EXTENDED ERP USING RESTFUL WEB SERVICES
CASE STUDY: WINMENTOR ENTERPRISE®

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ABSTRACT

Enterprise Resource Planning Systems are dominated by explosion of Internet technologies and WEB evolution. Concepts like extended enterprise ERPII and ERPIII became more attractive and suitable for newest business process. The purpose of this paper is to examine the new generation of ERP and REST concept used in ERP II implementations. The paper offers a concrete case study using WinMENTOR ENTERPRISE® implemented with REST as an ERP II solution for e-commerce in a company of bio products.

KEYWORDS: *Extended ERP, RESTful web services, e-commerce*

1. INTRODUCTION

The origin of Enterprise Resource Planning (ERP) stands in 1960 when appeared first Inventory management and control systems. A brief review pointed evolution to 1970: MRP (Material Requirements Planning) systems, 1980: MRPII (Manufacturing Requirements Planning) systems then in 1990 Enterprise Resource Planning (ERP).

Internet Development and companies' extension via e-business solution forced another ERP expansion (started to millennium) to Extended ERP/ERPII systems. From now one term like Enterprise Systems (ES), Enterprise Information Systems (EIS) and Enterprise Applications (EA) describe better actual processes in companies. ERP solve internal application integration: back-office and front-office (Espinoza and Windahl, 2008).

ERP II proposes a web-centric solution, which involves Web platform, new modules like: e-business, business intelligence (BI), cloud SaaS, thin client-server. Extended ERP solve an inter-organizational integration across the whole supply chain, both customers and suppliers and offer also open source ERP systems as a solution for small enterprises (Mullaney, 2012). Web 2.0, 3.0 and 4.0 facilities were used in Extended ERP and from 2010 software vendors and developers offer a Post-Modern ERP or Entire Resource Planning (ERPIII). This approach include BI and analytics, RFID, performance IT tools, internet of things (IoT), ecosystems, in-memory technologies, mobility, and increased integrated functionality (Wood, 2011).

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This paper presents a solution for Extended ERP implementation for a medium size company which used e-commerce solution as main relation with customers. After a short introduction, section 2 describes main issues of ERP system and Restful Web services. The next section offers a practical implementation of WinMENTOR ENTERPRISE® with Restful Web services and a functional evaluation and results based on quantified business parameters. Conclusions and future work are described in section 4.

2. THEORETICAL FUNDAMENTALS

2.1. From ERP to ERPII and ERPIII

For ERP evolution argumentation we find several definitions, all of them agree that ERP is the core system in every ES software. Motiwalla & Thompson approach (2012) put the accent on internal value chain and from that point of view "ERP systems are the specific kind of enterprise systems to integrate data across and be comprehensive in supporting all the major functions of the organization". If we analyse an ERP from the supply chain process, it "is a modular software package for integrating data, processes, and information technology, in real-time, across internal and external value chains" (Shang&Sheddon, 2002).

Another comprehensive definition for ERPII underlined that it "extends the foundation ERP system's functionalities such as finances, distribution, manufacturing, human resources and payroll to customer relationship management, supply chain management, sales-force automation, and Internet-enabled integrated e-commerce and e-business" (IGI-global, 2017).

Table 1: ERP, extended ERP and their functionalities (de Búrca et al., 2005).

Functionalities	
ERP	Extended ERP
Procurement	e-procurement, SCM
Production	SCM, CRM, Supplier web
Sales	e-commerce, SCM, CRM
Distribution	e-commerce, SCM

As a synthesis, Table 1 shows how ERP II extend business process function with e-procurement, SCM, CRM, e-commerce and supplier web and Figure 1 shows a relevant manner on how customers and suppliers are in central role of companies' business, linked together with central databases' information and cooperate with companies via SCM, CRM e-commerce and e-procurement modules.
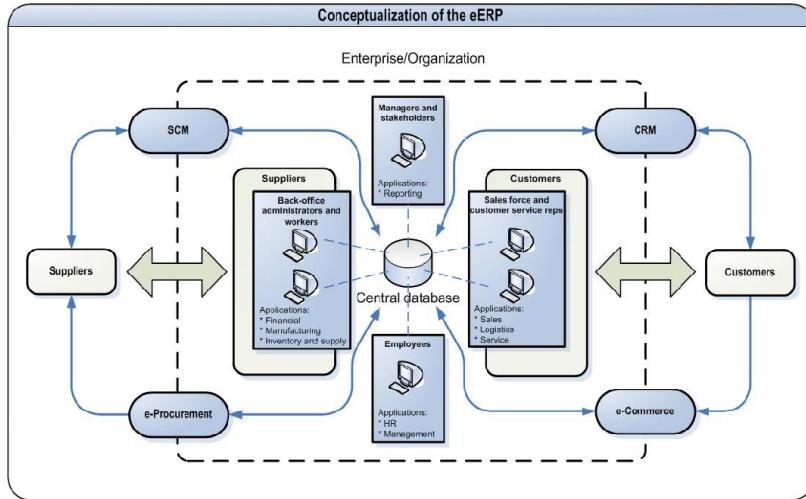
Figure 1. Conceptualization of the extended ERP (Espinoza and Windahl, 2008)

ERP marketplace is dominated by SAP, which offers revolutionary approach of business started to MRP in '70 and followed with SAP R/3, SAP ECC, SAP Business One and SAP Hana. Second serious competitor is Oracle but both have serious impediments for implementation: highest price and complexity. Microsoft is another competitor, with Microsoft Dynamics AX, an ERP system fit for Windows systems and for companies in quest for project and financial software. All are fit for large companies.

For small and medium companies we find: Infor, with a solution for discrete production: Infor Discrete Manufacturing Essentials, Industrial and Financial Systems IFS, Abas ERP for manufacturing and distribution, Epicor, Syspro, BatchMaster ERP, Sage (Shaul, 2015). Romanian solutions for ERP system are dominated by Borg and WinMENTOR ENTERPRISE®, followed by Clarvision and other ERP systems.

2.2. RESTful Web Services

The concept of REST (REpresentation State Transfer) was introduced by Roy Fielding. It describes a new architectural style of Web applications and network systems (Sun, 2009). For gaining work extensibility on Internet Web servers, clients, and intermediaries shared some four principles which Fielding calls REST constraints:

1. Identification of *resources*
2. Manipulation of resources through *representations*
3. Self-descriptive *messages*
4. *Hypermedia* as the engine of application state (HATEOAS)

In fact these principles form a consistent metaphor of systems and interactions on the Web. More detailed, resources *(1)* could be identified with everything that can be named by a target of hypertext (e.g., a file, a script, a collection of resources). The client receives a *representation (2)* of that resource, as a response to a request for respectively. The representation of the resource may have a different format than despite the resource on the server. Manipulation of resources is done via *messages* on the Web, as HTTP methods.

All links or URIs kept state of any client-server interaction in the *hypermedia (4)* which is exchanged. The client and the server exchanged state information from messages, are maintained stateless (Fielding, 2000).

Another comparison study between RESTful and WS-* services was focused on 3 levels: 1) architectural principles, 2) conceptual decisions, and 3) technology decisions (Pautasso et al., 2008). Both support architectural principles consist on protocol layering, heterogeneity and loose coupling to location (or dynamic late binding). As conceptual decisions, Pautasso et al compare 9 different designer decisions and RESTful services make 8 of them, while WS-* only 5, offering more alternatives than RESTful services. Technology decision shows 10 solutions for both styles.

Relevant principles for systems available on the Web afford to identify four system properties of RESTful services: 1) uniform interface, 2) addressability, 3) statelessness, and 4) connectedness. WS-* services offers three of these four properties while RESTful Web services includes all in resources, URIs, representations, and the links (Richardson and Ruby, 2007).

3. EXTENDED ERP IMPLEMENTATION USING RESTFUL WEB SERVICES

The ERP implementations are widely acknowledged in even small and medium-sized enterprises. Diversification of web solutions and technologies and the explosion of e-commerce alternatives have spurred the modernization and development of enterprise solutions in ERPII or ERP III. Beyond the schemes presented in paragraph 2.1, we aim to offer a concrete ERP II implementation solution using WinMENTOR ENTERPRISE® and RESTFul web services (WME®, 2018).

Starting with 2008 TH JUNIOR SRL offers a modularized and full integrated ERP - WinMENTOR ENTERPRISE® (WME®), based on Oracle DB technology as a host central database. During the following few years WME® was continuously developed from an ERP classic solution (contained accounting, finance, human resource management, production management, logistic management, CRM and SCM) to a modern approach linking together several newest modules: DataWareHouse, WME® Analytics (BI), WME® EDI, Import/Export Module, Web-Rest-Server (WME®, 2018).

Thus, the developers offer a solution for the ERP II approach and WME® can be implemented successfully in corporate companies or in small and medium-size companies, which decided to extend them business via e-commerce.

We will present the characteristics of the main modules involved in implementing the ERP II solution for a company producing bio products, which sells them on the Internet.
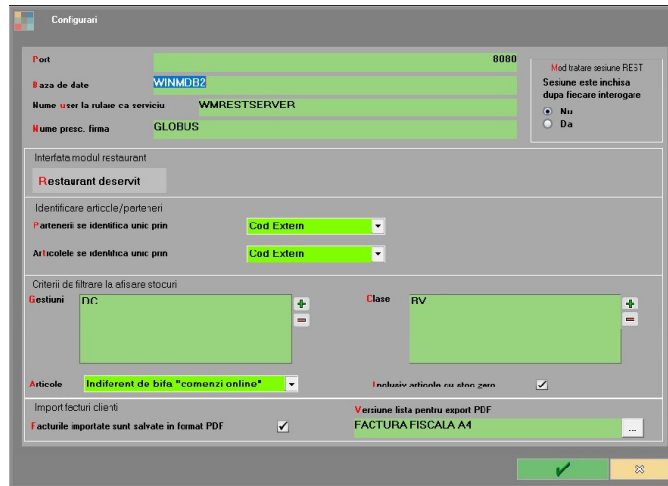
Figure 2. Configuration option for REST Web service

RESTful WebService allows other virtual applications to communicate with the Oracle Database (DB) of WinMENTOR ENTERPRISE® (WME®). The functions contained in this server offer the following features for virtual businesses (WinMENTOR®,2018):

- *Update functions*, which refer to: article, new client, new order, new order from different management, customer outgoing, vendor inputs, house or bank transactions, which gives it the advantages of using the central database in virtual business.

- *Query functions*: client-side databases, active discount criteria, earnings, item information, order information, client order status, price promotions are designed to facilitate access to DB virtual client information.

Other category of functions focused on Production process *Query functions*: release stage in production, subunits nomenclature, status queries, inventory, inventory accumulated, not discharged on management.

The *EDI (Electronic Data Interchange)* module is used for importing documents from other applications, or exporting documents in standard formats. It allows export of payments to banks in MT103 format, import of payments made, bank or POS receipts, import of invoices, notices, orders, transfers, teaching notes, etc. It also facilitates the import of client orders in XML, TecNET and EdiNET formats and is a permanent subject to customization, depending on customers' demands.

The link between both modules and Oracle DB is shown in Figure 2 and a sample of Order status from virtual customers is presented in Figure 3.
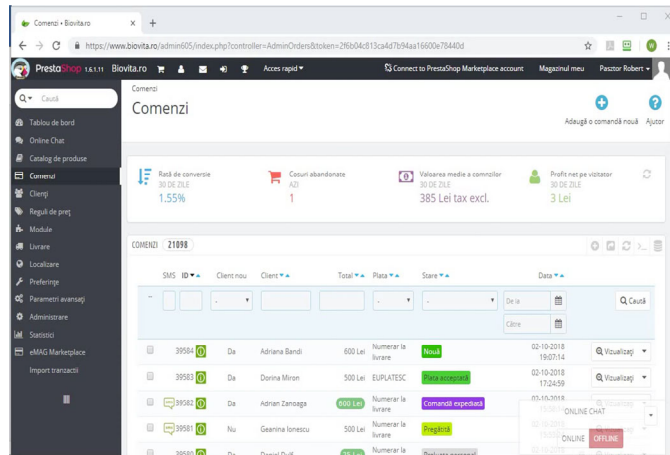
Figure 3. Orders status

Commercial documents related to e-commerce activity (especially invoices and warranty certificates) are automatically generated in PDF format, according to customer requirements, sent to every customer via email and stored in special directories (Figure 4).
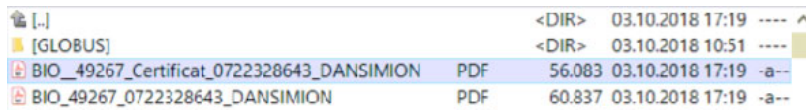

Figure 4. Commercial Documents

4. EVALUATION OF THE PROPOSED SOLUTION

The practical implementation of the WME® as an ERP II solution was done for the benefit of a bio-company that did not have an earlier ERP solution and wanted to develop its virtual business in parallel.

The WME® and Web Rest Server solutions allow the company to generate more than 1,000 bills per month, with a single operator, and also to process billing documents for virtual payments in less than an hour.

This means that the documents received by the banks are processed by the REST and EDI modules, to enable the automatic generation of the accounting notes related to the collections of the issued bills.
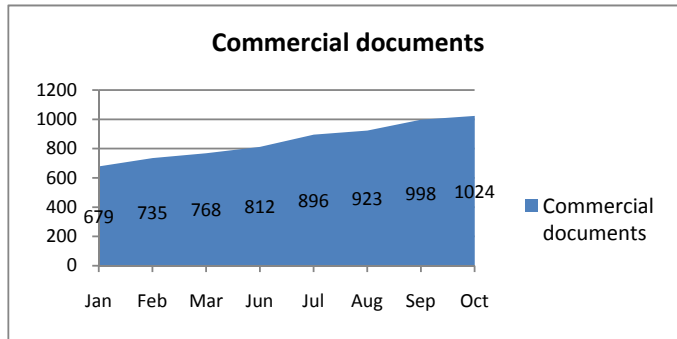
Figure 5. Dynamic of Commercial Documents

Since January 2018, when the implementation was completed, and until October the same year, the number of automated business documents has increased from 679 to 1024 (Figure 5).

Automatic generation of PDF bills and warranty certificates and automatic send just-in-time to all customers is essential to eliminate manual effort at customer's company. Major benefits consist on increased number of automated documents during a period of time besides reduce number of employers. The company has only one operator in the delivery process and a fast courier company is charged to deliver products requested by customers.

By aquisiton another ERPII module: WME Analytics (BI under Qlik) company could make a decizion optimization. It will increase efficient management and business evolution.With this solution, the client benefitting from the implementation estimates that it will be able to increase the activity volume by at least 10 times.

CONCLUSIONS

This papers presents an extended enterprise implementation for a company specialized on bio production, which offers an e-commerce solution as main customer relationship tool for developing businesses.

The core of implementation is WinMENTOR ENTERPRISE®, a Romanian ERP solution, which is extended with Web RESTful services and EDI modules. In this manner all the commercial documents are generated as PDF files and sent via email to customers. Payment process is linked with the central Oracle database via the Web-REST and EDI modules.

By implementing an ERP II solution, the company automated the order processing and payment processes, increased the sales and offered a modern solution to its customers. Beside all, the company reduced the sales employees number , increased business indicators and started an initiative to become a paperless company.

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