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Reuse-Oriented and Internet-Based Collaborative Framework for Transport Logistics Service Providers

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Abstract

This study describes the approach aimed at supporting industrial enterprises, especially small and medium enterprises in the business sector of transport logistics services. The approach is focused on defining the framework for organizations that are moving towards a systematic reuse program and Internet-based information technology (IT) solutions.
KEY WORDS: *transport and logistics, software reuse, e-business solutions.*

1. Introduction

The transport logistics segment is characterised by a very high competition and especially strong pressure from logistics giants. Logistics giants with their international networks have significant advantages over small and medium-sized transport logistics companies. For individual small and medium enterprises (SME) it is difficult to solve the problems alone; however, by co-operation and efficient utilization of knowledge and resources, they can keep relatively big segment of the world transport logistics market.

Looking at the transport domain, we face one of the biggest challenges of the next 10 years. As a response to these challenges, all SME actors have to cooperate and develop sustainable innovative solutions that will lead to advances in improving freight forwarding and logistics. At the same time in the current situation of financial crisis it is extremely important for applied technologies to provide some economic and organizational benefits by reducing development and operating costs, and by efficient utilization of development knowledge and corporate expertise. The need in systematic approach and effective software engineering methods, which allow reusing experience to address recurring problems successfully, is obvious and important in the transport domain. With more than 40-year history reuse is recognized as an important mechanism to improve software quality and development productivity [1]. Today, we are just at the start of this challenge but we believe that the synergy of Internet-based and reuse-oriented methods for software solutions may revolutionise the world of SME-based transport and logistics by creating a new platform of business opportunities.

The paper presents the review of the ongoing joint research activities related to the introduction of systematic software reuse and web-based collaboration in the enterprise paying special attention to the needs and the problems of transport logistics service providers (LSP). The following sections discuss current limitations and expected benefits of the research. It is followed by the review of proposed reuse-oriented and Internet-based collaborative frameworks. Finally, the conclusions are made in the last section.

1.1 Current bottlenecks and limitations

The following bottlenecks and limitations have been identified as the main drivers for our joint research activities:

- Logistics service providers often lack global visibility and are poorly integrated with suppliers and customers.
- Intermodal collaboration among logistics service providers usually isn't effectively organized.
- Most LSPs must undergo Internet-based technology transformation.
- The existing IT solutions mostly support separate stages of logistics processes and are not focused on "user demand driven" integrated Internet-Based solutions that provide an opportunity to manage business processes within logistics chains.
- Existing efforts to attain the main objective of software reuse in the transport domain rendered some successful stories, however, to benefit in more systematic and repeatable way, additional research is needed.
- Reuse requires up-front investments in infrastructure, methodology, training and tools without payoffs being realized immediately and cannot be widely achieved in LSP organizations without support of top-level management. However, reuse will only succeed, if it makes good business sense, and it will only be chosen, if a good case can be made that it is the best alternative choice for the use of capital [2].
- Reusing of large-scale system components is a problem too hard to be solved in general way. It is more effective when systematically applied in the context of families of related systems and thus is domain-dependent.

1.2 Expected advances and benefits

The expected advances and benefits of the research are the following:

- The reuse-oriented framework for organizations that are moving towards an effective reuse program composed of different aspects of software reuse and related practices. The final goal is to ingrain reuse into an organization's entire software production process [3]. A formalized process increases the chance that the project success can be repeated, facilitates adherence to the established best practices, standardization of practices across multiple, and helps less-expert developers to succeed via reliance on a standard process. Additionally, the framework expected to define effective measuring of economic benefits of the software reuse and development costs, where operational and strategic benefits are defined and quantified within the context of broader business strategy. However, each organization should analyze its own needs, define the key benefits it expects, identify and remove impediments, and manage risks [4].
- The methodology for Internet-based Collaborative Framework (ICF) development is based on transport and logistics CMM and Web technologies. ICF provides the adaptation mechanism to distinct between different target groups (technology supplier, technology receiver, technology transfer facilitator). ICF also provides easy adaptation of technology transfer process (Fig.1) and commercialization to the new conditions of target countries and SMEs requirements.

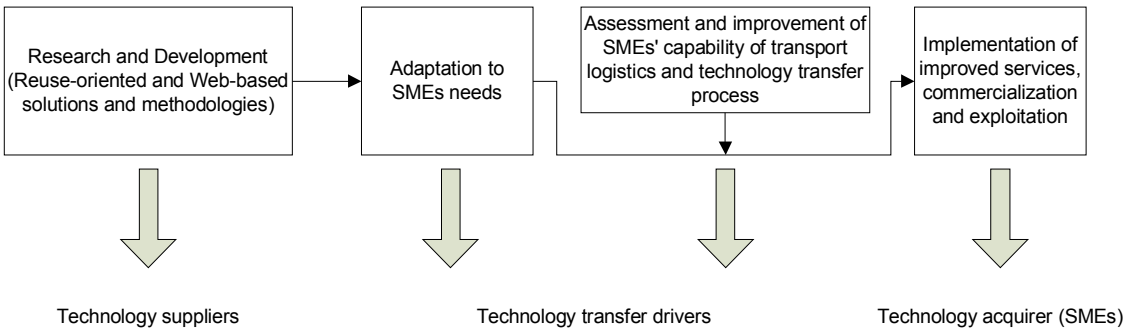

Fig. 1. General scheme of technology transfer process

2. Reuse-oriented framework for logistics service providers

Software reuse is the process of creating software systems from existing software rather than building them from scratch, whereby an organization defines a set of systematic operating procedures to specify, produce, classify, retrieve, and adapt software artefacts with the purpose of using them in its development activities [5], so that similarities in requirements and/or architecture between applications can be exploited to achieve substantial benefits [6]. Our retrospective analysis of the origins and main contributions in the research area performed in [1] outlines that software reuse is multidisciplinary and has deep and complex interactions with many areas of computer science. Table 1 consolidates the main benefits from [7] that can be achieved by the organizations with the maximization of the reuse level.

Directions and components for reuse-oriented framework comply with the following main conclusions that we have obtained through the survey [8] involving software organizations in Baltic regions, whose responses were analyzed and used to relate the characteristics of organizations with their reuse experience:

Table 1

Main benefits of reuse

Benefits of reuse	Description
Gains in quality	Quality of particular component could be improved because of error corrections accumulated from reuse
Gains in reliability	The use of a component in several systems increases the chance of errors to be detected and improves confidence in that component
Gains in productivity	Productivity could be achieved due to less design and code to be developed and less testing efforts
Gains in performance	Extensive reuse can be worth the effort invested in optimizations, that may yield better performance of a reused component
Reduction of maintenance costs	Fewer defects and reduction of maintenance costs can be expected when proven quality components have been used
Reduction of product time to market	By using reusable artefacts organizations could reduce the product time to market which influences the success or failure of a software product
Rapid prototyping support	Reusable components can provide an effective basis for quick building of a prototype of a software system

- 72% participants claimed to succeed in projects by the means of software reuse in their organization, and small and medium software organizations presented higher reuse success rates than organizations of a large size.
- Organizations should focus on the development of product families if applicable in the operating business area.
- Attention should be spent on the introduction of process-driven systematic reuse in the organization.
- Organizations should consider using repository for storing and retrieving reusable assets, and a configuration management process should guarantee proper evolution of these assets.

The overall structure of the proposed reuse-oriented framework is organized considering economic (A), organizational (B), and process (C) aspects of reuse as outlined on Figure 2.

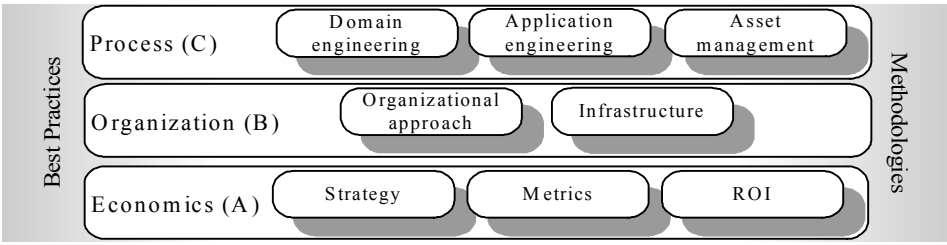

Fig. 2. The overall structure of reuse-oriented framework

(A) From the economic perspective implementing a reuse initiative in a corporate environment requires a decision about when and where capital investment for software reuse is to be made, and whether it will be proactive or reactive [2]. The measuring of economic benefits of the software reuse and development costs should be aligned with the following main principles from [9]:

- Economic value maximization drives reuse investment strategies for the business
- Strategy drives selection of reuse investments that are actively structured to maximize embedded strategic options.

Economic aspects of software reuse are divided into the following broad classes by [10]:

- metrics, which reflect attributes that increase the market value of an asset
- reuse cost estimation techniques and return-on-investment (ROI) models to quantify reuse related decisions.

(B) Several approaches exist for establishing a reuse program from the organizational perspective:

- Centralized, with an organizational unit dedicated to developing, distributing, maintaining, and providing training on reusable assets.
- Distributed asset development, where reuse is implemented collaboratively by projects in the same product line.

Reuse environment on the organizational level assumes development of

- managerial infrastructure in the form of a set of functions, responsibilities, reporting requirements, and reward, which are required to ensure operation of reuse processes
- technological infrastructure that includes a configuration management and quality assurance functions to support reuse operations, as well as enforcement of testing, verification and asset certification standards.

(C) Process-driven means that the software development is done in accordance with well defined processes that are enforced through management policies. A software process could be defined as a set of activities that lead to the production of a software product [13], and it is important in order to ensure efficiency, reproducibility, homogeneity, and predictable time and effort constraints. As it was noted already, a key concept of systematic reuse is the domain, which may be defined as an application area (e.g. transport domain) or, more formally, a set of systems that possess similar functionality and share design decisions (e.g. logistics information systems). By domain-specific reuse we assume, that the reusable assets, the development processes, and the supporting technologies are appropriate to the application domain for which the software is being developed.

It is common to identify three main stakeholders in the process of software reuse within an organization: corporate management, domain engineering and application engineering teams. By reviewing the tasks of each of these stakeholders, the following top-level reuse related activities can be identified:

- asset production – identification, development and classification of reusable artefacts
- asset usage – locating and evaluating assets, and achieving their actual reuse by integrating them into applications being developed
- asset management – asset storage, repository management, and asset dissemination
- maintenance and support – support for asset usage, methodological support, and corrective and evolutionary maintenance of assets
- reuse management – introducing and monitoring reuse within a company or department.

To support reuse, software processes have to consider two facets: developing for reuse and developing with reuse. As a result comparing to conventional “monolithic” set of tasks organizations are responsible for providing and maintaining software systems, software reuse introduces a differentiation between the tasks related to the production of reusable assets and the tasks related to the production of end-user applications [14]. Such two-life-cycle approach with

generalized activities schematically displayed on Figure 3 is commonly referred as domain and application engineering, which address development for reuse and development with reuse respectively.

From the technical point of view the LSP development within the proposed framework should rely on best practices and appropriate supporting methodologies facilitating global visibility, integration and collaboration as previously noted in section 1.1. The Internet-based collaborative framework (ICF) as further discussed in the next section aimed to provide a facade for several advanced IT solutions in order to support networked logistics service providers.

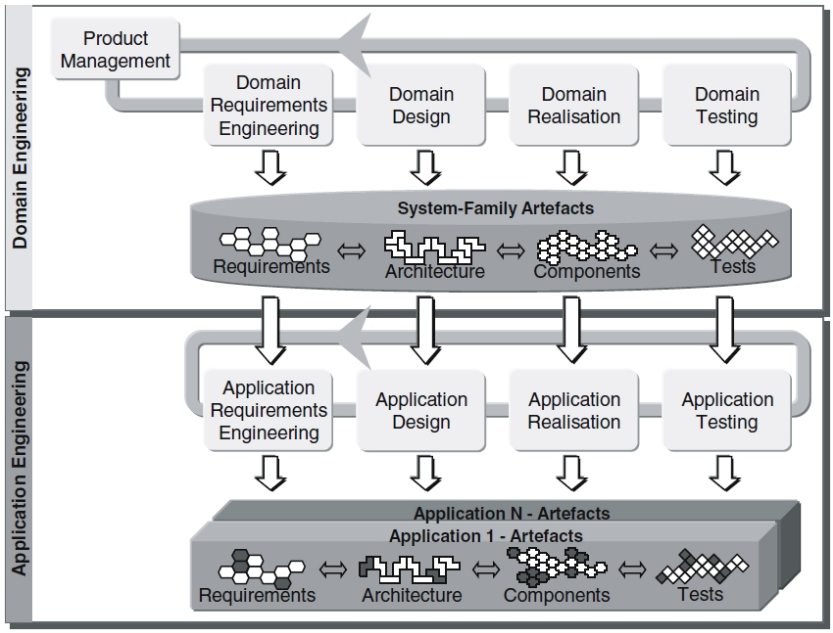

Fig. 3. The two-life-cycle model of domain and application engineering [15]

3. Internet-Based Support of Networked Logistics Processes

The number of stages of general logistics model "buy-move-make-sell" and, correspondingly, the individual structure of adapted to the specific needs of LSPs can be dynamically extended using Web-based coordinating mechanisms and semantic interoperable services. It is very important in a case when customers requirement are dynamically changed and they are willing to extend the number of provided services. The Internet enables and supports logistics collaboration among different LSPs, new dynamic relationships, new opportunities and markets.

Use of Internet-based Collaborative Framework incorporating several advanced IT solutions, makes it possible to support networked logistics service providers. The Internet enables LSPs to become the WYSIWYG (What You See Is What You Get) enterprises, where Web-based applications become as rich as their desktop equivalents.

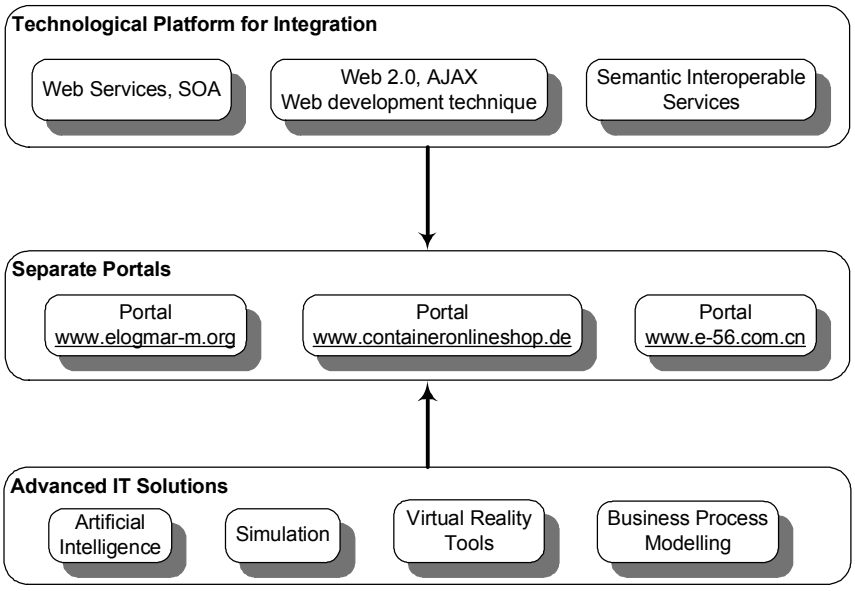

Fig. 4. Integration in ICF

SOA, Web services, Semantic Interoperable Services, XML, and AJAX Web development techniques are used as a technological platform for the integration. Using these technologies together with the existing enterprise web platforms and portal frameworks (Liferay, GateIn, WebSphere Portal, JetSpeed, etc), it is possible to design the integrated portals that will provide seamless integration of the various logistics-related services and data sources (Fig. 4). For instance, separate portals that support different logistics business processes along the selected freight route (www.elogmar-m.org, ww.containeronlineshop.de, www.e-56.com.cn) are united into one framework with a single entry point [11].

An enterprise portal, built with a robust portal product, provides an off-the-shelf framework for developing and deploying service-oriented applications. It can serve as a ready-made Web services consumer platform, and enables you to build composite applications, deploy syndicated content from other portals through remote portlets, replace/augment legacy interfacing applications, create common views of data, and facilitate access by mobile and wireless devices [12].

Most of the mentioned above portal frameworks also have personalization features. Personalization provides end-users with an opportunity to customize their version of a portal; thereby, greatly improving end-user performance and satisfaction. Using personalization mechanism, portal administrators can define specific groups which may represent portal users' real-life roles (operator, manager, CEO, etc). Depending on their roles, users will have access to the features and content designed for their group.

Conclusion

The need in systematic approach and effective software engineering methods, which facilitate global visibility and collaboration and allow reusing experience to address recurring problems successfully, is obvious and extremely important in the transport domain. The study presents the framework for organizations that are moving towards a reuse program that is organized considering economic, organizational and process aspects of software reuse. The concept of the development of the Internet-based collaborative framework for the transport logistics service providers, along with technology transfer model, is used to improve their business processes.

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