SOA-BASED APPROACH TO THE ENTERPRISE RESOURCE PLANNING IMPLEMENTATION IN SMALL ENTERPRISES

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Abstract. *The sector of small enterprises is characterized by a specific approach to the planning activities, determined by the circumstances of low margin and risk-driven business. The primary focus of small enterprise are income generators, rather than cost reduction activities. This reflects at ineffective and inefficient usage of diverse ICT technologies, implemented in a non-systematic manner. The objective of this paper is to present principles and guidelines for the customized approach to the implementation of the integrated enterprise information system, by using the step-wise implementation of the service-oriented architecture (SOA), managed and operated with a minimized threat to the business continuity.*

Key words: *Enterprise Resource Planning, ERP, Small & Medium Enterprises, Service-Oriented Architecture, SOA, Web Services*

1. INTRODUCTION

The environment of small enterprises can be described from the aspect of ICT investment, level of business organization and scope of strategic planning. These features are extremely important for setting the background basis for strategy, methods and tools for implementation of the enterprise information system. With regard to this, some important findings [1] are described below:

- Start-up investment is used for financing basic activities for market development and short-term business continuity management with the lowest margin possible. Planning horizon is low because of a small-scale startup investment and applied production strategy. Business is done on the basis of short-termed forecasts;
- Integrated enterprise information system is not implemented – a non-homogenous environment of different business applications, supporting individual business segments might cause data redundancy and threaten its integrity. Both could induce a risk of wrong or late information, needed for decision making;

- Low margin strategy determines the way of doing daily business. Top priority is to remove short-term risks – all resources are involved in fulfillment of sales objectives, rather than cost reduction, which is the primary goal of business IT applications;
- Less but more flexible workforce is capable of quickly adapting to business process re-engineering deliverables;
- Web-based marketing and e-commerce practices are often applied, because they are less demanding regarding investments and workforce, unlike in the conventional marketing and sales activities. This approach enables the company to adapt quickly to web-based business process management, and particularly, B2B activities;
- Lack of strategic risk management approach, caused by focused identification and resolution of short-term risks lowers the level of coordination towards fulfillment of business plan objectives;

General objective of research, presented in this paper, is to identify the technology stack, followed by relevant guidelines and methods, for ICT support in business management of small manufacturing enterprises. Specific objective is to define the technical framework for transition from dispersed legacy ICT environment to effective and efficient enabler for on-time delivery of accurate information in decision-making business activities. Focal point of the presented framework is maturation of business functions towards concept of business services [2] and their orchestration into processes, executed and managed on top of gradually integrated ICT environment.

2. IMPLEMENTATION OF ENTERPRISE RESOURCE PLANNING IN SMALL ENTERPRISES

One of the key preconditions for survival of small manufacturing company on the market is its flexibility and adjustment – capability of the company to respond to market changes, at strategic, tactical, operational and technology levels.

In complex manufacturing environments, the slightest alterations of the actual from the planned demand or supply can cause high deviations (Bullwhip effect), which cannot be compensated without a significant negative effect on customer loyalty or manufacturing costs. Success of a change of local business environment, induced by market fluctuation, depends on an accurate and detailed description of the current status of each and every business process in the company. Identification of the business disruption and proposition of the feedback are both possible only on basis of accurate and quantified status information. Primary tool for storage, delivery and management of company's business status information is Enterprise Resource Planning – ERP system. Completeness and accuracy of data is also the basic pre-condition for feasible and beneficial implementation of ERP system. For example, several case studies show that the feasibility of MRPII implementation is achieved only if the stock record accuracy goes up to 98% and beyond.

The primary objective of ERP system implementation is support in execution of core business processes in enterprise. ERP system resembles methods and tools for effective and efficient management of all enterprise resources: material, workforce, tools and machines, documents, space, time and money. The basic role of the installed ERP system is quantification of all these resources in any of business circumstances, within the context of specification, time and volume of their usage. It enables consistent and coordinated

planning and management of all enterprise departments – sales, purchase, supply and accounting, on basis of real-time generated, accurate views of business information.

The current evolution of ERP system is driven by response of the vendors to globalization processes, as well as hardening of the competitiveness requirements. Modern transformation of today's ERP systems is streamlined into three directions: expansion of business processes beyond the boundaries of individual enterprises; vertical specialization of industrial ERP solutions; and development of component, modular architecture. According to Gartner [3], these three features set the ground for transition of ERP concepts towards ERP II.

Implementation of ERP system in an enterprise assumes synchronization and integration of all of its business functions and respective information repositories. It is very complex, relatively long activity, within which a number of actors performs a transformation of a business environment and appropriate ICT infrastructure, with the common objective to integrate the selected business processes in unique environment. Often, this transformation involves radical changes in a way one enterprise performs its functions, with the most direct, significant impact on immediate actors of existing business processes. Costs of change management, in activity of ERP implementation could rise up to 70% of the project budget [4]; though it should be noted that they are extremely hard to quantify, and therefore, to plan and manage. From this point of view, change management in process of ERP implementation is the most critical part and source of most of the risks. Criteria of success in ERP implementation is not evaluated on basis of direct deliverables accomplished at the end of process implementation, but relative to the return on investment (ROI), measured in a long term. This value is primarily affected by a level of cost savings accomplished after ERP system implementation in a long term. The research project, performed at mid-2006 [5], with a sample of 264 companies of different sizes visualized the cost structure in implementation of ERP systems. The results showed that participation of software license cost in implementation of ERP system in small enterprise is 57%, compared to 24% in large and 27% in medium enterprises. Costs for consulting, customization and ICT infrastructure revision were significantly smaller in small than in large and medium enterprises.

On the basis of the existing experiences in application and implementation of ERP systems, the current trends in evolution towards ERPII concept, as well as features of environment for business of small and micro enterprises, described above, it can be concluded that basic principles for implementation of ERP systems in this segment are:

1. Limited, managed change
2. Graduate, step-wise change
3. Homogenous system
4. Integration capacity
5. Fast ROI

One of the basic principles for business integration by using ERP is limited and managed change – selection of a limited number of actions with maximum impact on business improvement (Pareto). This principle is implemented by identifying key business processes, which add maximum value to business deliverables, in the context of income or profits. Identification of the key processes is also performed on the basis of: its possible

impact on the quality of the product or services; duration; frequency; and costs for execution of each of its instances.

In sector of small and micro enterprises, one of the top priorities is to preserve business continuity, on a short-term basis. In order to achieve the maximum level of certainty, it is necessary to perform required changes in a graduate, step-wise manner. Phased approach in business process re-engineering, required by ERP implementation, is planned with minimum impact on the escalation of possible business integrity risks.

In the technical context, gradual introduction of changes is realized by continual preservation of integrity of existing information repositories, used by legacy applications, as well as functionality of respective client layers. In period of implementation, actual changes are performed in three streams of development, performed at hot site (Figure 1):

1. integration of repositories;
2. implementation of back-end layer with business services for their management; and,
3. implementation of front-end layer for orchestration of business services.
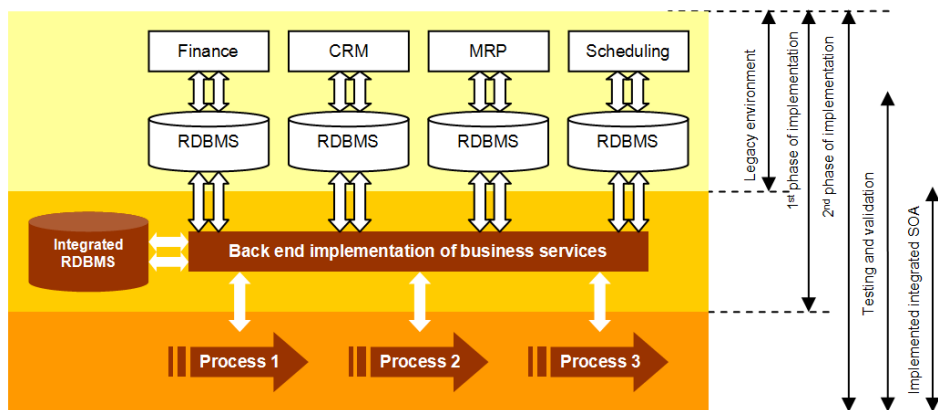
Fig. 1 Transition of Legacy Enterprise Information System into Integrated, Process-based Environment

Non-systematic approach to the design of small business enterprise application system is the most significant source of data diversification and redundancy. This has a significant negative effect on the enterprise's ability to extract real-time, accurate information on the past, present and future, as well as forecasted business activities. This effect is even multiplied in the context of a dynamic business environment, which is, otherwise, characteristic for the sector of small enterprises. It is generated by the continuous need for fast response in search of short-term solutions under the new market circumstances. Required flexibility of the business of sector of small enterprises has a great impact on decisions in the process of procurement or development of integrated enterprise information system. With regard to this, two of its most important features are: integration and collaboration capability; and modular architecture. Therefore, the use of open standards is crucial in its implementation. It is the basic pre-condition for establishment of universal interoperability of individual system components, as well as integral, secured and robust channels for

external communication of the system with enterprise partners. The achievement of a high level of system modules interoperability would enable rapid and seamless integration of any of new system components – proprietary, custom-made or open-sourced.

The second factor for development of interoperable environment is application of web standards. Primary benefit of using a web infrastructure as a medium for process execution is its availability, based on internet protocols. However, it is very important to note that web applications are usually characterized by three-layer architecture, realized by MVC (Model-View-Controller) pattern. It is the model for system design decomposition which clearly defines the layers of data storage, business logic and its implementation; and user interface. Autonomy of the business logic layer, prescribed by MVC pattern and opportunities for its reusing in different circumstances, raise the potential for integration of different web applications in unique enterprise system. The business logic layer actually contains implementations of business services, which are orchestrated with respect to the established process orientation of the business system.

Since majority of investments in ERP implementation in small enterprise belong to purchase of software license, it is obvious that it is focal point of management decisions with regard to ERP implementation. Therefore, the recommended orientation of small enterprises is the application of open-source technologies in development of ERP system, or usage of of-the-shelf open-source systems, like Compiere ERP & CRM, TinyERP, etc.

Beside savings in software license purchase, the diversity of open-source technologies and applications enables management with a direct and wide insight to face the opportunities for application of ICT technologies in planning and management of business resources. Another driver of ICT excellence in the context of application of open-source technologies is the fact that the open-source market is dedicated to development of open, interoperable standards – open-source applications are usually easy to integrate and, therefore, represent a firm basis for homogenous enterprise information system. Finally, the majority of open-source applications are web-oriented – their integration potential is much greater in contrast to the conventional client-server or desktop applications.

3. Service-Oriented Architecture Implementation

High level architecture, presented at Figure 1, is the basis for integration of services and information from enterprise application environment in small enterprises. It is an abstract description of the process of revision of legacy system by using principles and guidelines of the service oriented architecture (SOA).

SOA is the form of organization of integrated enterprise application environment, characterized by supply, demand and usage of its distributed functions, implemented by services. It enables a concept of uniform tools for exposition, discovery, interaction and usage of individual business functions in context of fulfillment of the defined objectives.

Growth of internet, electronic business (B2B), as well as supporting protocols and standards, particularly XML (eXtensible Markup Language), motivated development of technical solutions for exposition of business functions in a wider context, even publicly. Today, the primary tools for enterprise collaboration, as well as integration of its internal business functions, are web services – basis of SOA infrastructure. Basic standards for realization of web services are WSDL (Web Services Description Language) [7], used for definition of

structure of service - its "contract"; and UDDI (Universal Description Discovery and Integration), which prescribes the methods, principles and guidelines for management of service registry. BPEL (Business Process Execution Language) [8] language for process modeling is a tool for orchestration of web services. It is integral part of discipline of Business Process Management (BPM) – area of ICT application in definition, simulation, execution, optimization, evaluation and control of business processes.

Feasible alignment of SOA architecture with described approach in migration of legacy IT infrastructure is possible by implementing specific design methodology [1]. In general, methodology is executed iteratively, until the project objectives are achieved. It has a top-down character and prescribes the following design and development steps:

1. **Generic process description.** Identification of process activities and their sequence. Identified activities are analized, with goal to recogize automatic and manual activities, synchronous and asynchronous activities and a possible negative impact of each activity on the performance of the process on the whole (design of the process correction feedback - identification of fault handling and compensation activities);

2. **Process decomposition.** Identification of services by using a method of iterative process decomposition, their classification with regard to ownership and structure, provider responsibility, service levels and availability. Also, semantic model of service interoperability is developed – all messages exchanged by the provider of the service and its customer are defined and designed;

3. **Service implementation.** XSD schema and WSDL interface are implemented on the basis of identified information, as well as client;

4. **Services orchestration.** By executing individual business functions, customer of the service can fulfill only a limited goal of individual business activity - execute a business query, perform transaction, authentification, etc. However, a significant impact on business performance can be achieved if a range of business activities, using one or more services, are executed in a sequence, manually or automatically, with a different range of data used. In development of services orchestration environment, primary activities are: realization of abstract process definition by using BPEL language; implementation of conversational SOA elements (BPEL "partner link" elements); and realization of event, fault and compensation handlers and alarms.

On the basis of described migration process, as well as assumptions and deliverables of described development process, technical infrastructure for migrating legacy ERP functions of small enterprise to SOA-based environment is designed with architecture, described in Figure 2.

In contrast to the standard SOA architectural concepts, the applied approach of ERP implementation in small enterprises is characterized by appearance of generic WSDL client [6], whose role is to mediate in execution of different activities, performed during exploitation, but also – development of SOA. Primary functions of generic WSDL client are:

- Analysis of WSDL interface on any remote location, accessible by using HTTP protocol;
- Support in modeling of conversational elements of WSDL interfaces in real-time;

- Generation and distribution of user interfaces, on the basis of semantic interoperability of web services; and,
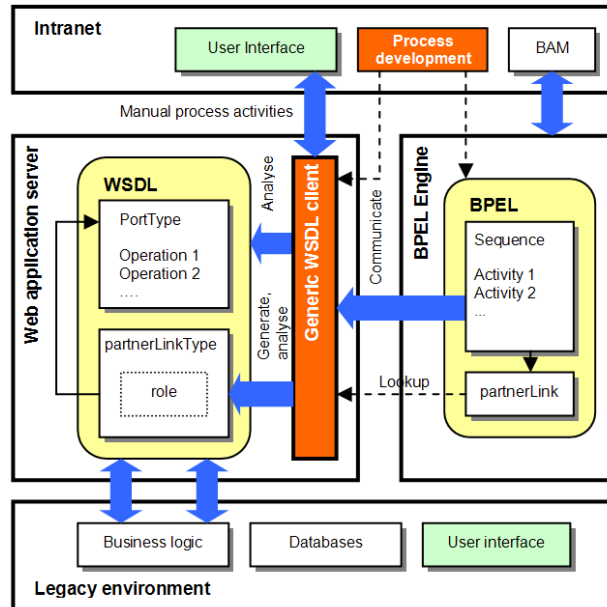- Support in modeling of BPEL processes.

Fig. 2 Technical Implementation of SOA in Small Enterprise

Development of generic WSDL client strongly motivates the research of methods for transfer of implementation activities from development, testing and prototyping to production environment. Basic driver for streamlining the future research in this direction is dynamic business environment of small and medium enterprises.

In order to validate described approach, a referent process of purchase order processing in make-to-stock business model has been chosen and tested in number of instances. It involved both synchronous and asynchronous services, fault and compensation handling by appropriate activities.

4. CONCLUSION

Current state of SOA standards and related industry experience provide a number of opportunities for implementing integration approaches in wide range of circumstances. SOA technology task is to enable the resolution of a number of general integration obstacles, both technical and non-technical. Service-based orientation of a system design and orchestration technologies are critical for successful and rapid business process re-engineering and involvement of micro-management activities, even in small enterprises.

Opportunities of web-enabled, service based business environment, as the most cost-efficient infrastructure for ICT support of activities of small and micro enterprises are

huge, particularly in knowledge management, business process reengineering (BPR) and collaboration. Conceptualization of corporate knowledge, experience and resources followed by atomization of production processes could create a structured environment for improvement of corporate market response, as well as its collaboration capacity. Expansion of this approach beyond corporate boundaries would create a basis for a more effective and efficient collaboration in the supply chain management.

Another objective of the research of SOA approach in implementation of ERP in small enterprises is to provide for third-party support in planning and management activities – ASP (Application Service Providing) based approach in ERP application delivery and its expansion to concept of virtual supplier hubs.

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SOA-ZASNOVAN PRISTUP U IMPLEMENTACIJI PLANIRANJA POSLOVNIH RESURSA U MALIM PREDUZEĆIMA

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Sektor malih preduzeća karakteriše specifičan pristup u aktivnostima planiranja, određen okolnostima poslovanja vođenog rizicima, sa niskom marginom. Primarni fokus malih preduzeća na generatore prihoda, umesto na ostvarivanje ušteda u poslovanju, utiče na to da se ICT tehnologije primenjuju i koriste na neefikasan način, a implementiraju nesistematski. Cilj ovog rada je da predstavi principe i smernice za poseban pristup u ostvarivanju integrisanog poslovnog informacionog sistema, primenom postepene implementacije servisno-orijentisane arhitekture (SOA), upravljane i eksploatisane sa minimalnim pretnjama na dnevni kontinuitet poslovanja.

Ključne reči: *Planiranje poslovnih resursa, ERP, Mala i srednja preduzeća, Servisno orijentisana arhitektura, SOA, Web servisi*