Scientific Paper

BiomaSoft: data processing system for monitoring and evaluating food and energy production. Part I

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ABSTRACT: The integrated food and energy production in Cuba demands to process diverse and voluminous information to make local, sectoral and national decisions, in order to have incidence on public policies, for which the support of automated systems that facilitate the monitoring and evaluation (M&E) of the integrated food and energy production in Cuban municipalities is necessary. The objective of this research was to identify the tools for the design of the data processing system BiomaSoft and to contextualize its application environment. The software development methodology was RUP (Rational Unified Process), with UML (Unified Modeling Language) as modeling language and PHP (Hypertext Pre-Processor) as programming language. The environment was conceptualized through a dominion model and the functional and non-functional requisites that should be fulfilled, as well as the Use Case Diagram of the system, with the description of actors, were specified. For the display of BiomaSoft a configuration based on two types of physical nodes (a web server and client computers) was conceived, in the municipalities that participate in the project "Biomass as renewable energy source for Cuban rural areas" (BIOMAS-CUBA). It is concluded that the monitoring and evaluation of integrated food and energy production under Cuban conditions can be made through the automated system BiomaSoft, and the identification of tools for its design and the contextualization of its application environment contribute to this purpose.

Key words: data processing system, food and energy production, monitoring and evaluation

INTRODUCTION

The present times are marked by a set of hazards that threaten the balance of ecosystems, because of climate change, environmental degradation, food crisis and the increasing biofuels *vs.* food contradiction, which has been generated by a senseless policy to obtain certain first-generation agrofuels from large extensions of food monocrops. For such reason the question emerged of how to make agroenergy, food security and environment protection coexist.

On the other hand, the remarkable growth of the world population since 1950 and the expectations of a better standard of living drive the increasing demand of agricultural products (FAO, 2009a). This has imposed a progressive pressure on natural resources (land, water, forests and biodiversity), which has increased because of the industrialization, commercialization and globalization of the economic activity, because traditionally the natural resources and services of the ecosystem have been undervalued or depreciated by the market and, as a consequence, excessively used. Likewise, the climate change and the widening of the biofuel production, as possible source of clean energy, subject the bases of the natural resources of Earth to considerable additional exploitation (FAO, 2009b).

At present, such biofuels (liquid and gaseous) are considered by governments and international institutions as an ecological alternative to fossil fuels due to their capacity to reduce the emission of GHG –very controversial aspect, with defenders and detractors–, besides promoting the development of rural communities of underdeveloped countries, which are the producing zones. Among the defenders of the sustainable production of liquid biofuels are the United Nations Environment Program (UNEP, 2007) and the Bioenergy and Food Security Program (FAO, 2008b), which promote the development of sustainable regulations for their production.

This is the approach promoted by the international project "Biomass as renewable energy source for Cuban rural areas" (BIOMAS-CUBA), funded by the Swiss Cooperation and Development Agency (SDC) and led by the Pastures and Forages Research

Station Indio Hatuey (EEPF-IH), in six Cuban provinces. The general objective of this project is to generate experiences for the integrated and sustainable food and energy production, in the framework of local strategies, in order to improve the living conditions of women and men in rural areas of the country (Suárez and Martín, 2011, 2012; Suárez *et al*., 2011).

Worldwide there are diverse data processing systems for the monitoring, control and/or evaluation of projects, such as the ones developed by Lee *et al*. (2008), Mahaney and Lederer (2010), Allúea *et al*. (2013), Pellerin *et al*. (2013), Hazir (2014) and Acebes *et al*. (2014), but focused on computerization projects and designed for developed countries. However, the integrated food and energy production, under Cuban conditions, demands to process and utilize diverse and voluminous information to make local, sectoral and national decisions, in order to have incidence on public policies, which is very troublesome without the support of an automated system that facilitates the monitoring and evaluation (M&E) of this complex process.

The objective of this study was to identify the design tools of the data processing system BiomaSoft and contextualize its application environment. (Parts II and III of this paper will introduce the development of the BiomaSoft system and the results of the implementation of the software, respectively).

Description of the technologies used in the design of BiomaSoft

a. Methodology of software development

The quality and proficiency required by a product in the software market make practically essential the use of methodologies for the development of arranged applications. The necessary competitiveness in a market dominated by large private enterprises can be obtained just by following regulations and standards. For such reason, regarding architecture, it was decided to use RUP (Rational Unified Process) as methodology of development. This product of the software engineering process provides a disciplined approach to assign tasks and responsibilities within a development organization. Its goal is to ensure the production of high-quality software, which solves the needs of the users, with a budget and in an established time (Jacobson *et al*., 1999).

b. Modeling language

For modeling the system UML (Unified Modeling Language) was used, due to its simplicity and standardization worldwide. In addition, this language is used by the RUP methodology, and allows to describe graphically a certain system, in a simple and comprehensible way (Rumbaugh *et al*., 2004).

c. CASE tool

To manage the software engineering activities, Visual Paradigm was used as CASE tool –Computer Aided Software Engineering– (Visual Paradigm International, 2012).

d. Architectural pattern

In order to achieve a solid and reliable system, the architectural pattern Model-View-Controller (MVC) was used, due to its capacity to organize and distribute the code generation process (Reenskaug *et al*., 1995).

e. Integrated development environment

To facilitate the system implementation tasks, NetBeans IDE (Integrated Development Environment) was selected as integrated development environment, which is easily integrated with the programming language and the selected frameworks (Sun Microsystems/ Oracle Corporation, 2013).

f. Programming language

The programming language used was PHP (Hypertext Pre-Processor). This is a script language the server interprets, and is used to generate dynamic web pages, included in HTML pages (Hypertext Markup Language)– and executed in the server (PHP Group, 2012). Such language should have Apache or IIS (Internet Information Service) installed, with the PHP libraries. The highest part of its syntax has been taken from languages C, Java and Perl, with some specific characteristics. Its files have the extension .php.

g. Development framework

To increase productivity in the implementation of the system and guarantee its maintenance and security, Symfony was used as development framework; thus the programmer is relieved from the basic and rudimentary operations of codification (SensioLabs, 2012).

h. Appearance framework

In order to facilitate the design and construction of the graphic interface of the system, Dojo Toolkit was selected as appearance framework.

Analysis and design of Biomasoft

Conceptualization of the application environment of BiomaSoft

The concepts and entities identified in the application environment of the system are the following:

a. General description of the Dominion Model

The person in charge of managing the M&E is based on the information obtained, through questionnaires designed for this purpose, in the productive scenarios and the municipalities; generates useful reports for the evaluation of the status of the integrated food and energy production (fig. 1); and makes an implementation, according to the formulated local strategy (Suárez *et al*., 2014).

b. Description of the entities

Figure 1 shows the entities of the data processing system designed (representations of the objects that interact in the application environment), which are described below:

- Users: the persons in charge of inserting, eliminating or modifying the existing information.
- Compiled information: specific attributes that can be associated to a project, which are obtained through questionnaires. It should be stored for future searches and analyses.
- Project data: elements that are digitalized in the system as result of the management processes of the gathered information and the generation of reports.
- Reports: pieces of information, results, alarms and conformities, specifically and dynamically specialized and organized. They constitute the intentional conjunction of the stored data, and their interest is the conformation of follow-up records and management strategies.

Specification of the functional and non-functional requirements

The identification of requisites is made in order to achieve a good design, besides the adequate modeling and results. In this process the functional requirements are defined, that is, the capacities, properties and functionalities the system should fulfill.

These functional requirements manage the data of the productive scenarios (system data), management strategies and specialized reports (follow-up records), associated to the M&E (fig. 2). Managing includes the actions showing, creating, modifying and eliminating.

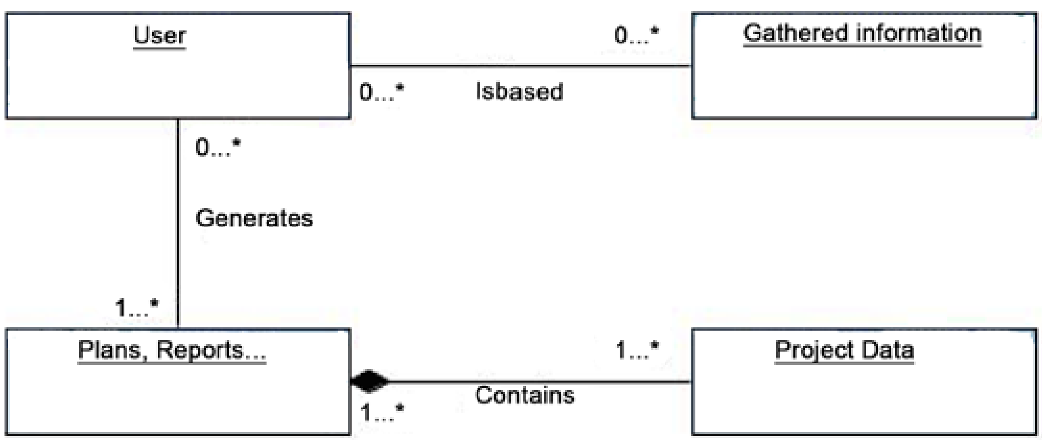
On the other hand, the non-functional requirements are the properties or qualities the system should have, and they are more focused on its characteristics than on its functions. Such requirements are the following:

a. Security

The system should guarantee the integrity, availability and confidentiality of the information. The request of confirmation should be made before irreversible actions, for example, the elimination of any information.

b. *Usability*

Usability, a usual term in the field of computer science, refers to the capacity of a software of being understood (ISO/IEC, 2005), for which the system



Source: elaborated by the author
Figure 1. Diagram of the Dominion Model

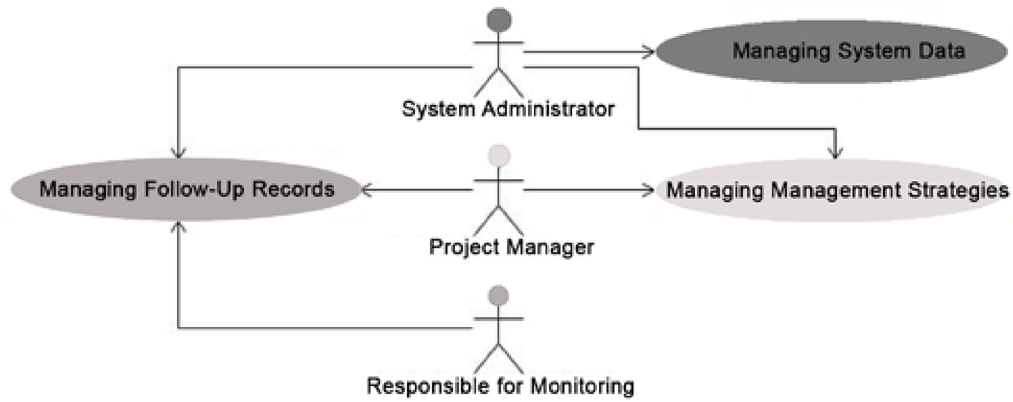


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Figure 2. Use Case Diagram

is conceived to be used by people who have basic knowledge of computer science and project management, in the municipalities as well as in the top management of BIOMAS-CUBA.

c. Appearance and graphic interface

The graphic interface of the application is conceived with a simple environment that can be easily and intuitively navigated by the user. The colors should be conveniently used, depending on the objective of a certain situation; they should be light in most of the application and with other shades to highlight the interaction messages.

d. Hardware

The system requires, as minimum, the following hardware resources:

- In the servers: Pentium III processor, 1 Gb of RAM and 2 Gb of storage.
- In the client stations: Pentium III processor, 256 Mb of RAM and 2 Gb of storage.

e. Software

The system requires the following software resources:

- In the client stations: any operative system and navigator (the use of Mozilla Firefox 3.6 or superior is recommended).
- In the servers: any operative system Linux based on Debian, postgreSQL as database manager and Apache as web server.

The BiomaSoft system for M&E

The above-described requirements are transformed in the Use Case Diagram of the BiomaSoft system (fig. 2), in which each of the requisites comprises a series of actions executed by the actors. These actors and the use cases, as well as their descriptions make up the system model.

a. System actors

A system actor represents a set of functions that users perform when interacting with the use cases. The following are defined as system actors: the system administrator (in charge of the database management process and of the administration of the internal functioning of the system as a whole), the project managers (people in charge of the strategic management of the project, as well as the verification of the data included in the follow-up records), and the ones responsible for monitoring (people who are to provide follow-up for the productive units, through the application of surveys in the participating scenarios).

b. Class diagram of the design of BiomaSoft

The class diagram of the system design (fig. 3) allows to organize, according to the architectural pattern MVC, the classes and components utilized for each use case described, which allows to structure the components as follows:

- Model: composed by the ORM (Object Relational Mapping) Doctrine. The framework (Symfony) uses it for the data management and processing.
- Controller: composed by the frontal controller Project Manage.php. It is in charge of receiving requests (generally URL –Uniform Resource Locator–) and of determining, using the Symfony components (package that encapsulates the framework functioning), the module Actions

and the action that should be invoked, in order to respond to the request received.

- View: composed by files with suffix success (encapsulated in the package Complement Actios), which are in charge of adhering, together with the Layout, the results of the actions; which will be used by the frontal controller to construct the client pages Manage Index, that will be ultimately shown to the user.

c. Display diagram of the system

The display of BiomaSoft is associated to its application and it is conceptually based on the connections among the elements of its configuration (figure 4 visualizes the software components located on physical nodes). These elements consist in a server node –located at the EEPF-IH–, which encapsulates the web server and the database manager, which in turn contain the necessary software components for their functioning; and in a client node, representing the client computers in the scenarios that participate in the BIOMAS-CUBA project, which are used by the local coordinators of M&E to process the captured information. In it the information obtained through the annual application of questionnaires and in the municipal management associated to the integrated food and energy production, is introduced and processed, by means of a HTTP connection (Hypertext Transfer Protocol).

CONCLUSIONS

The integrated food and energy production under Cuban conditions demands to process and utilize diverse and voluminous information to make local, sectoral and national decisions, in order to have incidence on public policies, for which the support of automated systems that facilitate the monitoring and evaluation of this complex process is necessary. The identification of the tools for the design of BiomaSoft and the contextualization of its application environment, presented in this paper, contribute to this purpose.

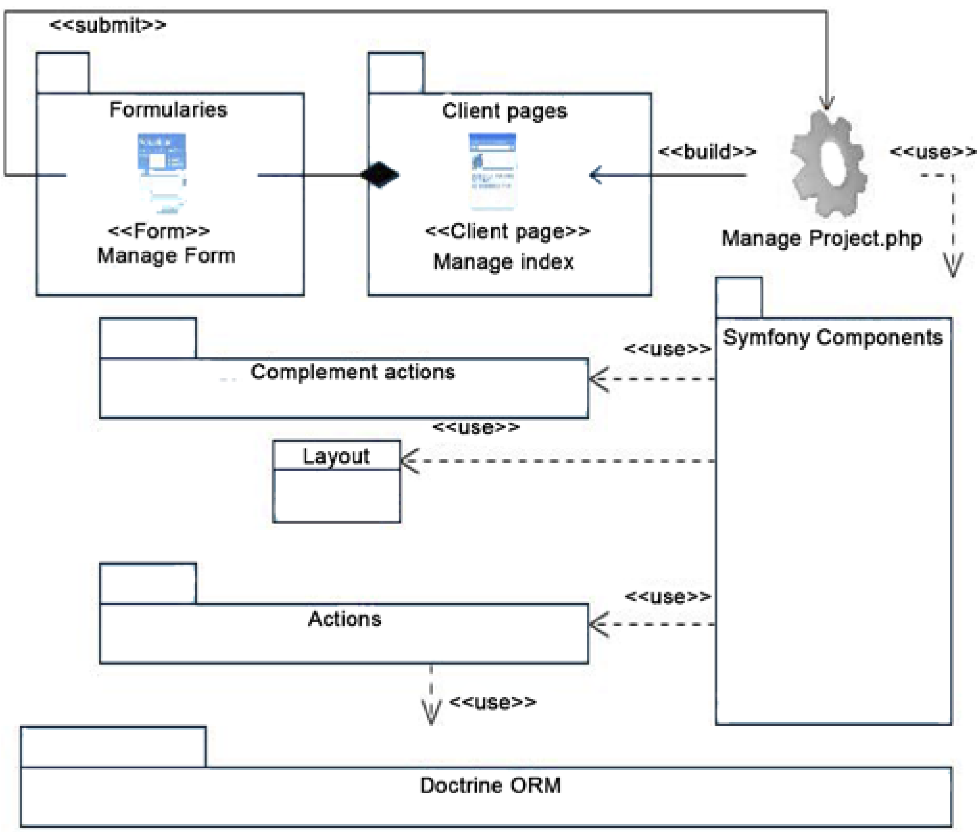

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Figure 3.Class diagram of the design of the system.

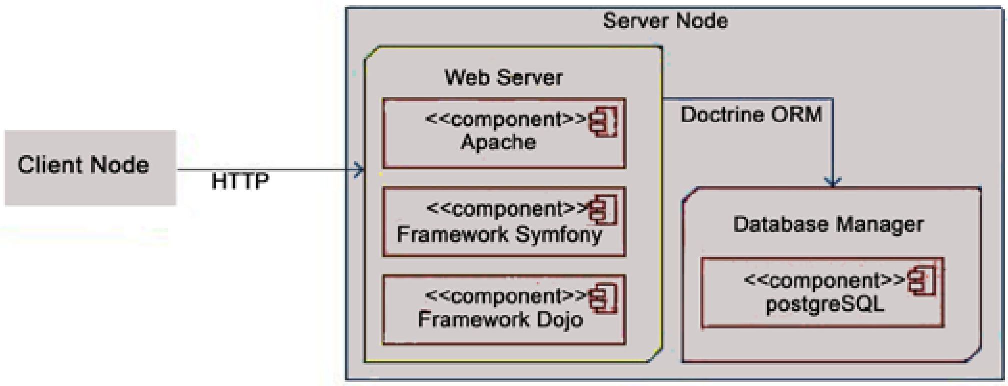

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Figure 4. Display diagram of the system.

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