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Contribution to the Study of the Contribution of UML to the Management of Environmental Projects at Company Level

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SUMMARY

This doctoral thesis in science focuses on the contribution of technologies to the management of environmental projects of Algerian companies. Thus, the use of the unified modeling language (UML) allowed us to design and validate a software for evaluating the environmental performance of an Algerian company (SCIMAT) on the basis of its Environmental Management System and through a set of environmental performance indicators, which allowed us to develop a new approach for continuous improvement of the EMS of Algerian companies certified ISO 14001 in general, and of SCIMAT in particular. This constitutes an interesting contribution in the management of environmental projects by artificial intelligence.

Keywords: Environmental Management System, ISO 14001, Performance Environmental, Performance Indicators, UML, SCIMAT.

General Introduction

The field of environmental management is a recent field for the company. Before the 1970s, the environment was not a management object for companies. Currently, the latter are faced with an imperative of sustainability that seems a priori contradictory to the imperatives of sustainable development. But, ensuring its sustainability forces the company to have to constantly overcome the vagaries, risks and threats populating its environment.

To respond to new environmental challenges, companies need to control the effects of their activities or products on the environment, and therefore to assess them, so as to set up action plans and measure their effectiveness. Environmental Management Systems (EMS) are part of this context, offering a management method that guarantees the integration of environmental concerns at all levels of the company. These systems need to be supplemented by environmental performance assessment tools to improve the role and functioning of the EMS.

These tools can also allow companies to go through the environmental analysis phase accompanying the implementation of an EMS, or be used independently, to form the basis of an environmental management system adapted to the company. Indeed, an EMS must be continuously evaluated to ensure continuous improvement. The ultimate goal of assessing environmental performance through the use of performance indicators is to ensure that industrial activities are moving in a sustainable direction at a rate acceptable to society and the environment.

At the heart of environmental and industrial issues, the performance evaluation of the EMS has grown considerably in recent decades. Improving environmental performance is very important for the sustainability of companies, as well as the complexity of change, and uncertainty, faced by Algerian companies. In this order of ideas, it is relevant to ask whether modeling by the UML (Unified Modeling Language) can have a contribution for the evaluation of Environmental Management Systems at the level of Algerian companies. The need for IT tools makes it possible to achieve the objectives set in a minimum of time and at the lowest cost, which requires the application of human knowledge in very specific fields such as that of environmental management, in order to solve the problems of our companies in the management of environmental projects.

Objective of the study is the evaluation of environmental performance becomes more and more complex and the adoption of a new approach for this environmental evaluation is necessary at the level of our companies. Our study proposes to develop a computer tool which makes it possible to manage and evaluate the environmental performance of environmental management systems, within the framework of decision-making tools. The environmental performance evaluation approach consists of modeling the EMS of a pilot company (example of cement manufacturing) using the UML language (Unified Modeling Language) or the Unified Modeling Language which is considered to be the visual modeling standard used to specify, visualize, construct, and document software system artifacts.

Thus, UML is applied to the design and analysis of software. This language is essentially graphical, easy to read and understand. It defines the diagrams and conventions to be used when building models describing the structure and behavior of software. Thus, it is essential to start with the development of a system of environmental performance indicators concerning the activity of production of cement in order to achieve the design of our software which is an application intended to manage and evaluate the environmental performance of the cement company.

In addition to the design of the tool in question, the study should make it possible to locate, for the company, the priority areas of intervention for improvements in the environmental performance of the EMS. For this, two main research hypotheses emerge:

- Can new technologies, such as UML (Unified Modeling Language) be adapted to the needs of ISO 14001 certified companies with a view to controlling, developing and improving their environmental management system?
- Does the design of software for evaluating the environmental performance of companies based on UML allow the construction of a platform for evaluating the performance of their EMS?

I. LITERATURE REVIEW ON THE ENVIRONMENTAL MANAGEMENT SYSTEM (EMS)

1. Introduction

In recent years, we have witnessed the emergence of the environment as a societal value. This evolution has the consequence of gradually bringing public and private decision-makers to consider the integration of environmental requirements, not only in their activities but also within their structures by involving their various departments. And as the reduction of environmental impacts is increasingly becoming a collective responsibility that must be assumed in the daily management of companies. This awareness translates into practice through the implementation of environmental management systems (EMS) of which the ISO 14001 standard is a reference model.

2. The Environmental Management System (EMS)

Environmental management, also called environmental management, refers to the management methods of an entity (company, service, etc.) aimed at taking into account the environmental impact of its activities, evaluating this impact and reducing it. According to the ISO 14001 standard, environmental management is part of a sustainable development perspective. The EMS is a set of internal mechanisms which makes it possible to ensure daily that all the activities of the company are carried out in compliance with the environmental policy decided by the management.

Respecting the environmental policy means:

- Enforce the environmental program set by management to achieve the objectives set, taking into account environmental priorities when making decisions;
- Gradually and sustainably ensure compliance with the regulations applicable to the company in terms of the environment,
- Environmental Management Systems (EMS) are part of this context by offering a management method allowing the integration of environmental concerns at all levels in the company. The objective is to improve environmental performance. defined as "the measurable results of the EMS.

2.1.1. Phase 1: Implementation of the EMS

Adoption by the management of the company of an environmental policy ensuring regulatory compliance and committing to constant and reasonable improvement of environmental results. An environmental analysis of the company must make it possible to identify its impact factors. Based on these results, an environmental program with specific objectives is defined. When documents already exist, such as the impact study, the waste study or the hazard study, they can form the basis of the environmental analysis work.

2.1.2. Phase 2: Organization of the EMS

Definition of responsibilities, awareness and training of company personnel or organization of operational control.

2.1.3. Phase 3: Monitoring of the EMS

Monitoring ensures that the requirements of the EMS are well respected. In the event of non-compliance, corrective measures are programmed.

2.1.4. Stage 4: Documentation

A register of documents relating to environmental management is maintained.

2.1.5. Phase 5: Assessment

Environmental audits are periodically scheduled. They verify the proper functioning of the EMS.

2.1.6. Phase 6: Communication

The company must draw up an environmental declaration intended for the public, presenting:

- A description of the company's activities.

- An assessment of significant environmental issues related to the activity.
- A summary of the figures.
- A presentation of the policy, the program and the EMS.

2.1.7. Phase 7: Verification

The company must have the policy, program, EMS, analysis or

audit procedure and declaration in order to verify compliance with the requirements of the regulation. The implementation of the EMAS Regulation is shown in Figure I.1.

2.2. ISO standards

Like the development of quality standards, environmental management quickly translated into a need for international standardization. The globalization of economies implies, in fact, a harmonization of the standards and regulations in force in the barriers to the entry of certain markets which can lead to the liberalization of trade. the International Standardization Organization (ISO), and the Strategic Advisory Group on Environment ISO 14000 (SAGE), in acronym. The advent of international standards on environmental management, which are expected to replace national standards and other existing EMSs, reflects a movement to standardize the development of ISO 9000 quality standards. international level and the work of several working groups in which representatives of different countries participated. In total, around twenty standards on environmental management have been drawn up (management systems, verification, labelling, evaluation of environmental performance, product life cycle, etc.).

However, only the ISO 14001 standard on environmental management systems (EMS) may be subject to a certification process by an accredited body. The purpose of this process is to verify the compliance of the company's management practices with the requirements of the standard. The ISO 14001 system thus requires the implementation of detailed documentation and compliance by the company with the commitments and procedures defined in these documents. The proposals of the EMS must be documented and respected in a rigorous way, by its global, systemic character, and the certification of which it can be the object. The ISO 14001 standard is in fact the most important of the ISO 14000 series and stands out as the reference model for environmental management systems. The proposals of ISO 14001 are based on five classic management principles which will be the subject of the following paragraphs.

1. Environmental policy
2. Planning
3. Implementation and operation
4. Control and corrective measures
5. Continuous improvement

2.2.6 List of Environmental Management System standards

The list of ISO 14000 standards relating to environmental management standards is as follows:

- ISO 14001: 2004 Environmental Management System,
- Specification and guidelines for its use,
- ISO 14004:2004 Environmental Management System,
- General guidelines concerning the principles, systems and techniques of implementation,
- ISO 14015: 2001 Environmental assessment of sites and organizations,
- ISO 14030:1999 Environmental Management – measurement and monitoring of environmental performance,
- ISO 14031:1999 Environmental Management – evaluation of environmental performance – guidelines to follow,
- ISO 14050:2002 Environmental Management – Vocabulary.,
- ISO 14062:2002 Environmental Management – Integration of environmental aspects into product design and development,
- ISO 19011:2002 Guidelines for auditing Quality Management and/or Environmental Management Systems.

II: Literature review on the Unified Modeling Language UML

2. 1. Introduction

The new information and communication technologies offer the possibility of accessing increasingly large masses of information on increasingly varied media, so we can say that computerization is the most important in our time. It is now involved in most activities of daily living. Today, IT is at the heart of all large companies. As part of our study, what is the contribution of new technologies to the management of environmental projects,

2.2. UML (Unified Modeling Language)

When object-oriented analysis and design methods reached a certain UML maturity, the Unified Modeling Language emerged to become the object modeling standard. Indeed, UML is not a method but rather a notation that merges the notations of OOD, OMT, OOSE and others. The unification process undertaken in October 1995 began with the harmonization of the OMT and OOD methods and with the development of a common meta-model. The contribution of the OOSE method took place during the year 1996, when Ivar Jacobson also joined the initial team composed of Gardy Booch and James Rumbaugh.

Tools and design workshops had anticipated by proposing use case representation diagrams. The use of use cases is formalized in UML. The versions made available to the public were versions 0.8, 0.9, 0.91 and version 1.0 of January 13, 1997. It is this version which was given to the association OMG (Object Management Group) in order to establish an industry standard for an object model modeling language. In November 1997, the OMG adopted UML 1.1 as the modeling language for object-based information systems. The UML 2.0 version in 2006, continual transformations are constantly being made in this language to remove inconsistencies, make improvements and add new concepts.

UML is therefore not only an interesting tool but a standard that is essential in object technology and to which all the major players in the field who have contributed to its development have joined.

2.2.1 Definition

UML (Unified Modeling Language), can be translated by the unified modeling language, it is defined as a graphic and textual modeling language intended to understand and describe needs, specify and document systems, sketch software architectures, design solutions and communicate points of view.

UML unifies both object-oriented notations and concepts. It is not just a notation. But the concepts transmitted by a diagram have a precise semantics and carry meaning in the same way as the words of a language. UML also unifies the notations necessary for the various activities of a development process and offers, by this means, the means of establishing the follow-up of the decisions taken from specification to coding.

UML has a symbolic dimension and opens a new way of exchanging precise systematic visions. It consists of views, element models, general mechanisms and diagrams. The following sections briefly describe these sets.

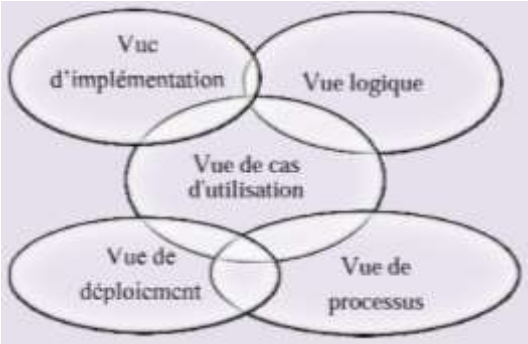
2.2.2. UML views

Views show different aspects of a system. A view is not a graphic element or a diagram, but an abstraction that encompasses a number of diagrams in order to describe the system from a given point of view.

Among these views are:

1. ***Use Case View***: This view defines the customer needs of the system and focuses the definition of the system architecture on meeting (fulfilling) those needs using scenarios and use cases. This view leads to the definition of a relevant and coherent architecture model. So it is a description of the system "seen" by the actors of the system. It thus corresponds to the needs expected by each actor (this is the WHAT and the WHO).
2. ***Logical view***: this view describes, in an abstract way, how to realize the functionalities of a system. It is dedicated to designers and developers. Unlike the use case view. The logical view is a view inside the system. It describes both the static structure (classes, objects, relationships, etc.), and the collaborations that can take place during the exchange of messages between objects in order to perform specific functions. Properties such as persistence, concurrency, are also defined in this view. The static structure is described in this view by class and object diagrams. The dynamic is specified by state machines, activity and interaction diagrams.
3. ***Implementation view:*** This view describes the main modules and their dependencies in a system. It is specific to developers. It shows the allocation of modeling elements in modules (source files, dynamic libraries, databases, executables, etc.). In other words, this view identifies the modules (physically) the classes of the logical view. The organization of the components, i.e. the distribution of the code in configuration management, the dependencies between the components, the development constraints (external libraries...), the view of the components also shows the organization of the modules in "subsystems", the interfaces of the subsystems and their dependencies (with other subsystems or modules) .
4. ***Process view:*** This is the temporal and technical view, which implements the notions of concurrent tasks, stimuli, control, synchronization, etc. It is very important in multitasking environments. It shows the breakdown of the system in terms of processes (tasks); interactions between processes (their communication); synchronization and communication of parallel activities,

5. ***Deployment view:*** This view describes the geographical position and the physical architecture of each element of the system. It also describes the hardware resources and the distribution of the software in these resources: the layout and the physical nature of the materials, as well as their performance, the installation of the main modules on the nodes of the network and the requirements in terms of performance (time of response, tolerance to faults and breakdowns, etc.). This view is represented by deployment diagrams and is used by developers, integration managers and testers.



III: MODELING OF THE EMS BY THE UML.

1. Identification of environmental aspects

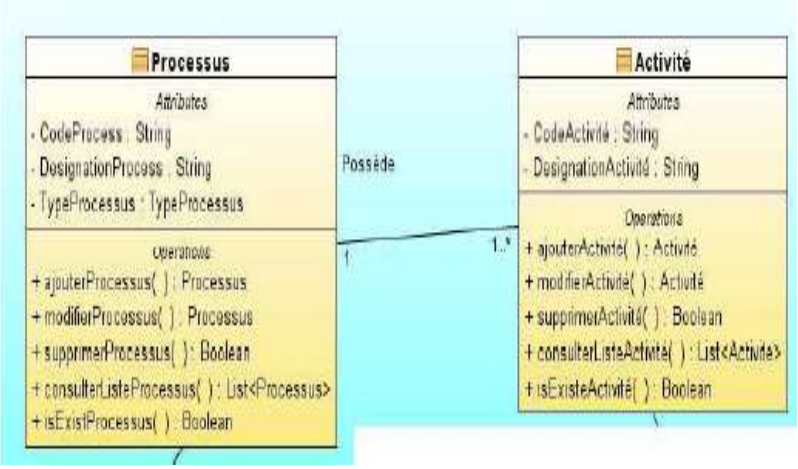
This involves determining the significant environmental aspects concerning the following areas: waste, soil, energy, and air pollution according to the method explained below. The assessment of environmental impacts is carried out according to a rating system. Each impact identified is characterized according to the criteria below: The environmental analysis is done by process and is essentially based on a breakdown of the cement plant site by area of activity. The manager of the SMQE process, in collaboration with the managers of the other processes, identifies the main activities of the cement plant and provides each department with specific sheets concerning the identification of environmental aspects.

At the level of the environmental aspects identification sheets, the department is presented by one or more departments. Each service is made up of one or more activities. Each activity is analyzed in order to allow an exhaustive inventory of the environmental aspects. For activities common to all processes, a single sheet is established by the person in charge of the SMQE process.

2. Principle and theoretical study of an Environmental Performance Evaluation software based on the EMS

(Case of the manufacture of the cement plant)

The cement manufacturing process within the cement plant includes one or more activities, each activity has a code and a name. The activity code represents a concatenation between the process code (in two positions) to which the activity belongs and an activity code (in two positions), as follows:



As for the environmental aspects of the cement plant, each activity has one or more aspects; therefore, the aspect code is formalized in four positions

Process code Activity code whose first two positions represent the activity code and the last two represent the aspect code, as shown:

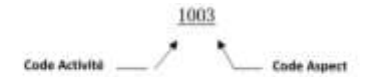


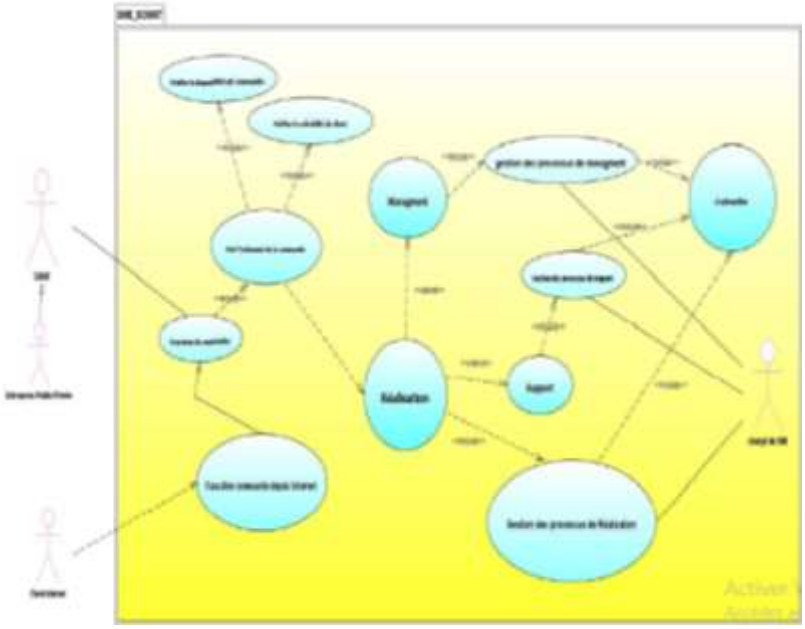
Figure IV.9 code de l'aspect [Réalisé par nos soins].

Le diagramme de classe UML qui modélise la relation entre les activités et les aspects du processus de fabrication est le suivant :

3. Use cases

Use cases make it possible to structure the needs of users and the corresponding objectives of a system, they center the expression of the requirements of the system on its users: they start from the principle that the objectives of the systems are all motivated.

Determining and understanding needs is often difficult because stakeholders are drowned in too much information, it is necessary to clarify and organize customer needs (model them). For this, the use cases identify the users of the system (the actors) and their interactions with the system. They make it possible to classify the actors and structure the objectives of the system.



We note that the links or stereotypes described (Cf. figure IV.11) are of the type: Include or Extend, the first indicates that the source use case contains the behavior described in the destination use case, while the second indicates that the source use case extends or refines the destination use case.

Note however that this division that we have chosen is not the only one possible. Indeed, a work of reflection could very well give rise to another vision of the system. We preferred to keep the breakdown closest to what was stated in the needs analysis phase so as not to deviate from the user's wishes. In addition, the proposed computerized solution consists of automating and optimizing calculation operations as much as possible.

For reasons of consistency of our case study, we will limit ourselves to the analysis and design of the use cases initiated by the person in charge of the EMS. Indeed, the automation of the management of the EMS processes must allow all the updating functionalities such as the addition, modification and deletion of information associated with the processes, activities and aspects of the EMS.

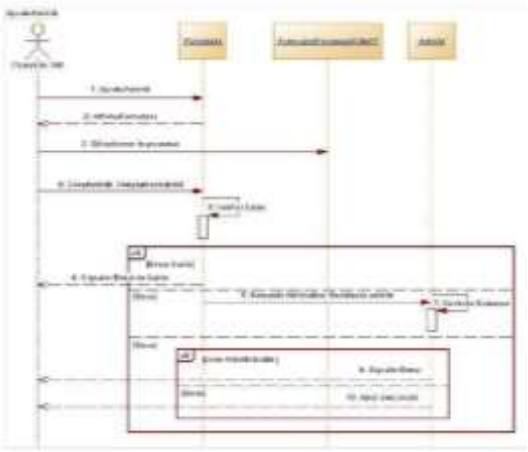
4. Scenario modeling using sequence and communication diagrams

Sequence and communication diagrams present a way to document the possible scenario associated with each use case described in the system. The order of use of a sequence or communication diagram one before the other is left to the free choice of the user. In our case, we will start with the sequence followed by the communication.

Note that the scenarios we are going to describe directly target the IT solution, i.e. we already provide the necessary elements (controls, interface, etc.)

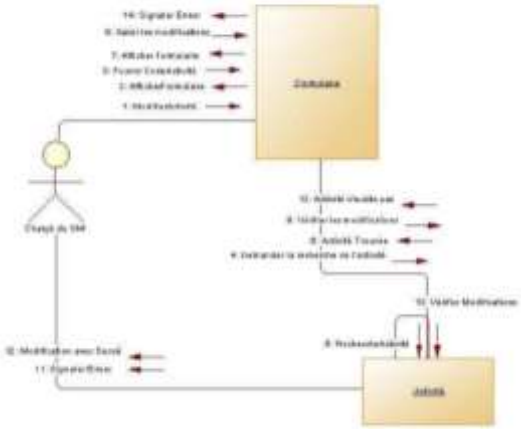
We will focus our study in this part on the management of EMS process activities related to use cases: management of management activities, management of support activity and management of implementation activities:

5.2.1. Scenario : Ajout d'une activité



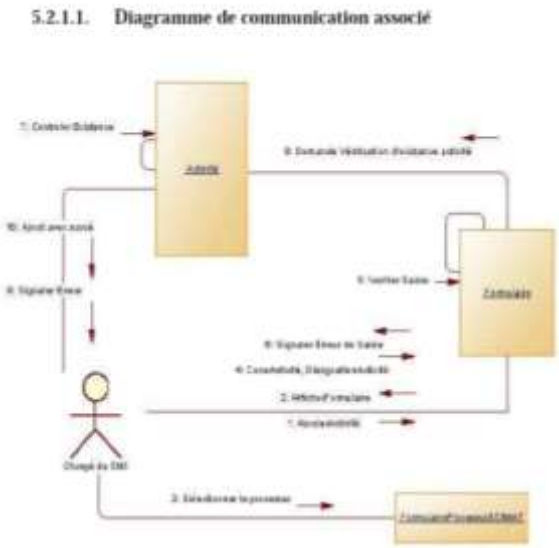
The person in charge of the EMS asks the system to add a new activity via the appropriate interface. The system then asks him to first select the process code in which the activity in question belongs, then the system asks him to provide information on this activity, after validation the system verifies the various information entered. If there are no errors, the recording will be made, otherwise any errors will be reported.

5.2.2.1. Diagramme de communication associé



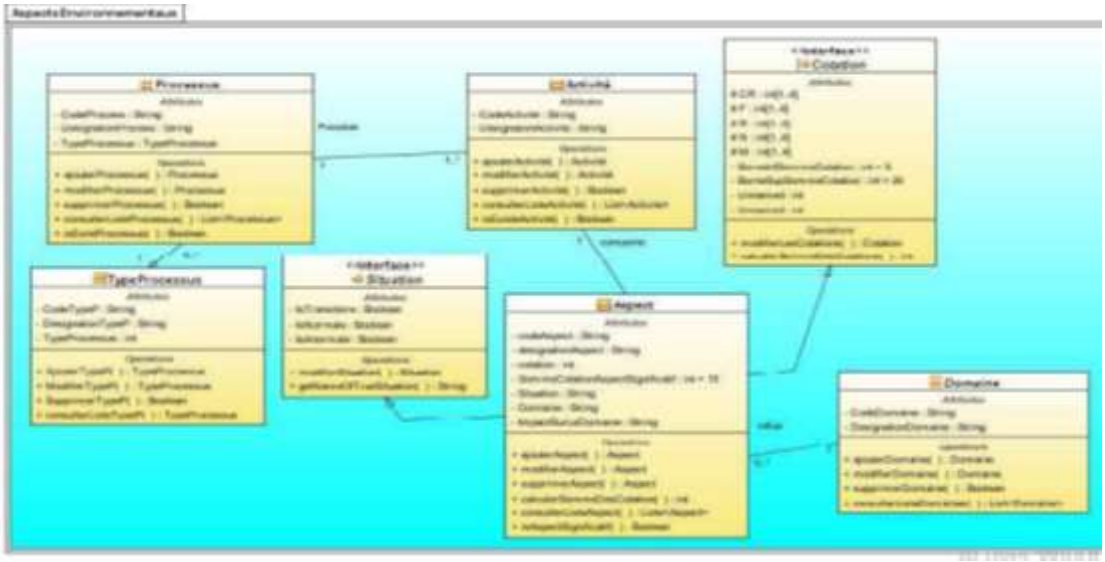
5. Scenario: Editing an activity

The person in charge of the EMS requests the system to modify the properties of an activity, the system first asks to specify the code of the activity to modify and then proceeds to search for its existence. If the code is not found, the system will signal to the person in charge of the EMS that "This activity does not exist", otherwise it will provide the descriptive sheet which will begin to operate its modifications and then validate its entries by pressing the appropriate button. The system then checks the new information and if there are no errors, it will save the modification. Otherwise it will point out where the error needs to be corrected.



6. The class diagram

The following diagram represents the diagram associated with the use case related to the management of EMS processes.



General conclusion

In conclusion, the results of our study have enabled us through the developed approach to note that the contribution of a decision-making tool at the level of companies is necessary. Its purpose is to give the decision-maker the means to make an informed decision. The tool can provide the necessary information to the decision-maker to form his own opinion. The objective of this work was to develop and apply a decision support tool for the evaluation of the environmental performance of an Environmental Management System.

To answer this problem, we are interested in modeling by UML (Unified Modeling Language) as a decision-making tool. This information provides information on the inputs poorly taken into account by traditional management and indicates to managers that the modifications to be made to must ensure better consideration of the inputs identified for better control of the indicators ("Air", "Energy", " Waste", "Soil") which can reveal the non-conformities of the company. A process for analyzing the results of the assessments leading to the development of a preventive and corrective action plan clearly indicates that the SCIMAT EMS is well installed as a whole.

Nevertheless, there are still some improvements for it to reach a desirable maturity. The solution of the evaluation of the performance of the EMS by a computer tool, proposed within the framework of this research work, thus offers a renewed vision of the contribution of new technologies to environmental management, this solution constitutes an interesting contribution to the structuring and formalization of the EMS as a whole.

In addition, the identification of interesting prospects for improving the proposed tool, suggests very encouraging results on the contribution of the contribution of new technologies as an enriching solution for the performance of Environmental Management Systems at company level.

Several perspectives emerge from our work:

- The generalization of the use of the software at the level of companies;
- The enrichment of applications concerning environmental assessment,
- The construction of an environmental database for companies

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