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PROCESS RENOVATION: THE CASE OF E-LOGISTIC

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The paper deals with process renovation, the effective utilization of information technology and the role of process-based knowledge management in supply chain integration towards e-logistics. The paper describes business process renovation as the key element of an e-business orientation and the highest level of strategy for managing change that commonly cannot be handled by continuous improvement and reengineering methods or organizational restructuring. The theoretical findings are illustrated with a case study of the procurement process in a petrol company. Process modeling proved useful since it shows the process as a whole, the drawbacks of the existing process, bottlenecks in carrying out the process and it provides a critical insight into process execution and knowledge management.

Keywords: *business process, process renovation, process-based knowledge, e-logistic*

Renovacija procesa: Slučaj e-logistike

Izvorni znanstveni članak

Članak se bavi renovacijom procesa, učinkovitom uporabom informacijske tehnologije i ulogom upravljanja procesno baziranim znanjem kod integriranja nabavnog lanca s e-logistikom. Članak opisuje obnavljanje poslovnog procesa kao ključni element orijentacije ka e-poslovanju i najviši nivo strategije za provođenje promjene koja se obično ne može postići metodama kontinuiranog poboljšanja i reinženjeringa ili organizacijskim restrukturiranjem. Teoretski se nalazi primjenjuju u analizi procesa nabave jedne benzinske tvrtke. Modeliranje procesa se pokazalo korisnim budući da pokazuje proces kao cjelinu, nedostatke postojećeg procesa, zastoje u izvršavanju procesa, te daje kritički uvid u izvršenje procesa i upravljanje znanjem.

Ključne riječi: *poslovni proces, renovacija procesa, znanje temeljeno na procesu, e-logistika*

1
Introduction
Uvod

Business Renovation (BR) integrates the radical strategic method of Business Process Reengineering (BPR) and more progressive methods of Continuous Process Improvement (CPI) with adequate Information Technology (IT). Process renovation is a re-engineering strategy that critically examines current business policies, practices and procedures, rethinks them through and then redesigns mission-critical products, processes and services [26]. It is suggested to use the modeling and simulation of business processes in BR projects as this allows the essence of business systems to be understood, processes for change to be identified, process visions to be developed, new processes to be designed and prototyped and the impact of proposed changes on key performance indicators to be evaluated [8].

Approaches that focus on knowledge management at the business-process level are limited [33]. Knowledge-related perspectives need to be part of business process reengineering (BPR) [24]. The links between the design of business processes and knowledge management is also stressed by Heisig [14]. Heisig presents an approach to analyze the business process from a knowledge management perspective and tries to integrate knowledge management activities into daily business. The model-based knowledge-management approach adds a new perspective to the modeling of existing business processes, especially knowledge-intensive processes. Business rules represent the 'know' part of corporate business processes. They really mean establishing the encoded knowledge of corporate business practices as a resource in its own right [29]. According to this definition, business rules can be seen as a subset of business knowledge.

In our paper we introduce a case study of business process modeling and present a simulated use in the field of e-logistics enrolment. In Section 2 the role of business process modeling in current BR efforts and plans for e-logistics enrolment are discussed. Section 3 follows, in which a business rule-transformation approach to business renovation and the value of modeling in BR projects are briefly presented. The core part of the paper is Section 4, where we outline the e-logistics strategy and BR with the case of a business renovation project of a petrol company.

2
Business process modeling
Modeliranje poslovnih procesa

The goal of business process modeling is to reach a common understanding about how activities should be carried out (e.g. in which order) and what the business produces It has become largely agreed that knowledge management activities should be integrated within day-to-day business processes to ensure continual process improvement and facilitate learning and the gradual development of organizational memory.

Modeling should be divided into strategic (business), tactical (business-process) and operational (information system, workflow) levels. Business modeling includes an analysis of corporate strengths, weaknesses and culture, the assessment of information systems in

the organization, along with organizational and management competencies. It is the basis of all further actions and is carried out by corporate management. Corporate goals, strategies and critical success factors form the basis of selecting and modeling core business processes at the global level of description. The business process model on the tactical level, together with information on the organization's current state, is fundamental for evaluating and benchmarking vis-à-vis other corporations. Detailed information system modeling of the processes or workflow structures takes place at the operational level. Workflow systems are able to support business processes if the business process is clearly structured and defined [18]. At this level, the more exact and certain information about a workflow is the better the modeling results will be. The problem lies in the conflict of aims arising between the need for accurate information and the difficulties of obtaining it due to the often obsolete documents describing the flow structure, varying or even contradictory statements from the employees, and time constraints [10].

For many years there has been increased recognition in Information Systems (IS) modeling of the dynamic behavior of organizations [9]. Business process models are maps or images of the logical and temporal order of business activities performed on a process object. Business process modeling has been embraced as an appropriate way to describe business behavior. Every process is represented by its precise description, which contains both the behavior and structure of all objects that may be used during execution of the process. Business-process modeling as an approach focuses on understanding the underlying business processes where business rules are one of the most important elements for the detailed and formalized description of all facts or business knowledge, which are to be implemented during business process renovation and IS development [4].

The aims of using business process modeling are: (1) to help the BR team obtain a holistic view of the process under study; (2) to identify areas for improvement; (3) to visualize the impacts and implications of new processes [6]; and (4) to describe the rules that underlie the business process. The enterprise model, such as business process models, captures knowledge, which explains the motivation for the existence of rules [2]. If enterprise models represent process knowledge then we must better understand the role of business rules, the process of knowledge transformation and the extent of knowledge externalization (codification of tacit knowledge) from tacit to explicit.

In knowledge-intensive settings, business processes are typically complex and weakly structured and therefore incapable of being a direct basis for the development of knowledge infrastructures supportive of the business process [32]. To resolve this problem of complexity, some authors propose a rule dictionary [20] or rule repository where business rules [15, 16, 17] and business knowledge have to be represented [12]. This searchable repository where we capture, store and manage business rules is the core of a development environment providing appropriate tools for process, workflow, data and organization modeling, process refinement, as well as import and export capabilities. A rule-repository system also provides the opportunity to put into play capabilities for analysis and simulation [17]. Our experience leads us to the conclusion that a rule-based methodology (as a part of process-based knowledge management) has advantages over established tool-supported Petri nets (i.e. INCOME) and EPC (i.e. ARIS) rule-refinement approaches (described in [1] and [31]).

3
Business Renovation Approach (BRA)

Pristup zasnovan na renovaciji poslovanja

To support the transition between the business model and the IS/WF model, we propose the Business Renovation Approach (BRA) based on a hierarchical derivation of business rules in the rule repository performed by three subsequent iterative development phases, from a higher (behavioral) to lower (structural) level of abstraction. During each of these phases business rules are discovered, documented and modeled.

This approach involves a radical departure from traditional decomposition approaches to IS development. It exploits 'contingency theory' and some advanced ascertaining of the existing business rule approaches [12, 13, 25, 27, 19]. In the context of technology investment, contingency theory suggests that, while technology and organizational practices (such as BPR) may have separate impacts on performance, together the two might also affect performance significantly.

The following example illustrates the different business rule types. At the business level, we can usually find global business rules, such as: "Establish the optimal connections with our suppliers, establish an e-payment system… including supply constraints…" Performing business activity, at the business process level, from these rules a business activity rule is derived: "An invoice, received by mail or received via Internet, may be registered only if it has been received from our existing supplier". At the IS/WF level, the structure of this rule is transformed to (an ECAA notation):

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Business rule: "INVOICE _REGISTRATION":
ON          (invoice) OR (e-invoice)
IF          (related order exists) AND (receipt exists)
THEN        begin invoice registration
            raise event "INVOICE_ACCEPTED"
ELSE        reject invoice
            raise event "INVOICE_REJECTED"
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BRA planning, development and the implementation process (more and detailed about BRA in: [18]) can be divided into several iterative development phases, as follows (Figure 1):

- Strategic BR planning;
- Business process restructuring and information architecture (IA) development; and
- Information system/WorkFlow (IS/WF) development and implementation.

Strategic BR planning implies an attempt to alter a company's strength relative to that of its competitors in the most efficient and effective way. It focuses on the direction of the organization and actions needed to improve its performance. In this process we recognize the (extended) critical success factor (CSF) approach as a beneficial concept and method for companies operating in a dynamic environment with fast-changing customer needs.

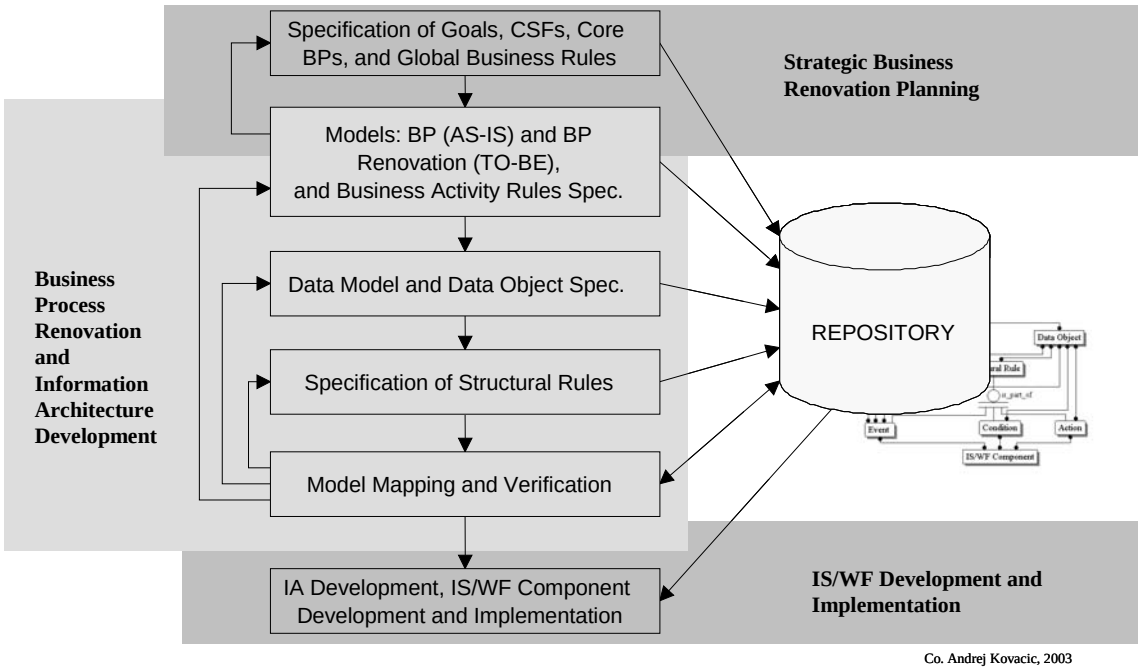

Figure 1: Business Renovation Approach: phases and results
Slika 1: Pristup zasnovan na renovaciji poslovanja: faze i rezultati

The strength of using CSFs is that they provide an important link between the business strategy, business process renovation strategy and the information system development strategy. To be able to establish this link an extended CSF approach recognizes and determines two distinct results: the key information requirements of top executives and business rules or business knowledge statements relating to overall business (global rules). Information requirements and global rules should be written in a business language. They should be concise and clear. They should state the business requirements, not the system requirements [25]. All of these results are captured in the rule repository and used in the next phases of the BR process.

During the **Business process restructuring and IA development** phase the analysis, a simulation of the AS-IS model is performed to reveal the actual time spent and costs of the process activities. The AS-IS model is developed in several iterations. In each iteration the model is validated against the real process in the sense of a process flow by following several process executions, and in the sense of performance by comparing times obtained in the simulations to average times measured for the entire process and its segments. The final AS-IS model is reasonably close to the actual process, with some minor discrepancies resulting from the fact that not all real-life situations can be anticipated and modeled. Finally, the TO-BE model is developed and its efficiency is analyzed.

During this project phase, the information architecture is defined in the second step. Information architecture (IA) is the planning, designing and constructing of an information blueprint which covers the business process rules at the activity level, and satisfies the informational needs of business processes and decision-making. It derives from the TO-BE business process model and the strategic business process renovation plan orientations. This plan is developed in the strategic planning phase. IA calls for full recognition of the importance of business rules and data in the design and development of information systems, and for a perspective that exhibits a balance between processes and the data.

The results of the business renovation and IA development phase are a company's TO-BE business process model (Process Architecture), global data model (Data Architecture), and technological/organizational foundations. The business process model consists of a profile of the main business activities performed, how they are triggered (business events), how they flow in a sequence and how they are executed (business knowledge - business activity rules), and finally the data which are transferred from one activity to the next.

In the phase of **IS/WF development** we presume that a company's TO-BE business process model and global data model developed in the previous phase contains its main business rules and information needs, and is a suitable foundation for further development activities. These activities depend on the company's IS/WF development and implementation strategy (the proprietary (own) development or software packages implementation).

4
Case study - E-logistics
Analiza slučaja - e-logistika

The purpose of this case study is to underline the theoretical findings seen in previous sections. Literature review on Supply Chain (SC) shows that e-logistics is recently widely investigated [3, 21, 22, 30]. The goal of our case study is to show the enhancement of SC maturity [21] with business renovation and knowledge management. Since procurement and fulfillment are the key processes in a SC [23] we decided to show e-logistics transformation of a petrol company. The company decided to renovate due to intense business competition on the market. The business renovation project followed previously described BRA. Since overall business transformation is enormous, only a petrol company's procurement process is shown. A broader description of the case study can be found in [11], whereas here the most relevant aspects of the case are used to explain the theoretical concepts mentioned above.

The case deals with the fulfillment/procurement process in an SC that contains the petrol company (with multiple fuel stations at different locations) and the supplier that transports the fuel to the fuel stations from a few larger warehouses.

The main goals are similar to the usual SC goals: to offer good service to the final customer, while keeping costs and lead-times low. As both the prices and quality of fuel in Europe are regulated, the main quality indicator is the number of stock-outs. The main KPI's and cost drivers are therefore: number of stock-outs, stock level at the fuel station and process execution costs (work, transport etc.). Lead-time is defined as the time between the start (measurement of the stock level) and the end (either the arrival of fuel or the decision not to place an order) of the process.

The description of the current process is as follows: the stock level is measured manually once a day. The results are faxed to the purchasing department that collects information from all fuel stations. It predicts future demand, while taking seasonal and cyclical movements into account. An additional consultation with a fuel station manager is possible, if needed. The needs of several fuel stations are merged into one order. Tacit employee knowledge is used to make and optimize orders and transport routes.

The analytical department controls possible changes in demand and supply patterns and transport routes. If necessary, it can adjust or cancel orders. After that, the order is sent to the transport company – this is also the first information given to the transport company about the needs. The order has to be fulfilled with the available fleet, but cannot be modified. Financial compensation is paid to the transporter for its services based on the number of miles driven, fuel delivered and punctuality of deliveries.

While the description focuses on one typical fuel station, the inputs from other stations are also taken into account at various points in the model. Most importantly, the capacity of each truck is considerably higher than the needs of one station so orders from different stations are usually merged into one. Obviously this is a specific case study with a standardized product and only one supplier so the results cannot be generalized to other industries without caution.

4.1
Process modeling
Modeliranje procesa

The captured information provided a solid base for developing a preliminary AS-IS model of the process. The experience of using different business process modeling and simulation tools (ARIS, Income, iGrafx Process) in our research practices shows that, due to the great insensitivity of communication with employees, simplicity and understandability may be assumed to be some of the most important advantages of the modeling technique. In addition to its simplicity, the iGrafx Process (Discrete Event Process Simulation package) was selected as it integrates powerful and complete discrete-event simulation functions. Process analysis was divided into process decomposition that enables an overall and distinct analysis for business processes and process dependency analysis that analyzes interrelationships among processes.

Process maps were used for visualization of the model. Process maps are the standard method for modeling and analyzing in business renovation. One of their main advantages is that employees can be quickly taught how to develop and validate these models [6]. They enable analyses of the costs and time needed for the process. The Igrafx Process 2003 with a graphical user interface was used – such an interface enables an easy understanding of everything involved in the

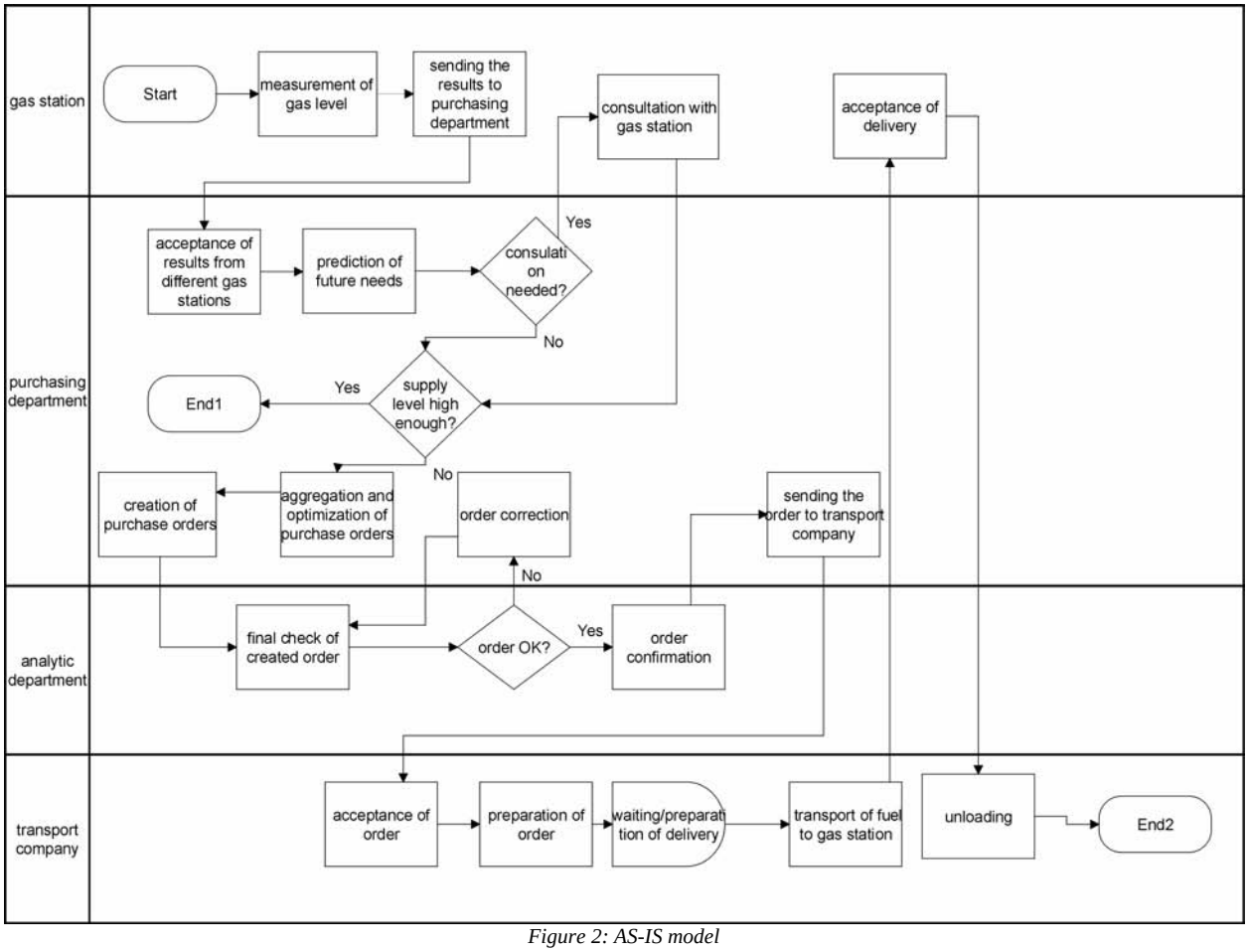

Figure 2: AS-IS model
Slika 2: Model AS-IS

project [4] – this is especially vital in a SC context as employees from different companies must understand the developed models.

Based on the description above the AS-IS model was developed (Figure 2) and validated by employees in both companies.

The developed business model helps us understand the current problems and also makes them more visible to all decision-makers in both companies.

The main problems identified on the tactical level are:

- the stock level cannot be measured accurately with a measuring stick since the tank always contains some water (the exact quantity of water is unknown);
- the communication between various departments and companies is costly (using telephones, fax machines etc.): and
- the transport company's trucks are not fully utilized.

However, even bigger problems are found on a more strategic level, such as:

- the flow of information in the process is slow and costly; also the process is not being executed efficiently;
- full information is not available when making a decision (e.g. the purchasing department does not have much information about the truck fleet);
- the prediction of future demands is approximate, based on human tacit knowledge;
- human limitations prevent the decision-maker from using all available information (e.g. stock levels at all petrol stations);
- each member in the chain is trying to attain its local optimum instead of the global chain's optimization; and
- consequently both the stock levels and transport costs are higher than necessary.

Business modeling plays the role of a facilitator of changes. It helps identify some of the above mentioned problems. In connection with business process simulations it also helps measure the benefits of the changes.

As the current state of processes is now clear to all those involved (employees in both companies and various departments), it is easier for them to suggest possible improvements to the model and consequently convince them to accept necessary changes. Human resistance is usually one of the main hindrances in the implementation of changes [5].

In the process modeling we focused on knowledge flows in which knowledge was transferred from one activity to other activities. It is crucial to model and manage knowledge flows among knowledge workers. Lacking a business rule and business process repository (tool), the petrol company's intranet was used for capturing and presenting documents (process models and related documentation). Regarding the incompleteness of the captured documents the missing information was added through an additional interpretation by the process owners.

The capturing of information about the process and their modeling is a difficult and time-consuming task which lasted for almost six months. The models had to be changed several times. Finally, a modeling of the renewed processes (TO-BE) was performed and organizational changes were proposed.

4.2
Process renovation
Renovacija procesa

Based on the mentioned problems, several improvements were proposed. The main change is that the processes at both companies are now integrated and the supplier takes responsibility for the whole procurement process. The renewed business model is shown in Figure 3.

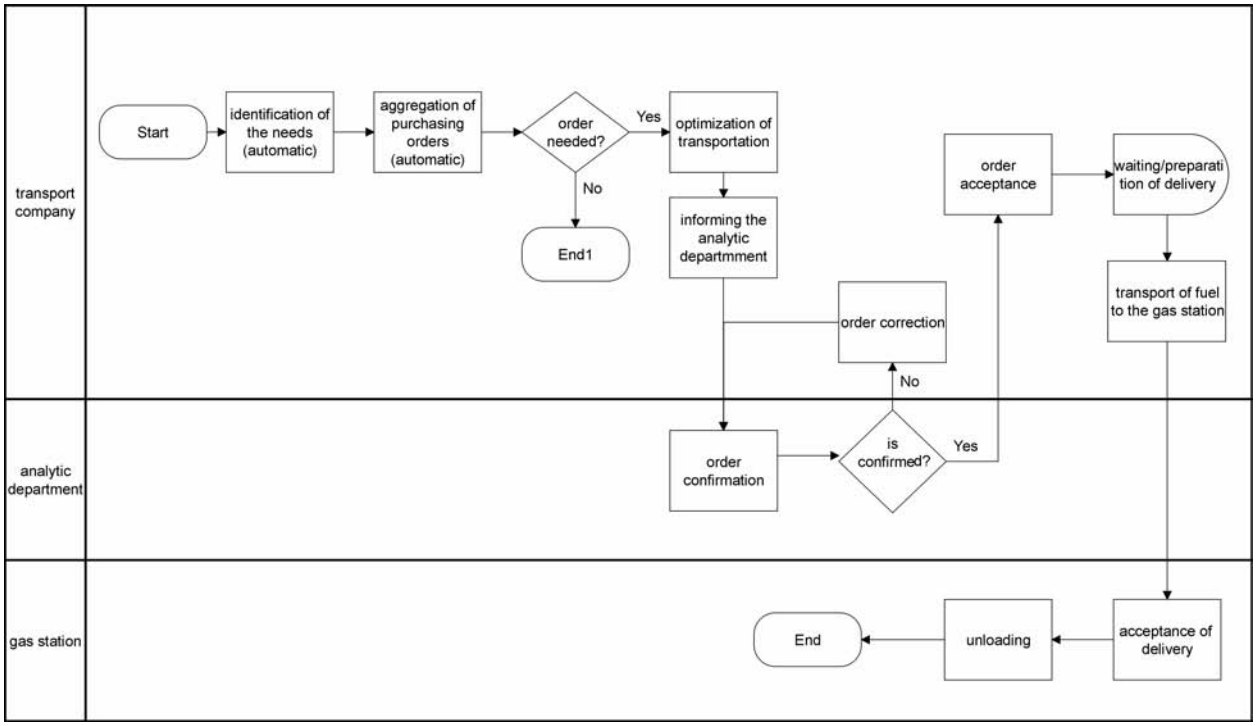

Figure 3: TO-BE model
Slika 3: Model TO-BE

Although all phases are supported by IT, deep structural changes were needed to fully realize the potential benefits. Some of the proposed changes can be described with the popular buzz-word 'vendor-managed inventory' (VMI), others with material requirements planning, data mining, operations research and everything can be gathered under the umbrella term SCM. It is, however, the interconnection of those changes that brings about the desired benefits.

The main idea is that the transport company takes a strategic role in providing a sufficient inventory level to fulfill the demand of the end customer. It takes all important decisions regarding orders in order to realize this goal.

The proposed changes are:

- the measurement of petrol is now automatically; the stock level information is exact;
- the stock levels from all fuel stations are instantly available to the transport company;
- future demand is predicted using the model based on neural networks;
- the system at the transport company automatically

identifies the current levels of stock, predicted future needs and suggests possible orders and delivery distribution among different petrol stations;
- the final decision is made daily by an employee in the transport company and is approved by the petrol company;
- operations research methods (e.g. the vehicle routing problem) are used to optimize transportation paths and times (see [7]) for a detailed description of such a system); and
- in the long-term the locations of the warehouses can also be optimized.

Further advantages not directly visible from the figures include:
- due to the use of optimization methods with full information available the transport is more efficient;
- similarly, the activity 'preparation of delivery' is shortened and mostly automated; and
- the predictions of future demand are considerably improved - from a decision based on tacit knowledge to the developed neural networks. Therefore, the real demand deviates less from the estimate than previously.

The role of IT in all these suggestions is crucial. An automatic system for the measurement and communication of current levels of stocks at all stations, neural networks, computer-assisted operation research methods etc. enable the changes.

4.3 Measuring the effects
Mjerenje učinaka

The effect of the changes can be estimated with a simulation of business processes (the methodology, advantages and some problems of this approach are presented in depth in [4]) and simulations of supply and demand. The results of the simulations enable the measuring of the effects of possible experiments in business process models.

With the first simulation we estimated changes in process execution costs, lead-times and employee workloads. The methodology used [4] does not enable the direct measurement of the quality of the process and/or its outputs. Therefore, a second simulation was used to estimate changes in the quality and level and costs of stock.

Both simulations are especially important as they enable us to estimate the consequences of possible experiments. The possible benefits of such changes have to be carefully weighed up against the costs needed to make those changes to find out the business feasibility of such changes (as shown in [11]).

First a three-month simulation of both the AS-IS and the TO-BE model was run. In the AS-IS model a new transaction is generated daily (the level of petrol is checked once a day), in the TO-BE it is generated on an hourly basis (the level of stock is checked automatically every hour). In the AS-IS model the following employees take part: analyst, purchasing worker, fuel station manager, fuel station worker, transport worker and driver. Their hourly wages are considered in the model. In addition, transport vehicle (road tanker) costs are included in the simulations of the model. In the TO-BE model the fuel station manager and purchasing worker are no longer needed.

The simulations enable the measuring of both the effects on the SC as a whole and at each company and department involved. The cost of each activity or subprocess can also be estimated.

The convincing results are summarized in Table 1. The label 'Yes' refers to those transactions that led to the order and delivery of fuel, while the label 'No' means a transaction when an order was not made since the fuel level was sufficient.

Table 1: Comparison of simulation results for the AS-IS and TO-BE models
Tablica 1: Usporedba rezultata simulacije za modele AS-IS i TO-BE

transaction	no.	av. lead-time (in hrs)	av. work (in hrs)	av. wait (in hrs)	av. costs
Yes (AS-IS)	22	29	14	14	$1054
No (AS-IS)	67	5	5	0	$82
Yes (TO-BE)	22	11	6	5	$320
No (TO-BE)	1058	<0,01	<0,01	0	$0,09

The average process costs are reduced by almost 70 %, while the average lead-time is cut by 62 %. From this it is clear that this renovation project is justifiable from the cost and time perspectives, while the quality changes cannot be directly measured with these business process simulations.

Another interesting observation is that even every NO transaction in the AS-IS model costs $82 for every fuel station each time (that is on a daily basis). These costs are due to the time and costs needed for communication, consultation and decision about orders, even when an order is not placed. They are almost completely removed in the TO-BE model due to changes in the process and automation of those activities.

The simulations also enable an estimation of the benefits for each department or organization. While we seek a global instead of a local optimum, it should be noted that a single company is unlikely to become involved in such a renovation project unless it can expect benefits for itself. The results in Table 2 show that both companies can realize important savings – the results can be used to convince them of the justifiability of the project. The main savings are realized by the petrol company, while the transporter also makes considerable savings that are, however, smaller because it has to take responsibility for some activities previously performed by the petrol company.

Table 2: Total costs per department (3 months)
Tablica 2: Ukupni troškovi po odjelu (3 mjeseca)

Department	AS-IS	TO-BE	Index TO-BE (AS IS =100)
Analytic department	$51	$72	141
Fuel station	$866	$168	19
Purchasing department	$8070	$0	0
Fuel company total	$8987	$240	3
Transport company	$19686	$6903	35

The results of the simulations of the AS-IS model are approximately in accordance with the current state of the company, which further validates the model. The transfer and utilization of information drastically reduces the costs, lead-times and employees' workload, while smaller and more frequent orders have the strongest influence on inventory levels and costs. Yet it should not be forgotten that the process changes and reduction of process costs enable more frequent orders in the first place.

5
Conclusion
Zaključak

In the paper we analyzed the main aspects needed for the successful knowledge management on the foundations of renovation, integration and operation of SCs. The core idea is that the successful implementation of SC integration projects is not as much a technological problem and that a thorough study of the current and desired states of business processes in all companies involved is required. To resolve deficiencies of knowledge management and process orientation techniques that arise in practice we propose a concrete approach to analyzing knowledge based on business processes.

This case confirms that the analysis and carefully used simulation of business processes is indeed useful since it provides insights into the policies, practices, procedures, organization, process flows and consequently shifts people's minds from a functionally- to a process-oriented organization. The proposed business renovation approach is valuable for understanding business rules and the relationship between knowledge and the processes, while the process model works as a knowledge mediator between a knowledge worker and their successor. The proposed approach is conceived out of the need to facilitate the capturing and navigating of the knowledge required to carry out business processes.

Our study has some limitations. Decomposition rules for knowledge flows need to be investigated, and they should be included in the proposed knowledge repository. In the future, we expect this work to be more oriented towards further research on the implementation of a process-based knowledge management system.

6
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