Sustainability data integration; A prototypical implementation of a light-weight information system component

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Abstract

The environment matters. At least this is the minimum denominator the members of the World Climate Conference have been finally agreeing upon. Unfortunately a successor of the Kyoto Protocol has not yet been ratified. Induced by recent natural catastrophes an increasing public awareness of sustainability concerns became more visible.
In order to fulfil the growing customers demand for greener products companies have to act and adopt new technology to fill this information gap. The information technology adoption rate has been visibly increasing during the last decade. The product and service lifecycle however is still narrowly focused on classical product or service attributes such as price, quality and availability. Hardly any of the current information systems for the midsize segment integrates environmental data. Within the frame of this paper a "business trip use case" is taken as an example to show how sustainability data can be integrated into the classical procurement process by using a light-weight and Open Source based Portlet platform technology. The example has been conducted as part of the research within the frame of the EU-project "Solution and Services Engineering for Measuring, Monitoring, and Management of Organizations' Environmental Performance Indicators" (OEPI).

1. Introduction

Since the last century, preserving the environment has emerged as an essential topic. Today, it is one of the vital global issues and the main aim of many worldwide public policies. Natural disasters, media and policy are some of the factors that encouraged the public awareness towards sustainability. It became more obvious that environmental effects are amongst the most challenging tasks in all business segments, starting from individuals over organizations to governments.

For organization, environmental problems remain the same whether they are related to manufacturing, logistics, IT, cattle industry, or transportation (tourism, travelling etc). Unfortunately, environmental problems have not been seriously tackled, regardless of industry. Nevertheless, companies have begun to monitor and reduce their impact on the environment. This has been accompanied with an accelerating pace due to wider public awareness, and publications continued to indicate a growing awareness to the exhaustion of the natural environment through human activities on local, regional, and global levels (Welford 1996). Companies' environmental actions take many forms. Implementing an Environmental Management System (EMS) like the Environmental Management and Audit Scheme (EMAS) or the ISO 14000 series as a guide for their actions, is a classical example to establish a framework for setting objectives and targets that allow an organization to evaluate and improve its environmental compliance and performance.

Information Technology turned to be a major pillar in supporting the organizations to assess, optimize, and report the current impact of their processes and operations on the environment by providing a diversity of solutions during the last decades. These solutions called Environmental Management Information Systems (EMIS).

The research on Light-Weight Composite Environmental Performance indicators (LWC-EPI) (Jamous et.al, 2011) focuses on how Small and Medium sized Enterprises (SMEs) -one of the biggest business sectors in the world (e.g. 20 million SMEs operated in 2009 in the European Union) (EC-E&I 2009)- can be

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encouraged to monitor and report their environmental sustainability situation. In this vein, a recommendation system or a dashboard in the spirit of an EMIS could play a vital role in keeping an organization's management well informed about how the environmental impact of their decisions directly affect the competiveness of their organization.

This paper contributes to the body of knowledge by summarizing general requirements of environmentally aware ERP-Systems and a brief market overview on already existing solutions. Based on defined requirements a prototypical integration of a publicly available environmental database (AMEE) with an EMIS resulted from an EU research project named "Solution and Services Engineering for Measuring, Monitoring, and Management of Organizations' Environmental Performance Indicators" known as (OEPI) will be conducted. Section two clarifies the used terms and technologies, whereas section three, four and five provide an overview on the Open Source based Liferay platform, the OEPI project and the AMEE solution. In section six, we will present a proof of concept on how a public environmental data collection like AMEE can be integrated with a public EMIS platform in order to enable its user to utilize the benefit of the provided services AMEE inside OEPI. In other words, we provide an example on how OEPI leverages data and calculation methods provided by AMEE.

2. Terms and Definitions

In order to plan and build a light-weight composite information system the terms flexibility and modularity and their relation will be briefly discussed. One of the more recent technology building blocks to build light-weight composite information systems (e.g. Portlets) will be discussed hereafter. The chapter provides a basic clarification of terms and technologies used throughout this paper.

2.1 Flexibility, modularity and the quest of light-weight information systems

A prerequisite for light-weight composite information systems are flexible as well as extensible underpinnings. The times in which investments into information systems were mostly investments into an uncertain future are over. Especially looking through the lens of SMEs, information technology must be easy to use, relatively cheap and immediately supporting the core business.

Although the quest for usability and cost reduction is not limited to SME, scarcity of skilled personnel and financial resources renders SME special compared to large enterprises. Additionally, flexibility is even more important for SME. While large enterprises can withstand economic crisis and down-turning markets to a certain extent, SME are very likely to lose their economical basis in the blink of an eye. This is especially true, if they cannot flexibly amend their information systems to changing business needs and customer requirements.

Luckily the utilization of information technology has increased and matured during the last 20 years throughout all markets and branches. The Internet, often rewarded as the most influencing technology of its time, rendered the efficient use of information technology one of the most contemporary business imperatives.

Flexibility and modularity of information systems are two seemingly similar subjects. They can be also seen as the two sides of one medal. While "flexibility" is the desired quality, often weakly structured and misconceived (Eden and Mens 2006), modularity and modular information systems can objectively be built and measured (Cai and Huynh 2008, Hornby G. S. 2005). There is a quite huge body of literature on achieving modularity of information systems by applying design patterns early in the design phase. Especially in the Internet age and with the rise of standards such as web-services and service-oriented architec-

tures reusability of functions, data and information became much more popular. In this regard Portlets are a great means to achieve modularity by means of small functional components.

2.2 Portlets

Portlets are small applications components that are based on the so-called Portlet standard. The first accepted Portlet standard, has been issued by Sun and IBM as an official Java Specification Request (JSR 168) with the support of various other industry companies such as HP, SAP, Daimler AG. The design idea of Portlets is to build up an easy to use frontend interface that can be used inside the browser as part of a Portlet server.

Portlets can be interpreted as a view that consolidates or represents data of an underlying information system. It can be used to implement application systems view components while adopting a standard model-view-controller (MVC) design pattern.

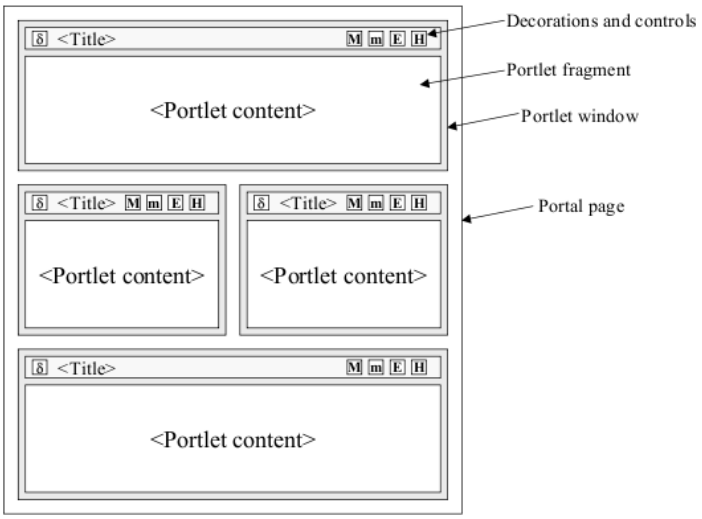

Figure 1: Portlet Server Page according Hepper (2008)

Different Portlets are usually combined and integrated on one Portlet server instance (see Figure1). The JSR-168 standard has been revised and extended to better cover interPortlet communication (IPC) and include the Web Services for Remote Portlets (WSRP) network protocol standard[2] amongst other new features[3]. It has been reissued as JSR-268 (also known as Portlet Specification 2.0). There are different Portlet servers that are JSR-268 compliant.

3. Liferay

Amongst different commercial Portlet servers such as SAP Netweaver, IBM Websphere or BEA Weblogic, Liferay is the most prominent technology in the Open Source space. Liferay is provided either as community edition or enterprise edition. While being technically mostly identical, the enterprise edition contains additional non-technical features such as service-level agreements (SLA), indemnification, per-

2 http://www.jcp.org/en/jsr/detail?id=286

3 http://portalhub.wordpress.com/2011/01/13/portal-specifications-difference-between-jsr-168-and-jsr-286/

formance measurement and monitoring[4] amongst others. Whereas specific content of different business applications can be exposed as a Portlet, the Portlet server comes with standard functionality that significantly lowers the ramp-up time of new functionality. The most important core functions of Liferay are:

- Secure and role-based authentication with Single Sign On (SSO)
- Personalization of content and arrangement of content items via Drag and Drop functions
- Document uploads via standard WebDAV technology
- Multilanguage support
- Platform indepence, scalibility and replication

Liferay has been widely adopted by industry. Companies such as Lufthansa, Allianz, BASF and the French Ministry of Defense use the technology[5]. It was ranked a leading portal server technology provider by analyst Gartner in one of their recent surveys[6]. Liferay isn't a technology built standalone but rather on top of a versatile and mostly Open Source based technology stack. As such Liferay can be deployed on Linux, Windows and Unix operating systems, comes bundled with an application server such as Geronimo, JBoss or GlassFish and is capable to utilize IBM, Oracle, MySQL, PostgreSQL databases connections. The Portal as well as the content management and collaboration features are even more impressive[7].

4. OEPI project

The project "Solution and Services Engineering for Measuring, Monitoring, and Management of Organizations' Environmental Performance Indicators" (OEPI) is an international research project supported and funded by the European Commission within the Seventh Framework Program (FP7). OEPI is a cooperative project consisting of nine consortium members coming from the industry or academic background from different countries and with varying competences and different profiles worked together. Namely, OEPI consortium consists of: SAP AG, Siemens AG, Kone Corporation, Ericsson Corporation, VTT Technical Research Centre of Finland, ATOS S.A., Carl von Ossietzky University of Oldenburg, Otto-von-Guericke-University of Magdeburg, and the University of St. Gallen.

The project goal is the development of standardized Environmental Performance Indicators (EPIs) and an application system platform for its collection, management and reporting grounded in a semantic standardization concept. OEPI aims to provide any organization access to services and tools for integrated, cross-organizational EPIs' services and tools that give access via multiple consumption channels: mobile devices, internet access, ERP integration, and web services serve the need to be aware of the environmental impact of business or regulatory decision, and where further tools and services are published through. The project provides a proof-of-concept and prototypical implementation in a real-world scenario throughout European organizations and assesses the impact on corporate social responsibility related topics and further strategic decisions.

OEPIs' vision is "Bringing sustainability to the daily business", so OEPI focuses on providing business users with an inter-organizational platform & tools to provision and share environmental performance indicators across the chain and incorporate them in intra- and inter-organizational processes (Meyerholt, D. (et.al), 2010). In this vein, OEPI provides four use cases divided into four distinct application focus areas: Sustainable procurement; Design for environment; Network deployment & circuit provisioning; And Corporate communications. Each use case was driven by at least one of the industrial partners in order exam-

4 http://www.liferay.com/downloads/liferay-portal/overview

5 http://www.liferay.com/de/about-us/news/-/asset_publisher/2oZC/content/id/13905422

6 http://www.gartner.com/technology/reprints.do?id=1-17RTIFE&ct=111025&st=sg

7 http://www.liferay.com/products/liferay-portal/tech-specs

ine the best way to integrate the EPIs in the respective business processes and to determine as well to support the targeted user group (e.g. business users, customers, etc.) best in reducing environmental impacts.

5. AMEE solution

AMEE is a collection of environmental data sources that can be uniformly accessed by using the AMEE technology platform. It covers a broader range of information (e.g. standards, methods, data and units of measurement) and tries to link as much as possible information to one central data store providing a unified access to this data source (AMEE 2011). The information pool of AMEE contains data and methods from various information sources such as the Greenhouse Gas Protocol (GHGP), the Environmental Protection Agency (EPA), and the Inventory of Carbon & Energy (ICE), among others. In total, AMEE has integrated more than 300 single sources of information. It is stated that the "content in AMEE ranges from data sets on embodied emissions and emission conversion factors, calculation methodologies, reporting frameworks [to] energy efficiency data (AMEE 2011)". Mainly, AMEEs' major goal is to provide a single information store for environmental data that can be uniformly accessed by using the AMEE technology platform. AMEE developed the *AMEEsure* (AMEE-content 2012) as a continuous data quality assessment process to assure high data quality and accuracy by applying six steps: Source Validation; Data source examination and veracity proof; Peer review; Multiple reviews of data sets; Benchmark testing; Live Auto-Testing; Documentation; And a continuous Testing.

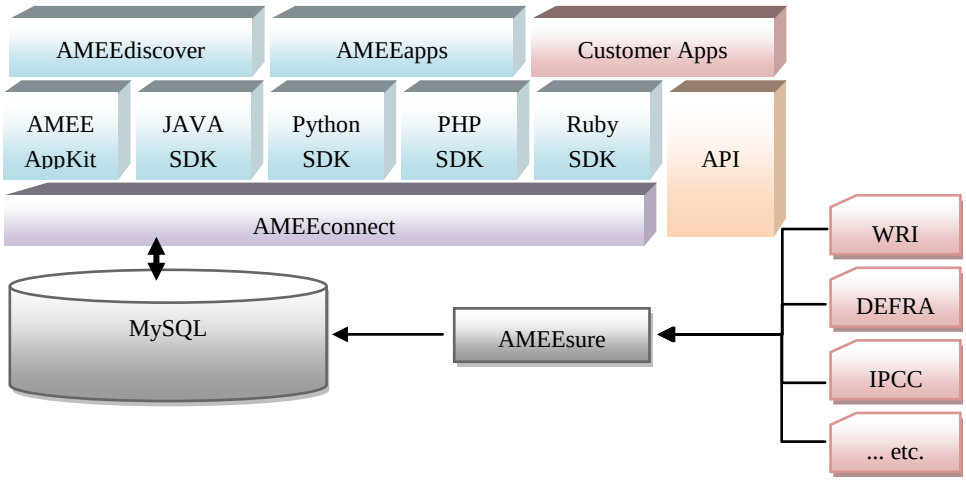

Figure 2. AMEE Technology Platform

AMEE provides many products and services towards its customers like AMEEconnect, AMEEdiscover, and the AMEEapps. AMEEconnect is the web service application programming interface of AMEE that handles access to all information of the AMEE database. On top of this, AMEE provides Software Development Kits (SDKs) for Java, Python, PHP, and Ruby, as well as the Rails based data abstraction and persistence layer named AMEEappkit. Figure 2 shows the technology platform of AMEE. The central entry point to AMEE data is the AMEEconnect web service API.

6. Integrating OEPI and AMEE

The principal task of OEPI was to standardize Environmental Performance Indicators and multi-stakeholder reporting rather than to be too much concerned about external environmental data sources. The work on terminological and semantic formalisation of the EPI concept has largely been influencing

the development of the OEPI ontology. As already mentioned, there is more than one standard and more than one database offering data, methods and calculations to display the environmental impact of an arbitrary activity or production process. Comparability mostly doesn't exist. Even if we would assume that semantic mapping is easily accomplished, a semantically coherent data and method pool would be only half way through with regard to the OEPI goals.

From a business perspective it is very important that the information is at the hand of various stakeholders (internal as well as external to the company) at the time they need it for their daily business. This requires flexible, scalable and highly customizable information system platforms. OEPI was dedicated to serve as an information system and reporting platform for such a diverse group of stakeholders. Since Liferay as already mentioned offers a lot of functionality with regard to these general requirements (see section 3) it has been selected as the primary implementation platform. The following example shows the integration of the consolidated data store of AMEE with the OEPI platform.

Example use case

Employees of public bodies are usually obliged to select the cheapest means of transportation. This is to assure that no tax money is wasted. We further assume that a shift of public regulations shall also oblige the secretary to compare the offers of the travel agency according to their CO2 emission per person. The use case presented in figure 3 propose that an employee situated in Hamburg should travel in a business trip to Munich, the secretary should provides at least two offers for travelling by airplane and two offers for travelling by car.

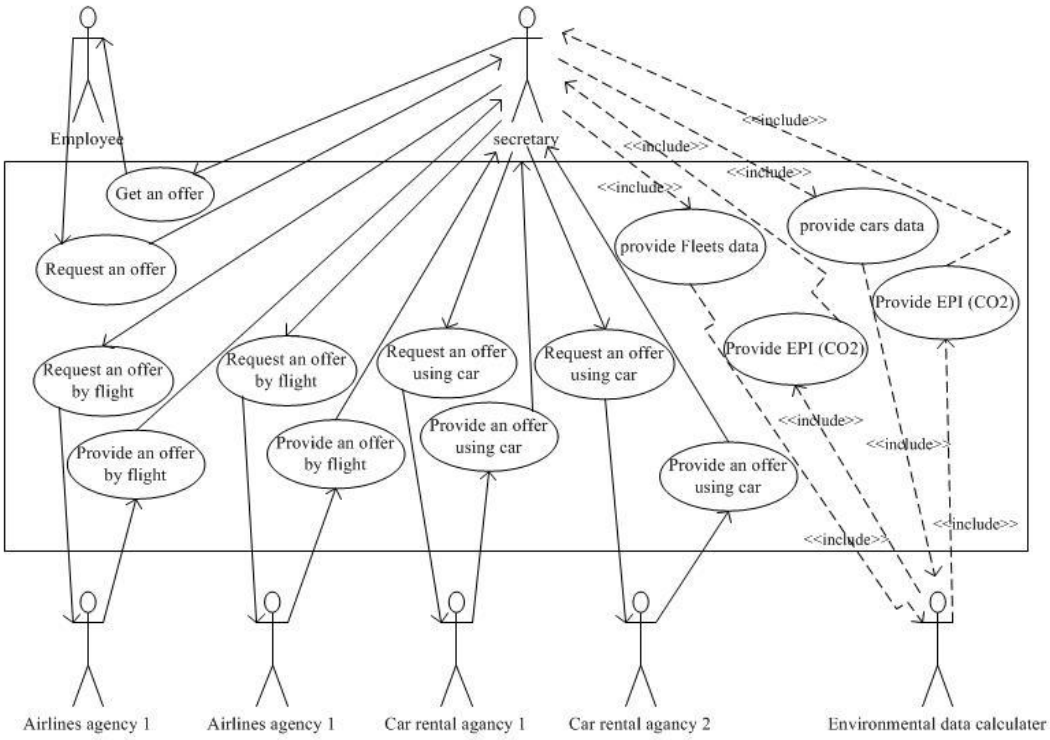

Figure 3: Use case diagram for travelling scenario

We assume that the information system in place already contains a Portlet that requires providing the **source** and the **destination** of the travel to automatically query a rental car service and various airlines for their quotes. These quotes are then handed over to our "AMEE Sustainability Comparator" Portlet as it is shown in Figure 4. For simplicity purposes we further assume that the source and the destination cities of the journey have an international airport, connectivity to the domestic railway carrier and highway con-

nections at their disposal. We assume a round trip business trip from Hamburg to Munich, and both cities match the aforementioned constraints. The air-distance between Hamburg and Munich is 612 km whereas the distance on highways is 775 km.

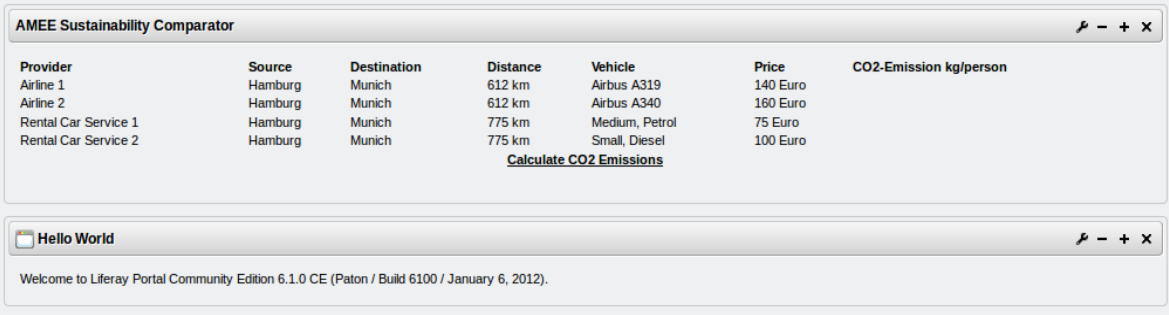

Figure 4: AMEE Sustainability Comparator Portlet

Figure 4 shows that airline 1 is offering a return ticket from Hamburg to Munich for 140 €. Airline 1 operates the flight with an Airbus A319 airplane. Airline2 is offering the seat for 160 € and operates the flight using an Airbus A340 airplane. Rental car service 1 offers a medium-sized car at 75 € incl. all kilometres whereas rental car service 2 offers a small car incl. all kilometres at 100€.

As already outline AMEE is rather a collection of data sources and methods than a data source in itself. However the advantage of AMEE is that all its contents can be accessed transparently by using the AMEEconnect Software Development Toolkit (SDK). The following code snippet shows how the "Specific Aircraft Methodology" can be utilized via that API.

```
// Initializing the server connection
AMEEContext.getInstance().setUsername("api_key");
AMEEContext.getInstance().setPassword("password");
AMEEContext.getInstance().setBaseUrl("http://stage.AMEE.com");
AMEEObjectFactory objectFactory = AMEEObjectFactory.getInstance();

// The path and drill to identify the correct calculation
String profileCategory = "transport/plane/specific/jet";
AMEEDrillDown drillDown = objectFac-
tory.getDrillDown("transport/plane/specific/jet/drill");
drillDown.addSelection("aircraft","Airbus A319 [319]");

// Create a new profile
AMEEProfile profile = objectFactory.getProfile();

// Get the UID of the data item
drillDown.fetch();
String dataItemUID = drillDown.getDataItem().getUid();

// Set options for new item
List<Choice> values = new ArrayList<Choice>();

values.add(new Choice("distance", SOME_VALUE));

// Store profile item and perform the actual calculation
AMEEProfileCategory cat = objectFactory.getProfileCategory(profile, profile-
Category);
AMEEProfileItem item = cat.addProfileItem(dataItemUID, values);
```

```
// Return the calculation results
return item.getAmount();
```

Listing 1: AMEEconnect query to obtain carbon footprint of flights

In order to invoke AMEEconnect to calculate the carbon footprint of the car trip the only few lines of the code that need to be changed are the following:

```
String profileCategory = "transport/car/generic";
AMEEDrillDown drillDown = objectFac-
tory.getDrillDown("transport/car/generic/drill");
drillDown.addSelection("fuel","petrol");
drillDown.addSelection("size","small");
```

Listing 2: Changes to calculate the car trip

The necessary four requests to AMEEconnect can be done dynamically when the Portlet Action Handler is invoked by pressing the "Calculate CO2 Emissions" button (see Figure 4). The response is than dynamically used to render the result screen of the Portlet (see Figure 5).

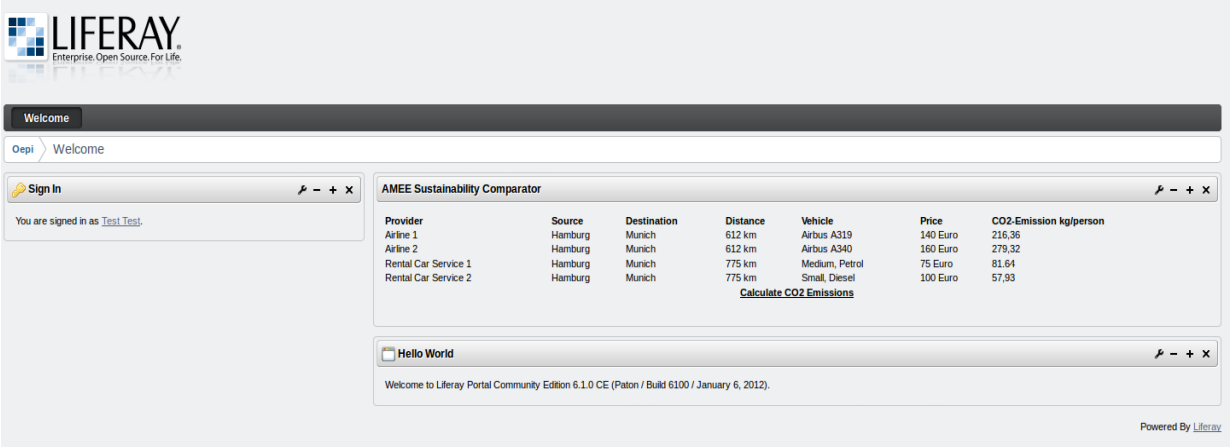

Figure 5: AMEE Sustainability Comparator Result Screen

7. Outlook and future steps

Starting from the importance of the information technologies as a support factor to the companies in order to to fulfil the growing customers demand for greener products, this paper shows how environment sustainability data can be integrated into the classical procurement process by using a light-weight and Open Source based Portlet platform technology. Since the current information systems for the midsize segment do not integrate environmental data, a "business trip use case" has been presented as an example to show how this integration could be done to link a public environmental data collection like (AMEE) to a public EMIS platform like the "Solution and Services Engineering for Measuring, Monitoring, and Management of Organizations' Environmental Performance Indicators" (OEPI), in order to enable its user to get the benefit of the provided services from AMEE through OEPI rather than to duplicate resources. In other words, we provide an example on how OEPI leverages data and calculation methods provided by AMEE.

The example however, shows that a lot of data and methods stored in AMEE can be used by OEPI. The API of AMEE offers unified access to this data repository, assures data quality and even allows storing original compositions on the platform. The tiny example provided within this paper is just a small show-

case how easy data and information integration can be nowadays. However the potential of Liferay as a platform to build light-weight information systems goes far beyond the limited scope of this paper. For example the calculation methods provided by AMEE are statically mapped to the type of the service provided (rental car or flight) and its attributes (e.g. Airbus A319, small petrol-driven car). A dynamic mapping of the AMEE data source through a dynamic connection with the OEPI ontology for example using the Joseki SPARQL implementation could be an interesting future research objective. In this case the OEPI platform could take the role of a mediator that unifies and standardizes access to data and method providers (such as AMEE) by dynamically leveraging the OEPI ontology.

8. Acknowledgment

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9. Bibliography

AMEE (2011). http://www.AMEE.com. Accessed 18 December 2011.

AMEE-content (2012). http://www.AMEE.com/what-we-do/AMEE-content/. Accessed 9 Jan 2012.

Cai, Y. and Huynh, S. (2008), Measuring Software Design Modularity, Proceedings of the 2nd Workshop on Assessment of Contemporary Modularization Techniques.

EC-E&I (2009): European Commission for Enterprise and Industry [Online] // European Union. - 2009. - http://ec.europa.eu/enterprise/policies/sme/index_en.htm.

Eden A.H. and Mens T. (2006), Measuring Software Flexibility, IEEE Proceedings, Volume 152, Number 3, pages 113-125

Hepper S. (2008): Java Portlet Specification 2.0, IBM Coorporation.

Hornby G. S. (2005), Measuring, enabling and comparing modularity, regularity and hierarchy in evolutionary design. In GECCO '05: Proceedings of the 2005 conference on Genetic and evolutionary computation, pages 1729–1736, New York, NY, USA, 2005. ACM Press.

Jamous, N. (et al.): Light-weight composite environmental performance indicators (LWC-EPI) concept. [Book Section] // Information Technologies in Environmental Engineering, New Trends and Challenges / book auth. Golinska Paulina and Fertsch Marek / ed. Marx Gómez Jorge. - Berlin : Springer, 2011. - Vol. 3. - http://www.springerlink.com/content/j86665463452kt25/. - ISBN 978-3-642-19535-8.

Meyerholt, D. (et.al) (2010): Bringing Sustainability to the daily business: The OEPI Project. In: Proceedings of the 24st International Conference on Informatics for Environmental Protection (EnviroInfo2010), Bonn & Cologne, Germany, Oct. 6 – 8, 2010.

Welford, R. (1996): Corporate Environmental Management: systems and strategies [Book]. - London : Earthscan Pub, 1996.