sanctions ranging from fines, withdrawal of licenses and permits to mandatory closures and shutdowns. Naturally, the principle *ignorantia legis non excusat* (ignorance of the law excuses no one) applies. Accordingly, companies

hire internal and external environmental law specialists to assure that companies comply with all relevant statutory regulations.

Companies often employ environment management systems [9] to be able to comply with the environmental law requirements more efficiently. Organizations undertake to systematically review, adjust and fully document legal compliance through the implementation of such systems. Documentation of environmental law compliance is a mandatory prerequisite for certification according to international environmental management standard ISO 14001 [19] which was established in 1996 by the International Organization for Standardization (ISO). According to researchers from the Iowa State University and the University of Washington the adoption of ISO 14001 by firms leads to improvements of the adopters' compliance with governmental regulations [20]. Given the above described documentation obligation, an organization must always be able to furnish documentation that shows that the organization 1. has knowledge of current statutory regulations applicable to the organization and 2. that the organization always meets the associated requirements in a timely fashion. This obligation to produce documentation requires companies to perform extensive and interrelated information processing activities. These include, for example, activities such as the gathering of information on amendment notices, the assessment of amendment notices and the determination of required measures. Furthermore, extensive documentation tasks must be completed. For example, decision making activities regarding measures, measure implementation and measure effectiveness must be documented. Additional central activities include the organization and coordination of decision making processes with participants from various company divisions and departments.

IV. ADDRESSING ENVIRONMENTAL LAW COMPLIANCE IN THE DAILY OPERATIONS OF SMES - INVENTORY OF THE CURRENT SITUATION AT SMES

For understandable reasons, only relatively few companies provide information on company-internal processes and measures regarding environmental law compliance. Accordingly, this inventory of the current situation at SMEs is primarily based on information provided by our major industry partner. This partner is a southern German SME producer of industrial chemicals and plastic additives. For competitive reasons the name of the company is not being published in this article. The company will be referred to by a fictitious name, C-Experts, to anonymize the industry partner. The company has been in business for more than 120 years and is a recognized consulting partner in the safety and environmental law sector (a separate subsidiary provides these services). Based on C-Experts' long-standing experience, the company has gained a wealth of knowledge and extraordinary insight into the development and implementation of environmental law compliance management at a large number of SMEs. The information gathered from the inventory is also based on the information provided by the State Agency for Environmental Protection, Metrics and Nature Protection Baden-Württemberg.

A. *Environmental Law Compliance Management in SMEs - Characteristics of the Status Quo.*

The following list of central characteristics was derived from the collection of qualitative data:

- Overall process-oriented thinking is not widespread and process descriptions, such as instructions, are only available in the form of rough drafts, if at all.
- Activity in environmental law compliance management is dominated by "myopic" thought processes, which are largely focused on individual tasks.
- Even if the ERP systems used by SMEs offer environmental law compliance modules (often referred to as EHS – Environment, Health and Safety), SMEs do not employ such modules.
- Only in individual cases are dedicated commercial information system solutions for environmental law compliance employed. However, these systems are generally not or only to a lesser extent integrated into other operational information systems.
- Simple documentation management and file share systems are largely used for the allocation and distribution of information and tasks, however, dedicated cooperation support solutions (e.g. work flow management systems) or collaboration platforms are not being used.
- For a majority of companies, the use of IT for compliance management tasks (particularly status documentation, schedule and deadline monitoring) is limited to spreadsheet programs.
- A few companies utilize in-house developed desktop database solutions for certain environmental law compliance management tasks.

B. *Analysis of Problem Areas and Associated Effects*

At many companies, the characteristics described above create a variety of problems for compliance managers.

The data quality, which is the basis for compliance management operational and management tasks, is frequently of inferior quality. Accordingly, the ability of companies to provide accurate reporting is limited due to a lack of up-to-date data, incomplete overviews and analyses.

Due to the fact that data administration is usually distributed over disparate systems, centralized documentation and reporting is not possible. In addition, data consistency problems can become an issue, which is associated with a high risk of permanent "data inconsistency" (lack of synchronization) within the disparate systems. Furthermore, decentralized data management virtually always results in difficulties documenting processes and obtaining status information.

These difficulties can result in a company erroneously coming to the conclusion that it is in compliance with

environmental law requirements, when in fact the company is (i.e. unknowingly or at a minimum upper management has no knowledge) violating relevant environmental law regulations. Should companies be faced with the above difficulties, companies must assume that they will, in all likelihood, not pass an environmental audit and obtain the respective certification.

For many companies the lack of process continuity and inadequate IT integration results in modal fragmentation, a low degree of automation and a high investment of time and expense for data maintenance. Consequently, companies are frequently confronted with inadequate process efficiency and high overall work costs associated with assuring environmental law compliance.

In conclusion, at many SMEs environmental law compliance management implementation is inadequate in terms of its significance and complexity. It is safe to assume, that only in exceptional cases, environmental law compliance management has been implemented in a systematic and holistic fashion; the same applies to companies continuously improving their compliance processes. Otherwise, the assumption can be made that very few companies have dedicated IT support solutions for compliance management processes.

V. REFERENCE MODEL FOR THE ASSURANCE OF ENVIRONMENTAL LAW COMPLIANCE

The study results support the assumption that a multitude of SMEs have not implemented overall organizational structures and holistic process integration to address all aspects of compliance management. The types of potential limitations to day-to-day compliance management that must be taken into account due to the lack of such organizational structures and processes are described in Section 4.

The relevant literature documents the positive contribution of reference models in providing practical solutions to process management problems [21]. Inspired by these successes, we developed the following draft of the first version of a reference model for the assurance of environmental law compliance. The model is designed to provide companies with a reference and orientation framework for the systematic and holistic analysis and creation of all compliance management tasks required to assure environmental law compliance. The reference model was developed in close collaboration with C-Experts to ensure the necessary practical relevance of the model.

A. *Basic Element Types of the Model*

Main processes required for the completion of central environmental law compliance management tasks are taken into account. The data objects used in these processes are also included in the model. The data objects are stored in the corresponding databases. The data objects represent compliance management objects that are either physical objects or only abstract objects of the real world.

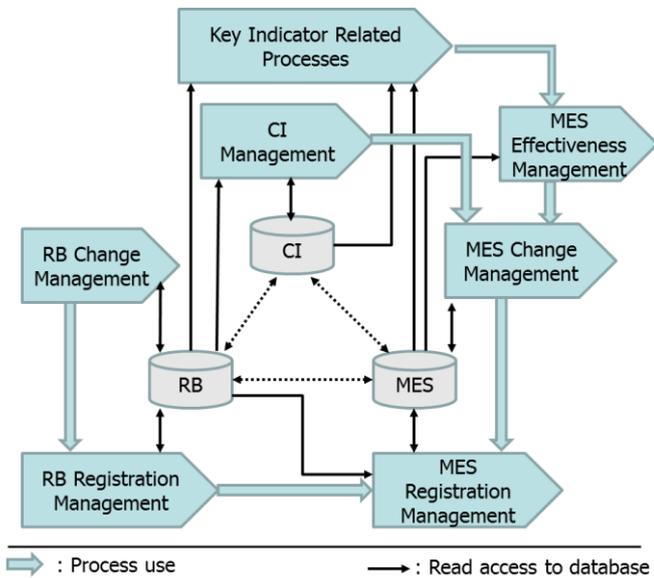


Figure 1 Reference Model for Compliance Management for the Assurance of Environmental Law Compliance.

Fig. 1 contains a chart of the model. In addition to other concepts, the model reflects the following relationship types between the individual elements:

- The relationship "process use" represents that a process accesses the services of another process to attain its objective.
- The relationship "read i.e. read/write access" represents that a process accesses a database to read out or edit existing data objects or create new data objects.
- The relationship "object reference" represents an existing link between two data objects or a reference from one data object to another.

B. Data Objects

In the following, the three data objects are differentiated.

Regulatory Basis (RB). A regulatory basis represents an individual law or individual sub-ordinated environmental law directives. The regulatory basis includes a company-specific assessment profile that identifies the relevant provisions of the regulatory basis that apply to the company as a whole or to individual company divisions/departments.

Measure (MES). A measure models an individual measure or a bundle of measures that companies resolve and which are to be implemented to comply with environmental laws or directives. An individual reference point or a number of regulatory reference points are assigned to each measure. A regulatory reference point is defined as a specific regulatory basis or an amendment notice (see below).

Change Incident (CI). A change incident represents an operation that is triggered by an external amendment notice with the associated operation-specific data and status information. In this context, the amendment notice refers to a clearly identified (potentially relevant) regulatory basis for

which the legislative or regulatory body issued an amendment notice. The operation-specific data includes relevance assessments, competencies and other requirements for measure decision making. This includes status information on the progress of initiated measures and on the results decisions have produced. The relevance assessments represent the relevance of an amendment to the company or the company's organizational units.

C. Processes

The model describes ("data-driven") main processes that create or edit data objects or that use unedited data objects. Some main processes analyze the current data object values and, if required, also analyze the linked data objects. The assessment findings are required for decisions regarding the continued progress of the processes. Fig. 1 provides an overview of the processes and databases, as well as the relationships between the individual elements.

The RB database and MES database are created by the two main processes depicted in the lower section of Fig. 1. The databases are continually updated through new data objects. The objective of the first process (RB Registration) is to identify the relevant regulatory bases for the company. Furthermore, the objective of this process is to assess the compliance relevance to the company and to provide this information to the RB database. In the second process (MES Registration), the associated initial measures are to be identified for the regulatory bases that are relevant in terms of compliance. This can be undertaken in the form of group decision making with the participants from the affected company departments/divisions. The measures that are to be implemented are stored in the MES database.

The two processes one level up in Fig. 1 relate to the respective change management. The first process (RB Change Management) addresses change management for the RB database. This addresses the issue of keeping the applicability periods of RBs that have already been created up-to-date and to create new RBs using the RB registration process. The focus of the second process (MES Change Management) is measures change management. The objective of the process is to determine the required changes to the existing measures and to map them in the MES database. Completely new measures may also be created by this process. Such measures are then created using the MES registration process.

The objective of the "MES Effectiveness Management" process is the review of the effectiveness of the implemented measures. If a change management request has been made, the main "MES Change Management" process is used to perform the change.

The objective of the main process "CI Management" is the registration of amendment notices that relate to the relevant regulatory bases. For each announced amendment a review must be conducted to determine if the amendment is relevant to the company. This is necessary, due to the fact that an amendment to a regulatory basis that is, in general, relevant to the company, may not be relevant to the company in a specific case. In accordance with the ITIL Service Management

Standard [22]this relevance review is a component of the CI management process. The process is based on a pre-defined status history model. If compliance relevance is identified, a measure review is to be conducted. To accomplish this, the process utilizes the "MES Change Management" process.

In the upper section of the model in Fig. 1 various compliance management processes are depicted ("Key Indicator Oriented CM Management Processes"), that are important for the management of compliance management as a whole. The primary purpose of these processes is to generate compliance management specific key indicators from the existing databases and e.g. to present data in the form of a management cockpit. Examples of such key indicators are risk-related key indicators that reflect the likelihood that at the current point in time the company is in environmental law compliance. To determine the likelihood that data on the current change management log and data on the required but yet to be implemented measures can be applied. A second example is key indicators that provide information on the compliance management staff's task volume.

At present, the model has not been expanded to include a separate main process that is focused on organization and implementation support of environmental audits. Due to the fact that all of the main processes in the model also cover

environmental audit aspects, the need for an explicit audit support process has not been identified.

VI. CCPro – AN EXAMPLE OF THE IMPLEMENTATION OF THE REFERENCE MODEL IN A CM INFORMATION SYSTEM

The following software solution "Compliance Center Professional" (CCPro) illustrates an example of the implementation of the reference model in an integrated compliance management information system. Recall from earlier that the implementation is based on the assumption that within a company's set of legal demands there does not exist any conflict. CCPro is presently being developed by the Steinbeis Innovation Center IVO as a tailored information system solution to assure environmental law compliance in the daily operation of companies. The functionality typical for operational application systems, such as integrated database, customizing tools, multi-user-support, user authentication, access management and documented activity logs/reporting are integral components of CCPro. In addition, the developer team has taken the specific requirements for a SME software solution in regard to usability and interaction design into account. Presently, C-Experts is testing CCPro and gathering first experiences on the operational use of the compliance management system.

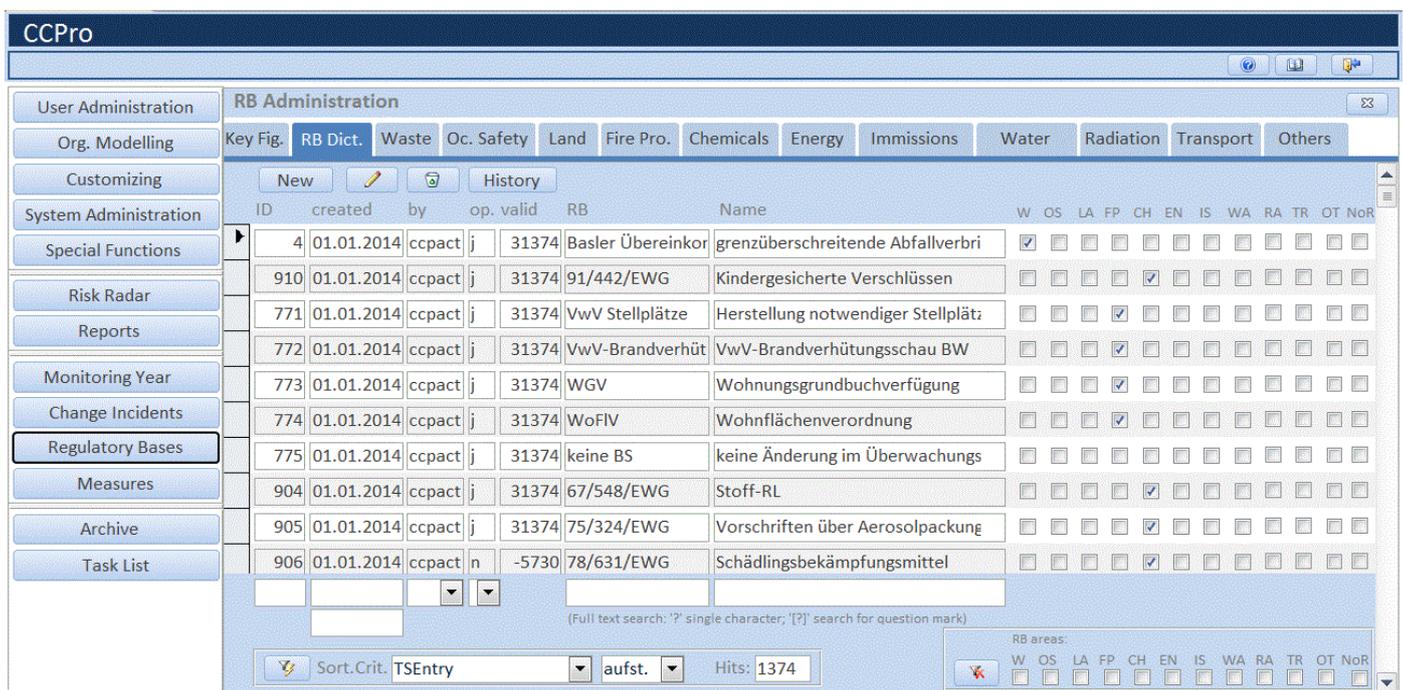


Figure 2. CCPro screen with a list of regulatory bases including their assignment to compliance management areas. The area at the bottom offers options to search within the entire RB Dictionary.

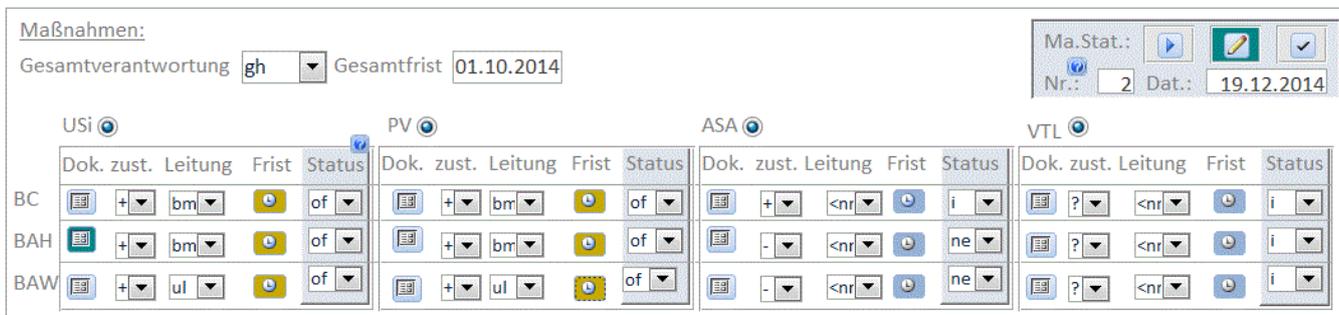


Figure 3. Example of a decision table with selected individual decisions and status information

Within the scope of organizational modeling, a number of parameters must be specified during the CCPro setup phase for a specific company. The compliance management application areas (i.e. the sub-application or sub-practice areas of environmental law and possible company-specific areas) must be defined for the system. Among others one needs to define the level of granularity for compliance management activities. One can choose between the company as a whole as point of reference for the compliance management activities. As an alternative it is also possible to choose that compliance management tasks can be selectively referred to specific organizational units (e.g. subsidiaries, divisions, plants). Furthermore, during the setup phase, also the responsible company decision making committees must be defined.

The CCPro installation at C-Experts addresses a total of nine compliance management areas, such as e.g. waste and

up in the system, which includes three independent organizational units and four different decision making committees. The implementation of this company-specific basic setting in the graphical user interface is illustrated in the sample screens below. The abbreviations BC, BAH and BAW signify the three independent organizational units and the abbreviations USi, PV, ASA and VTL signify the environmental law compliance decision making committees at C-Experts.

Fig. 2 is a sample CCPro screen depicting the main menu column on the left side of the screen and sample data is displayed in the work and display area located on the right side of the screen. The work area displays the processing of regulatory bases (RB), change incidents (CI) and measures (MES) that are stored in the database and the data objects are assigned to the various legal areas i.e. practice areas; the results are sorted and displayed in a list. Users can access detailed information that appears in another window by double clicking

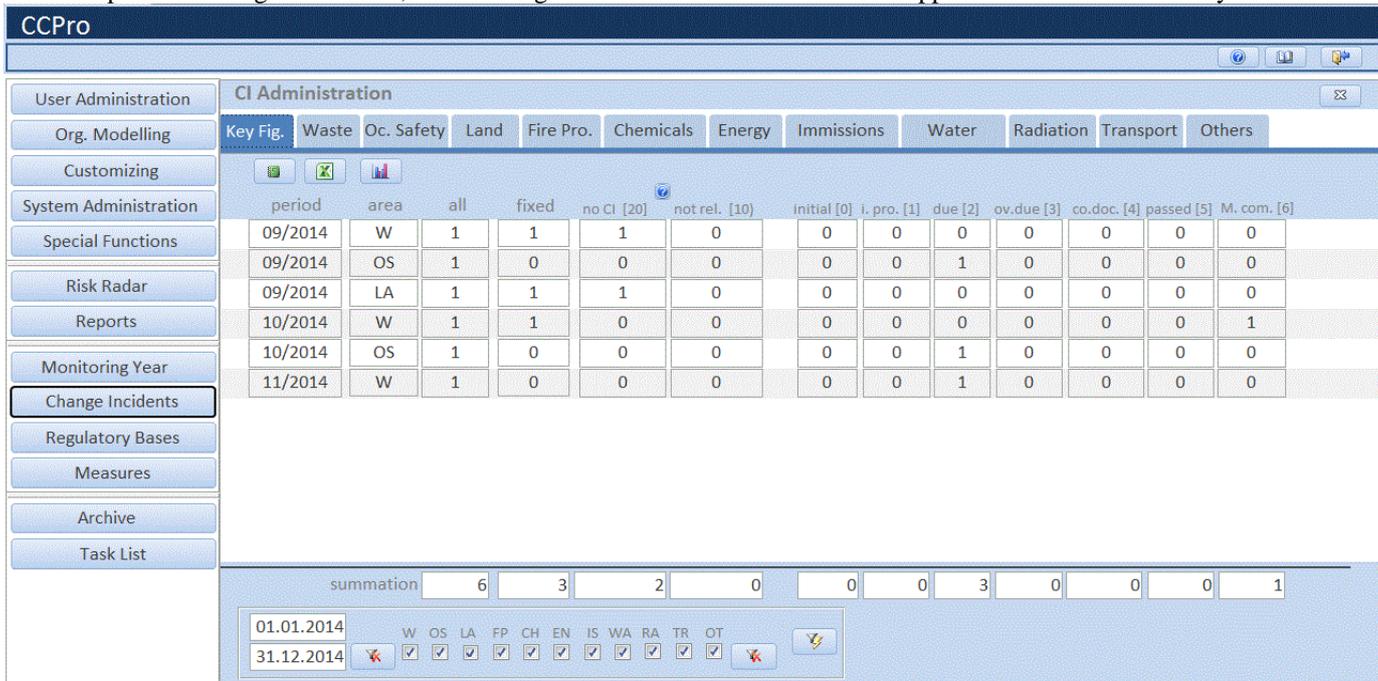


Figure 4. Report with key figures about change incidents and associated status information captured during a given time period. The filter options at the bottom allow to tailor the report to individual needs

occupational safety. Furthermore, a company structure was set on a list entry. Creating or processing a data object is

performed in the corresponding pop-up window. The system displays the corresponding selection lists for data entry and all cross-references are checked in accordance with the underlying data model.

The assessments of the regulatory bases and change incidents can either be processed for the entire company or for the individual organizational units. Fig. 3 illustrates a specific CI decision table that supports the user in creating a CI; the user can select the associated decisions that relate to the measures. In addition, the table also displays the screen for the creation and monitoring of status information on the selected decision making processes. The number of rows (organizational units) and the numbers of columns (decision making committees) of the table is dependent on the company specific company structure stored in CCPro.

CCPro decision tables analyze the decision deadlines specified by users and outstanding decisions are assigned a color and highlighted. Using the document symbol button located next to an individual decision, users can store and access the documents associated with the decision. These documents may include background information associated with the decision making process or committee/meeting minutes. CCPro manages the hyperlinks of the documents that are stored outside the system.

In addition to group decision support, CCPro provides additional functions that support the collaborative process. Users can exchange standardized text messages, such as work instructions or processing notes that are available in the task lists.

The beta version of CCPro includes various simple overview and analysis functions; these functions will be gradually expanded and included in future releases. The screen section in Fig. 4 displays statistical data about all change incidents captured in CCPro during the year 2014. The second column of the table indicates the respective practice areas; "W" denotes waste, "OS" denotes occupational safety, and "LA" denotes land. The numbers contained in the remaining columns for the respective time frame and practice area specify various helpful statistical data about change incidents, including the associated status information.

CCPro is a monitoring, documentation and reporting system that focuses on status updates and documentation of change incidents in accordance with the IT service management approach ITIL [22]. At C-Experts, monthly monitoring is performed using CCPro. At month's end, the competent compliance management records new relevant amendment notices through the creation of the respective change incidents for the corresponding monitoring period. If new amendment notices are not issued, a corresponding entry is made in CCPro. This ensures that amendment notices are not inadvertently missed and as such, a consistent and complete documentation history of all monitoring periods is available in CCPro.

All processing steps for each change incident and each regulatory basis are fully recorded in the database, including additional administrative data (date, time, user). These records

are protected against manipulation. Users cannot physically delete the data. Users can only mark data as deleted. This procedure ensures that comprehensive documentation and reporting is available for all completed compliance management activities in a company.

VII. CONCLUSION

Extensive expert knowledge is required to consistently and completely perform all compliance management tasks and as a result assures environmental law compliance in day-to-day operations. Specific requirements must be fulfilled to attain reasonable efficiency in meeting the documentation and monitoring obligations defined by environmental laws, as well as in the performance of information management and communication tasks. These requirements include, in particular, a systematic and holistic development and implementation of the associated processes, as well as the utilization of an adequate compliance management information system.

The reference model presented in this paper can serve as a useful basis for companies to realize a holistic and process-oriented development and implementation of environmental law compliance management. The CCPro software solution provides companies a tailored compliance management information system. The reference model processes presented in this paper can be mapped to exact specifications in CCPro.

During the next process phases, the reference model will be expanded and specified in more detail according to the various phases of a process-oriented approach. The next step will describe the essential business processes in the form of BPMN process models [23].

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