SySPE Solution and IT-for-Green Communication through Web Services

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Abstract—Corporate sustainability and sustainability management have become a key issues in modern organizations to achieve a more balanced and sustainable development. Nowadays IT supports to environmental and sustainability behaviours in business processes and it is part of the solutions to improve the sustainability performance in organizations. IT-for-Green is a project that proposes a new generation of Corporate Environmental Management Information Systems that allows to incorporate the strategic sustainability integration. The main motivation of this research was fill partially the important gap in relation with one uncover goal of this project “the integration with other applications”. The paper explores the architectural elements and the possibility to integrate the IT-for-Green project with the System of Sustainability Performance Evaluation using Zend Framework for web services generation, to add some future functionalities to IT-for-Green. A first web service definition and generation was designed.

Keywords— sustainability management, solutions integration, web services Introduction

I. INTRODUCTION

The recent growth in corporate sustainability made organizations consider this area as a key success factor that must be managed [1, 2]. IT plays an important role in sustainability management, specifically in sustainability performance evaluation [3-5]. Although IT has environmental impacts during its lifecycle, as a positive part, IT supports eco-controlling and efficiency in organizations. The last fifteen years have raised the support of IT to the environmental and sustainability behavior in business organizations [4, 6, 7]. Different concepts have been popularized through the academic and business world, e.g. Green Information Systems (IS), Green IS & IT, Green computing, Green IT and IT-for-Green. All are related to first-order effects (negative environmental impact of IT) and second-order effects (positive impact of IT in business processes). IT-for-Green is one of the newest concepts of the second-order effects and refers to the positive impact of using IT on business and economic processes. This perspective considers IT as part of the solutions to eco-sustainability [7].

Established tools for strengthening IT support are Corporate Environmental Management Information Systems (CEMIS), but those are not sufficient yet to achieve the strategic sustainability integration [8, 9]. For that reason, the project IT-for-Green started in 2011. IT-for-Green cover the complete product life cycle from input, transformation and output. It proposes a new generation of more strategic CEMIS, which should be able to support the company’s decision makers in all stages of product life cycle. Organizations need to track their sustainability goals and the goals of all their branches in a continuous way. The sustainability indicators are a good tool to compare sustainability business performance in different branches setting an internal sustainability benchmarking. Managers prefer the condensed information for a quick understanding of the whole business picture, identifying setbacks and progress related to the overall performance. The main motivation of this research was oriented to fill partially the important gap in relation with one uncover goal of this project “the integration of IT-for-Green with other applications”. Isolated applications tend to become problematic after a few years in use, when their integration in changing IT-environments becomes more difficult. IT-for-Green with a modular approach avoids that problem. The idea of add further functionalities from other applications using web services as a platform is a goal to improve the cover areas of IT-for-Green CEMIS. Also further contribution to the internal benchmarking of organizations through the strengthening and upgrading of reporting functionalities.

Communication and reporting are key elements of organization’s sustainability management. For that reason the idea of System of Sustainability Performance Evaluation (SySPE) developed for Cuban organizations [10], can be included as a future extension of web services collection for the IT-for-Green project.

SySPE is a tool to support the storage, retrieval management and integration of different sustainability indicators. The organizations’ managers set the indicators’ goals, related to the business performance into the application. SySPE helps to calculate the Corporate Index of Sustainability Performance (CISP). This index serves managers to discover which is the overall compliant of sustainability business goals and include the perception of different stakeholders. The application allows the graphical representation of CISP and visualizes the improvement potentials of indicators to redirect the organizational efforts.

SySPE functionalities can help to track business sustainability behavior and continuously improve the internal benchmarking. The main objective of this paper is to search architectural elements to integrate the IT-for-Green project with SySPE. The paper explores the possibility of effectively harmonize these
two systems, using web service with Zend Framework to add some future SySPE functionalities.

The paper outline is structured in (i) introduction, (ii) theoretical review of sustainability management and IT support, (iii) IT-for-Green and SySPE descriptions, (iv) web services definition and practical example and finally (v) future steps and conclusion.

II. CORPORATE SUSTAINABILITY AND SUSTAINABILITY MANAGEMENT

The recent boom in corporate sustainability, derived from the inclusion of the concept of sustainable development at organizational level, has led organizations to consider this area as an element that must be managed. Solve possible conflicts related to the dimensions of sustainability in the company, becomes a challenging task for decision makers. The first definitions of corporate sustainability were a faithful translation of the concept given in [11] at business level [12,1]. Others like SAP defines sustainability in a business environment. Sustainability requires us to consider environmental, social and economic aspects at the same time. If you are able to manage the risks and the opportunities holistically, it will lead to increased business success in turn [13].

Managing corporate sustainability is a major challenge for companies to demonstrate their contribution to sustainable development in spite of the difficulties in measuring the performance of the corporate sustainability [14]. The sustainability management is the formulation, implementation, and evaluation of both, environmental and socioeconomic sustainability-related decisions and actions [15]. The main objective of corporate sustainability management is balancing the organizational performance in the economic, social and environmental improvement opportunities identified simultaneously [16-18,14]. Sustainability management includes the internal development of environmental and social measures as well as the external contribution to the sustainable development of society and the economy [19].

Sustainability management are all the actions taken by the organizations to track and balance the business performance in economic, environmental and social areas; maximizing positives impacts and minimizing negatives.

Both concepts have an indissoluble relationship and have extreme significance to make the organizations more sustainable and reduce their negatives impacts and maximize the positive ones.

III. IT SUPPORT FOR CORPORATE ENVIRONMENTAL MANAGEMENT AND SUSTAINABILITY

The business has a great responsibility in the process of transition to a more sustainable development (SD). SD is a social concept, and is being increasingly applied as a business concept under the name of corporate sustainability [11].

In recent years, some tools had been developed to help organizations in the long path of sustainability. The role of IT to support environmental and sustainability management and reporting had being strengthened for the IT capabilities [4, 6, 7, 12-14]. Decision Support Systems are emerging as a suitable solution in the field of sustainability planning and control of complex systems [15]. According to [6] Specialized tools are: SAP Sustainability Performance Management (SuPM), Enablon SD-CSR, SoFi and credit360, and STORM. All these solutions are on the market as a commercial solutions difficult to access for countries like Cuba with a difficult economic situation and low level of internet access.

Another important tool is the project “Solution and Services Engineering for Measuring, Monitoring, and Management of Organizations’ Environmental Performance Indicators” (OEPI). This is an international research project supported and funded by the European Commission within the Seventh Framework Program [16] which is related to environmental performance indicators. A fundamental goal of the OEPI is to bridge the gap between various sources and types of environmental information and users of different backgrounds by providing an integrated information source [17]. OEPI provides to business users with an inter-organizational platform and tools to: provision and share environmental performance indicators across the chain and incorporate them in intra- and inter-organizational processes.

Other applications of IT solutions to support the relation between the organizations and the environment are: 1) ProPlaNET: a web based tool which supports sustainable project planning based on e-Participation and Web 2.0 [18]; This web provides a comprehensive framework to deal with the decisions support in relation to the planning process including a large quantity of indicators, stakeholders interests and the transparency of the decision process 2) SIMASE (acronym in Portuguese): Information System for Environmental and Corporate Sustainability Monitoring, is a software framework for social and environmental monitoring for diagnosis of organizations in terms of sustainability [19].

All of the above evidences how the role of information technologies has increased in recent years to support environmental and sustainability information in order to support business decisions and accomplish organizations’ sustainability goals.

According to [20] conventional CEMIS are not sufficient to achieve sustainability integration, a new generation of more strategic CEMIS will be able to support the company’s decision makers. IT-for-Green enrich traditional CEMIS using an integrated approach of handling processes [21] using workflows.

IV. METHODOLOGY

The research problem was identified as the necessity to make interoperable IT-for-Green with other applications to cooperate and use in relation with distributed applications in an open environment. The idea of add further functionalities from other applications to upgrade IT-for-Green is a goal to improve their cover areas.

The research method to develop the application was a multi methodological approach for Information System research called System Development (SD) [22, 23]. This method perform the research through exploration and integration of
available technologies to produce an artefact [22]. According with [22] based on [23] the systems development method consist in three steps: 1) concept building: investigating the functionality and requirements of the system and studying other disciplines for other ideas and approaches; 2) system building: the construction of the prototype system through the following steps: develop a system architecture, analyze and design the system and build the (prototype) system; 3) system evaluation. SD can be useful to consider as part of the exploratory stage of IS study. The firsts step was accomplished with the description of the two systems. Later a web service definition and design and finally the validation of the web service.

V. IT-FOR-GREEN PROJECT AS A CEMIS SOLUTION

The principal aim of this project is “increasing the environmental friendliness of companies and their processes by means of ICT” [20]. IT-for-Green proposed to research and create a new generation of Corporate Environmental Management Information Systems (CEMIS) which is able to support the company’s decision makers. The system is built in a modular manner [20, 24, 25] and the modules are:

Green-IT: Organizations have to deal with energy efficiency as a relevant element to reduce their IT infrastructure carbon footprint and the potential of their climate change impact, through the optimization of their electricity grid. This module is oriented to support energy efficiency and data modelling; it helps to calculate the energy requirements of a data center and compares the results with reference data to optimize energy use and costs.

Green Production and logistics: This module gives insight on two basic CO2 producing systems, namely production and logistics. For both systems there is a subsystem that models the existing processes and non-existing processes, so both can be compared to each other and to those of other companies.

Sustainability reporting and communication: The goal of this module is to collect and manage information about the real contribution of companies to sustainable development and stakeholders’ interaction. The module handles economic, social and environmental information, necessary to current and future stakeholder demands. Reports are elaborated with the accepted guidelines GRI G3, but also other kind of reports can be transformed into a schema to be generated by the application. IT-for-Green Next Generation CEMIS is built in a modular way follows the Service-Oriented Architecture (SOA). The modularization of IT-for-Green serves to different purposes: better integration in new IT environments, with IT-for-Green’s modules only a module has to be renewed, not the whole application; the possibility of modules customization in relation with the enterprise needs (they don’t need to acquire the whole package); the easy development, a modular system with loose coupling is easier to develop and maintain.

The platform is designed to be open and extensible for new modules and services through a workflow-based and service-oriented platform [24, 25]. According to [21] the runtime environment comprises of the core building blocks or components: a Green Service Mall, a Workflow Engine, an Event Engine and a user interface, to handle the internal and external services and business processes. Green Service Mall is the component that deals with web services, specifically it is a service repository where the web services can be published and discovered by consumers to satisfy their necessities.

The Workflow Engine is oriented to map the business process and it allows different tasks such as adding, updating, and deleting workflows; it is responsible for the system workflow execution and management, interacting with the service consumer and the workflow editor. The Event Engine is a component of the CEMIS with the main task to compare pre-established (environmental) requirements (e.g. water consumption, CO2 emissions, etc.) with the current variables’ performance and to detect possible violations and generate warnings and alarm messages automatically. The Event Engine is composed by different subcomponents like: management, executor, timer, condition model and Data Access Objects (DAO).

VI. SYSTEM OF SUSTAINABILITY PERFORMANCE EVALUATION

SySPE is an informatics solution born in 2012, impelled by the necessity of the Cuban energy sector as representation of Cuban business organizations to respond the pressures derived of the inclusion of Sustainable Development concept at business levels. It supports decisions associated to sustainability performance and provides an internal benchmark and a reporting tool to satisfy stakeholder’s information requirements. SySPE supports social, economic and environmental indicators related directly with organization performance distributed over key areas like: financial returns, costumers’ satisfaction and stakeholders’ interests, internal process and learning and growth. The idea of the Sustainability Balanced Scorecard (SBSC) was used, to pursue the balance among the perspectives and the economic, environmental and social pillars [26-28].

Nowadays Cuban companies have several difficulties to include sustainability issues into business strategies. Many Cuban corporations have defined strategies with sustainability topics included but the strategy fails when it is deployed. SySPE is built to support a sustainability performance measurement network to assess the strategy and achieve business long term value generation. SySPE has three modules (Figure 1).

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1 It was a project coordinated by the Carl von Ossietzky University of Oldenburg in joint effort with other German universities and business organizations. It was financed by the European Research and Transfer Network for Environmental Management Information Systems (ERTEMIS)
The first module is data collection: this one is related to the collection and storage of indicators defined by business managers and regulatory standards. The SBSC perspectives definitions belong to this module. Other actions are the update and elimination of information. These actions will be restricted to a small group of users that could interact with the module. 

The second one is indicators aggregation: this module allows setting the sustainability indicators defined over the SBSC perspectives and assign weights for indicators and perspectives to calculate the Corporate Index of Sustainability Performance. The CISP is based on the Corporate Sustainability Measurement Hierarchy and follow the suggested construction frame recommended by [29]. The first step was the indicators selection, the judgment of indicator’s impact and the data collection. The second big step was the indicators normalization process with the distance to a reference (or goal) method. The CISP idea is synthesized in an index the progress or setbacks in corporate sustainability performance to verify simple and continuously way if the managerial efforts, organizational management instruments and environmental training are translated into a better or worse business sustainability performance. 

The third and last module is graphic representation and report generation: this one allows users and stakeholders to visualize the behavior of CISP and sustainability indicators during a selected period and represent graphically the behavior of indicators and indexes. 

SySPE solution intends to cover a poor explored area in Cuban organizations; linked to the support of IT to sustainability performance management and business sustainability benchmark. The main goal is to support sustainability data and indicators to guide business managers and stakeholders to redirect organizational efforts.

VII. WEB SERVICES FOR SOLUTIONS INTEGRATION 

SySPE and IT-for-Green are two solutions that support organizations in relation with the environment and sustainability. Since the design point of view they run in different technologies and pattern designs. IT-for-Green uses a Service Oriented Architecture design pattern and SySPE implements a Model-View-Controller pattern. In order to upgrade the IT-for-Green solution, is possible to take advantage of SySPE functionalities and reporting capabilities. To achieve this goal one question should be answered: How to integrate two systems during the runtime effectively? A method of data exchange is needed.

An effective solution is a web service as a way to expose the SySPE functionalities and make it available through standard web technologies to facilitate applications communication reducing applications heterogeneity. Web services promote the specification-based cooperation and collaboration among distributed applications in open environment [30]. Web services have become a widely used form of adding depth to online applications and allow developers write applications that are interoperable with external services located anywhere in the world [31]. Web services use different web standards like XML and SOAP to tag and transfer the data. Web Services Description Language (WSDL) is used for describing the services available and the Universal Description, Discovery and Integration (UDDI) is used for list what services are available [32].

IT-for-Green have a web service provider, which allows handle with the new services which are not available in the stock version of the CEMIS [25] and a special controller can be implemented using Zend Framework to integrate through web services with SySPE. To establish the first steps in the integration between those applications, a web service architecture was defined (Fig. 2).
The service provider, SySPE, similarly has to generate service descriptions for those services, making these services known and publishing the corresponding service descriptions in a service registry. The service registry uses all the services descriptions to create a service collection and make it available when services clients request arrive.

SySPE validates the service request and sends structured data in an XML file, using the SOAP protocol. The XML file could be validated by the service client using an XSD file.

Zend Framework (ZF) was used to create the web service. ZF is a PHP framework and was used to develop a SySPE application and provide components to work with web services. The components provided by the framework, for web service creation, are mature and well-designed, they offer good integration with the rest of the framework and are comprehensively documented; the entire code is unit-tested and peer-reviewed and there is no licensing fuss around Zend Framework [33]. ZF includes a number of components that enable to work with existing web services as well as create your own. Zend_Service provides a straightforward interface to a number of popular web services like: Amazon, Twitter, Yahoo and Google’s services [34].

As a practical example was defined the web service called, to orient the example in one of the future direction identified by [21] (import of sustainability indicators) as base of business sustainability performance to upgrade module three. GET_INDICATORS web service allows obtaining all the indicators with their respective fields stored in SySPE. For it was created a PHP class named Services with one function GET_INDICATORS. This function establishes the connection with the database, executes the query and return the result in JSON (JavaScript Object Notation) format. JSON is a format for transferring data from one program or system to another and allows making the file with the class names more readable for humans.

ZF allows automatically generate a WSDL XML, based an existing code. To test the WSDL file a PHP class called client was created. The class defines a function WSDL_call and uses a Zend_Soap_Client by pointing a Zend Soap Client instance at the URL returning the WSDL in an XML format to test the service.

The web service is published at Green Service Mall. This component is responsible for the registration of external and internal services offered by IT-for-Green solution to be discovered by the consumers.

VIII. WEB SERVICE VALIDATION

After the web service design a review and validation of the WSDL is necessary to evaluate the web service. To achieve this, the web services was invoked from “Web Services Validation Tool for WSDL and SOAP 2.1”[2]. The Web Services Validation Tool for WSDL and SOAP analyzes and reports problems in SOAP messages and WSDL schemas before implement web services applications. The validation test consisted in visualize the web service input and output to check the desire outcome, the JSON file with all the indicators stored in SySPE application with their respective fields.

The next step was the validation through the SOAP messages. A SOAP message was introduced in the XML file to be validated. The web services GET_INDICATORS was invoke using a “parameter” called “EXAMPLE”. The SOAP request is transmitted to the server and the successful SOAP response from the Web Services Validation Tool was received.

This web service allows the communication, interoperability and integration of those platforms through a first example GET_INDICATORS. The web services are a powerful tool to achieve the communication and integration between those systems.

IX. OUTLOOK

The future direction of this research is oriented to implement the key functionalities of SySPE, the calculus of Corporate Index of Sustainability Performance and graphic generation as a web service to be used by consumers of IT-for-Green to analyze the indicators associated to production process, products or services as internal benchmarking of organizations. Since the practical point of view this initial stage is a first step to accomplish the goal of integration with SySPE.

X. CONCLUSION

Nowadays the organizations need the support of IT resources to monitoring, controlling and supporting decisions making processes in relation with sustainability performance as a real imperative. IT-for-Green and SySPE are two solutions emerged of this needs. The first covers the complete product life cycle and the second allows tracking business sustainability indicators to help managers to discover which is the overall compliant of sustainability business goals using the CISP, which includes the perception of the different stakeholders. The communication and integration between those solutions is possible through the web services implementation. To achieve this goal, a web services architecture was defined between IT-for-Green and SySPE. A web service GET_INDICATORS was defined using a bottom-up model were is possible to implement classes first, and then, use a WSDL generating tool to expose methods from these classes as a web service. ZF was used as WSDL automatically generating tool based on existing code.

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2 This software was developed and supported by IBM Corporation.