Upgrading Reporting, Communication and Benchmarking Tools of IT-for-Green Project

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Abstract

Corporate sustainability and sustainability management have become key issues in modern organizations to achieve a more balanced and sustainable development. The IT development has increasing increased drastically in recent years and in the same way how IT can support the environmental and sustainability behaviours in business processes it can be part of the solutions to improve the sustainability performance in organizations. In the last years different projects had been working in this area, to guide and provide tools for decision makers and stakeholders. IT-for-Green is one of this projects that propose a new generation of CEMIS that permit to incorporate the strategic sustainability integration. Another solution, the System of Sustainability Performance Evaluation supports social, economic and environmental indicators related directly with organization's performance distributed over key areas. This paper explores the possibility to upgrade and integrate those two systems that actually run in different technologies and pattern designs using web services to facilitate application integration reducing application's heterogeneity. A first GET_INDICATORS web service definition and implementation was made, taking advantage of one of the facilities of IT-for-Green as an open platform.

1. Introduction

The recent growth in corporate sustainability made organizations consider this area as a key success factor that must be managed. IT plays an important role in sustainability management, specifically in sustainability performance evaluation. 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 idea of how IT can support the environmental and sustainability behaviour in business processes. 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. Thus using IT to make enterprises greener refers to IT-for-Green [1].

Established tools for the strengthening of IT support are Corporate Environmental Management Information Systems (CEMIS), but those are not sufficient yet to achieve the strategic sustainability integration [2, 3]. For that reason, the project IT-for-Green started in 2011. IT-for-Green will cover 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. Organizations need to track in a continuous way their sustainability goals and the goals of all their branches. The sustainability indicators are a good tool to compare sustainability business performance in different branches, setting an internal

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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 objective of this paper is to propose an upgrade to the IT-for-Green project, specifically to the component, which is related to sustainability reporting and dialogue (called Module 3).

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, can be included as a future extension as a collection of web services for the IT-for-Green project to strengthen and upgrade the reporting functionalities and to contribute to the internal benchmarking of organizations.

SySPE is a tool to support the storage, retrieval management and integration of different sustainability indicators. SySPE helps to calculate the Corporate Index of Sustainability Performance (CISP), this index helps 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 business managers' efforts.

All these functionalities can help to track business sustainability behaviour continuously and to reduce environmental business impacts. The paper exposes the different technologies used for the integration and how to effectively integrate two systems that actually run with different design patterns through a web service definition and implementation, taking advantage of one of the facilities of IT-for-Green as an open platform.

2. IT Support for corporate environmental management and sustainability

The business has great responsibility in the process of transition to a more sustainable development (SD). The SD is a social concept , and is being increasingly applied as a business concept under the name of corporate sustainability [4]. The first definitions of corporate sustainability were a faithful translation of the concept given in "Our common future" at business level. 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 [5]. The main objective of corporate sustainability management is balancing the organizational performance in the economic, social and environmental improvement opportunities identified simultaneously [6, 7].

In recent years, some tools had been developed to help organizations in the long path of sustainability. Decision Support Systems are emerging as a suitable solution in the field of sustainability planning and control of complex systems [8]. Some of the most prominent specialized tools are: SAP Sustainability Performance Management (SuPM), Enablon SD-CSR, SoFicredit360 and STORM. All presented tools offer similar possibilities regarding their reporting capabilities [9]. Other important tools is OEPI related environmental performance indicators; a fundamental goal of 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 [10].

3. IT-for-Green project as a CEMIS solution

IT-for-Green is a project coordinated by the Carl von Ossietzky University of Oldenburg joined with other German universities and business organizations. It is financed by the European Research and Transfer Network for Environmental Management Information Systems (ERTEMIS). The principal aim of this project is "increasing the environmental friendliness of companies and their processes by means of ICT" [11]. The project proposes 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 has different functionalities clustered in three modules [11-13]:

- *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:* This module's goal 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 and it follows the Service-Oriented Architecture (SOA). The CEMIS is a service-oriented platform that allows for loose coupling and bundling of necessary methods [12]. The platform is designed to be open and extensible for new nodules and services through a workflow-based and service-oriented platform [12, 13]. The architecture is shown in the figure 1, 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.

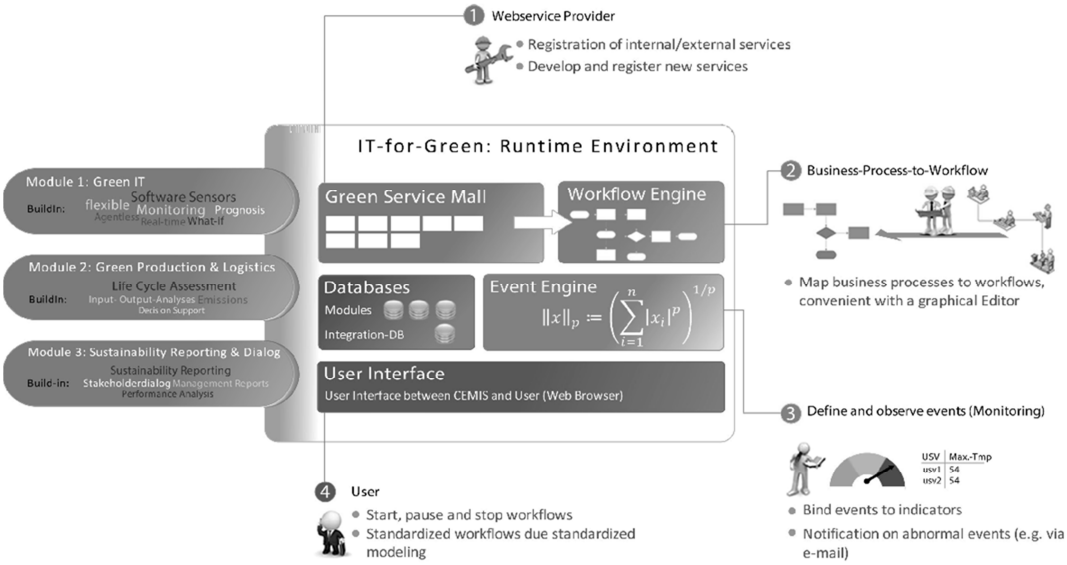

Figure 1: Next Generation CEMIS Architecture.[13]

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, CO 2 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 layer between the CEMIS and the users and can be operated using any kind of web browsers.

Actually IT-for-Green is moving forward to achieve more ambitious goals. The next steps will be to integrate the prototypes into the surrounding web service infrastructure and the import of sustainability indicators and the generation of schemes [14]. The integration of IT-for-Green with other applications is a near future objective.

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

SySPE has three main modules (Figure 2. a). *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.

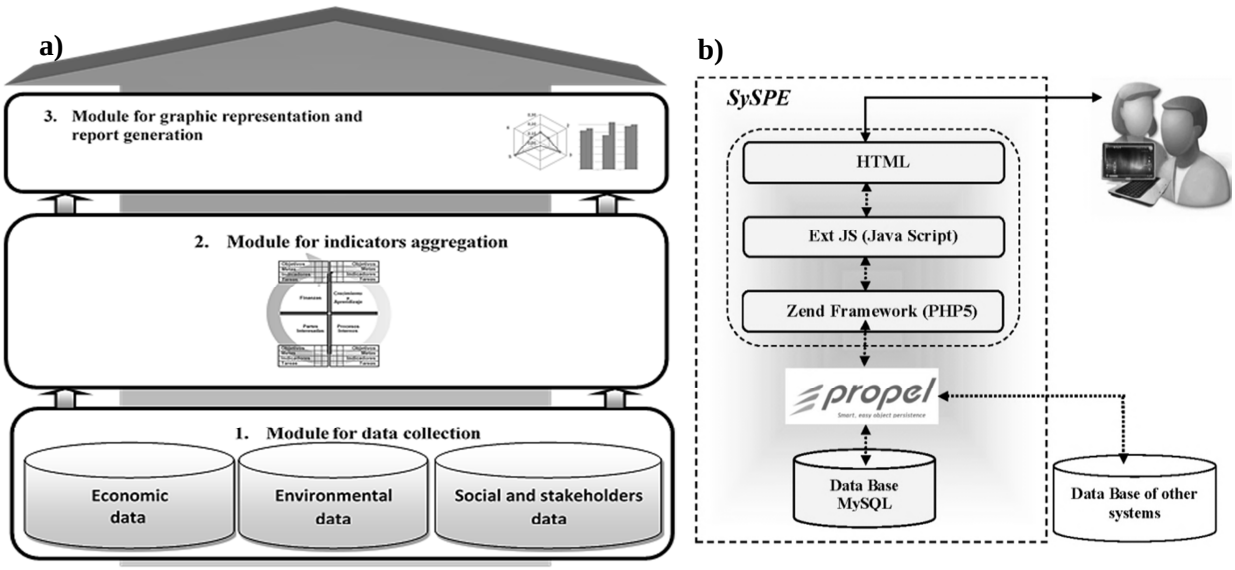

Figure 2: SySPE architecture.[15]

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). 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 behaviour of CISP and sustainability indicators in a period and represent graphically the behaviour of indicators and indexes.

The technologies used for application development were various (Figure 2. b), 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. [16]. 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.

5. Integrating SySPE with IT-for-Green

SySPE and IT-for-Green are two solutions that actually 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 effectively two systems that actually run with different design patterns and technologies? A method of data exchange is needed, that doesn't depend upon a particular programming language or design pattern.

An effective solution is a web service as a way to expose the SySPE functionalities and make it available through standard web technologies to facilitating application integration reducing applications heterogeneity. 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 [17]. 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 [18].

To establish a real integration between those applications, web services architecture was defined (see Figure 3).

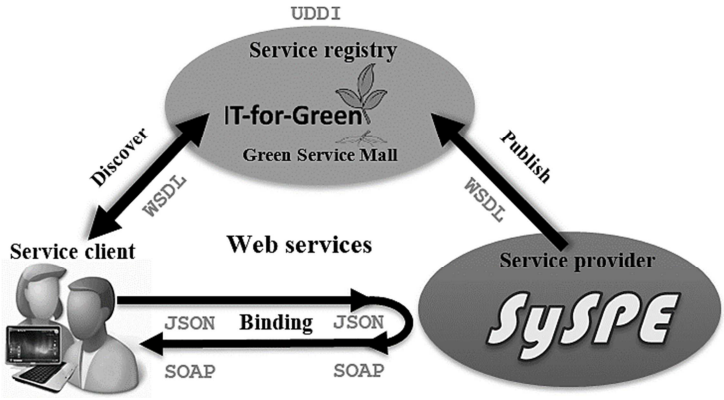

Figure 3: Web services architecture.

Its shows how a service client contacts and discovers 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 and will make its services known by publishing the corresponding service descriptions in a service registry. The service description is used by the service registry to catalog each service and search for it when requests arrive from service clients. SySPE validates

the service request and sends structured data in an XML file, using the SOAP protocol. This XML file would be validated again by the service requester using an XSD file.

To create the web service Zend Framework will be used, the framework of PHP was used to develop 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 [19]. ZF includes a number of components that enable work with existing web services as well as creating your own. Zend_Service provides a straightforward interface to a number of popular web services like: Amazon, Twitter, Yahoo and Google's services [20].

As a practical example the web service called GET_INDICATORS was defined, to orient the example in one of the future directions identified by [14] (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 this was created a PHP class named Services with one function GET_ INDICATORS (Figure 4). This function establishes the connection with the database executes the query and returns the result in JSON (JavaScript Object Notation) format.

```
<?php
class Services {
    function  GET_INDICATORS(){
            $path = realpath(dirname(__FILE__).'/../../config.ini');
        $config = new Zend_Config_Ini($path, 'database');
        $con = new Myapp_SQLDBCONNECTION();
        $con->selectdb($config->database, $con->connect($config->server, $config->user, $config->passw
        $query = "SELECT indicadores.idindicador AS id, indicadores.nombre AS `name`,indicadores.descr
        $result = $con->createquery($query);
        $information = $con->getarrayobject($result);
        $json = "{".'"'.'rows'.'"'.':'.json_encode($information).'}';
        return $json;   //INDICATORS
```

Figure 4: Class services.

ZF allow you to automagically generate a WSDL file based on existing code. To test the WSDL file a PHP class called client was created (Figure 5). The class defines a function WSDL_call and use 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.

```
<?php
class client {
        function WSDL_call() {
        $path = realpath(dirname(__FILE__).'/../config.ini');
        $config = new Zend_Config_Ini($path, 'webservice');
        $client = new Zend_Soap_Client($config->service_url);
        $ca =  $client->GET_INDICATORS();
        echo $ca;   } }
$C = new client();
$C->WSDL_call();
```

Figure 5: Class client to test GET_INDICATORS web service.

The services description (WSDL) was generated for the service created using the class client (Figure 6). This web service should be 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. This web service is an initial approach to demonstrate the possible integration of those platforms trough a first example GET_INDICATORS. The web services are a powerful tool to achieve the real integration and communication between those systems.

```
- <definitions name="Services" targetNamespace="http://localhost/siedawebservices/webservices/servicecontroller.php">
  - <types>
      <xsd:schema targetNamespace="http://localhost/siedawebservices/webservices/servicecontroller.php"/>
    </types>
  - <portType name="ServicesPort">
    - <operation name="GET_INDICATORS">
        <documentation>This method return indicators fields</documentation>
        <input message="tns:GET_INDICATORSIn"/>
        <output message="tns:GET_INDICATORSOut"/>
      </operation>
    </portType>
  - <binding name="ServicesBinding" type="tns:ServicesPort">
      <soap:binding style="rpc" transport="http://schemas.xmlsoap.org/soap/http"/>
    - <operation name="GET_INDICATORS">
        <soap:operation soapAction="http://localhost/siedawebservices/webservices/servicecontroller.php#GET_INDICATORS"/>
      - <input>
          <soap:body use="encoded" encodingStyle="http://schemas.xmlsoap.org/soap/encoding/" namespace="http://localhost/sie
        </input>
      - <output>
          <soap:body use="encoded" encodingStyle="http://schemas.xmlsoap.org/soap/encoding/" namespace="http://localhost/sie
        </output>
      </operation>
    </binding>
  - <service name="ServicesService">
    - <port name="ServicesPort" binding="tns:ServicesBinding">
        <soap:address location="http://localhost/siedawebservices/webservices/servicecontroller.php"/>
      </port>
    </service>
    <message name="GET_INDICATORSIn"/>
  - <message name="GET_INDICATORSOut">
      <part name="return" type="xsd:string"/>
    </message>
  </definitions>
```


Figure 6: XML of GET_INDICATORS WSDL.

6. Conclusion/Outlook

Nowadays business need support of IT resources to monitoring, controlling and support decisions making process as a real imperative in organizations. In the last years different solutions were developed with diverse functionalities oriented to corporate environmental management and sustainability. 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 CISP and include the perception of the different stakeholders.

The communication and integration between those solutions that run in different technologies and design patterns to complement and upgrade IT-for-Green solution is possible through the web services implementation. To partially 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 were it 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.

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.

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