Integrating IT-for-Green Project through Web Services with the System of Sustainability Performance Evaluation

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Abstract: Corporate sustainability and sustainability management have become a key issues in modern organizations to achieve a balanced and sustainable development. Nowadays IT can support the sustainability behaviors in business processes to improve the sustainability performance in organizations. IT-for-Green is a project that proposes a new generation of Corporate Environmental Management Information Systems allowing to incorporate the strategic sustainability integration. The main motivation of this to provide a first approach of how to achieve communication, interoperability and integration with other platforms to improve the cover areas of IT-for-Green and accomplish one of the goal of this project “the integration with other applications”. The paper explores the communication and integration of IT-for-Green with the System of Sustainability Performance Evaluation using web services as a platform. A first web services definition was designed.

Keywords: sustainability management, solutions integration, web services

1 Introduction

The recent growth in corporate sustainability made organizations consider this area as a key success factor that must be managed [Dy02] and [Sc11]. IT plays an important role in sustainability management, specifically in sustainability performance evaluation [MMW13], [Me10] and [PP09]. Although IT has environmental impacts during its life-cycle, 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 [Me10], [RB13] and [MA12]. 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 [MA12].

Established tools for strengthening IT support are Corporate Environmental

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Management Information Systems (CEMIS), but those are not sufficient yet to achieve the strategic sustainability integration [He07] and [Wo08]. For that reason, the project IT-for-Green started in 2011, IT-for-Green covers the complete product life cycle from input to transformation to 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 [It13]. 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 by 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 an important gap in relation with one goal of IT-for-Green project “the integration of IT-for-Green with other applications”. The business need to respond quickly to changes in the business environment in which they operate. Isolated applications tend to become problematic after a few years in use, then their integration in changing IT-environment becomes more difficult. The proliferation of web services within the last two years enables organizations to assimilate software and services from different companies and locations into an integrated service capable of streamlining important processes [LG15].

The goal is to provide a first approach of how to achieve communication, interoperability and integration of those platforms; to add further functionalities from other applications using web services as a platform 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 of other applications.

Communication and reporting are key elements of an organization’s sustainability management. For that reason the idea of System of Sustainability Performance Evaluation (SySPE) developed for Cuban organizations [Me13], 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) (see [Me13]). This index serves managers to discover which is the overall compliant of sustainability business goals and includes the perception of different stakeholders. The application allows the graphical representation of CISP and visualizes the improvement of the potentials of indicators to redirect the business managers’ efforts.

All these functionalities can help to track business sustainability behavior and continuously improve the internal benchmarking. The main objective of this paper is to integrate the IT-for-Green project with SySPE, specifically to the module, which is related to sustainability reporting and dialogue (Module 3). The paper explores the
possibility of effectively harmonize these two systems, using web service with Zend Framework to add some future SySPE functionalities. The validation of the web service was made through Web Services Description Language (WSDL) and SOAP messages validation.

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.

2 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 [St05].

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 been strengthened for the IT capabilities [Me10], [RB13], [MA12], [Ca13], [HB14] and [Hi14]. Decision Support Systems are emerging as a suitable solution in the field of sustainability planning and control of complex systems [Fi08]. According to [RB13] 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.

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 [Ja12] 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 [Ja12]. 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 [Gi10]; 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 [TP13].

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 [It13] conventional CEMIS are not sufficient to achieve sustainability integration, whereas 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 [So13] using workflows.

3 Methodology

Nowadays applications tend to become problematic after a few years in-use and being integrated in a changing IT-environment. The business need to respond quickly to changes in the business environment in which they operate.

IT-for-Green with their modular approach allows add SySPE functionalities to improve the cover areas of IT-for-Green CEMIS and to take advantages of their functionalities.

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 investigation was performed following three main steps through exploration and integration of available technologies to produce the artifact. The first step is oriented to review the characteristics of the applications, functionalities and requirements. The second step consists in web service building; in this step the web service architecture is defined based in the previous overview of the application and a first example of web service was built. The third step is to validate the web service through WSDL and SOAP messages validation.

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.

4 IT-for-Green project as a CEMIS solution

The primary goal of this project is “increasing the environmental friendliness of companies and their processes by means of ICT” [It13]. 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 [Ra11] and [Ma13] 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:

1. Better integration in new IT environments, with IT-for-Green’s modules only a module has to be renewed, not the whole application.
2. The possibility of modules customization in relation with the enterprise needs (they don’t need to acquire the whole package);
3. 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 nodules and services through a workflow-based and service-oriented platform [Ra11] and [Ma13]. According to [So13] 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).

The User Interface is the component layer between the CEMIS and the users and can be operated using any kind of web browsers.

One of the goals of IT-for-Green project is oriented to “integrate the prototypes into the surrounding web service infrastructure and the import of sustainability indicators and the generation of schemes [So13]. Actually the integration of IT-for-Green with other applications is an uncover objective.

5 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 to internal and external pressures derived from the inclusion of Sustainable Development concept at business levels, to support decisions, associated with sustainability performance and provide an internal benchmark and report tool to satisfy stakeholders information requirements. SySPE supports social, economic and environmental indicators related directly to organization performance distributed over key areas. Taking this into account, the idea of the Sustainability Balanced Scorecard (SBSC) was used, to pursue the balance among the perspectives and the economic, environmental and social pillars.

SySPE has three modules. Data collection is related to the collection and storage of indicators information defined by business managers and regulatory standards. The BSC perspectives definitions belong to this module. Other actions are the update and elimination of information; those actions will be restricted to a small group of users that could interact with the module system.

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 (CISP) see [Me13]. The CISP idea is synthesized in an index of the progress or setbacks in corporate sustainability performance, to verify simple and continuously if the managerial efforts, organizational management instruments and environmental training are translated into a better or worse sustainability performance. The third module for Graphic representation and report generation, allows users and stakeholders to visualize the behavior of CISP and sustainability indicators in a period and represent graphically the behavior of indicators and indexes.

The technologies used for application development were the MySQL, Propel as Object
Relational Mapping, Zend Framework (ZF) was used as rapid web development framework of PHP 5 implementing the Model-View-Controller (MVC) design pattern, which is the best current practice to develop modern web applications [Gi10]. The graphic representation of reports was implemented using the Business Intelligence and Reporting Tools (BIRT).

SySPE solution intents 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 sustainability issues efforts.

6 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 sustainability reporting and dialogue module, it is proposed 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 application integration reducing applications heterogeneity. Web services promote the specification-based cooperation and collaboration among distributed applications in an open environment [Xi05]. 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 [Pa09]. Web services use different web standards like XML and SOAP to tag and transfer the data, the WSDL is used for describing the services available and the Universal Description, Discovery and Integration (UDDI) is used for list what services are available [Al04].

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 [Ma13] and a special controller can be implemented using Zend Framework to integrate through web services with SySPE To establish the integration between those applications, a basic web service architecture was defined (Fig. 1).
It shows how the service client contact and discover the web service in service registry (Green service mall). The service registry answers with a service description indicating where to locate the service and how to invoke it. The service provider, SySPE, similarly has to generate service descriptions for those services, making its services known by 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 [Ma11]. 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 [Ly09].

A practical example was defined the web service called GET_INDI CATORS, to orient the example in one of the future direction identified by [So13] (import of sustainability indicators) as base of business sustainability performance to upgrade module three. GET_INDI CATORS 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.

7 Web service validation

After the web service design are view 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”. 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.

8 Conclusion and Outlook

Nowadays the different business need support of IT resources to monitoring, controlling and supporting decisions making processes as a real imperative in organizations. IT-for-Green and SySPE are two solutions emerged to address these needs. The first covers the complete product life cycle and the and the second allows tracking business

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sustainability indicators to help managers to discover which is the overall compliant of sustainability business goals by using 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 among services clients: IT-for-Green and SySPE. A web service GET_INDICATORS was defined using a bottom-up model, which make it 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. 

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 in order to analyze the indicators associated with production process, products or services. Due to practical point of view, this initial integration is a first step to accomplish the goal of integration with SySPE.

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10 References


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