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# THE STRATEGIC APPROACH TO ERP SYSTEM DESIGN AND IMPLEMENTATION

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*The use of modern information technologies (IT) will be successful only if information system (IS) development is closely connected to a business processes development strategy. Despite the fact that ERP systems are complex application packages with full functionality, they cannot be implemented immediately "from the shelf". The only way to maximise business effects, using modern IT for enterprise resources planning, is through the deliberate and extensive alignment of ERP capabilities with the business system (BS) development strategy. In this way, support for the business processes and enterprise resource planning (ERP) can be maximised. Such an approach is usually regarded as the* ***strategic planning of the information systems*** *(SPIS). There is no unified methodology which could be applied while performing SPIS. There are several methods, techniques and templates that should be inventively integrated to develop an optimal approach to ERP system design and to develop the implementation development of each particular manufacturing system. Thus, SPIS and ERP implementation appear as two parallel and closely connected projects, and the main outcome is a reengineered business system, supported by modern IT.*

*This paper illustrates how this integration of SPIS and ERP can be performed in order to obtain a consistent methodology. This methodology has been proved and applied in six large-scale projects in very different business systems. In this way, the theoretical approach was confirmed and extended by the new experiences presented in this article.*

**Keywords:** strategic planning, enterprise resource planning, information system, business process re-engineering, methodology.

## 1. Introduction

Discussions about IT implementation and IS development for production-oriented business systems might seem old-fashioned, insufficient, or not useful. Despite the challenge of discussions about the "post-industrial" or "information" society, and the ever increasing role and significance of the "service sector" in overall economic activities, we must not forget, not even for a moment, that those attributes can only describe those societies which will be able to continually meet their members' demands. Production, in any case, is the only economic branch that delivers new material goods. So, production is the basis and precondition for social prosperity; it is the pre-condition for people's existence and thus the pre-condition for the information society. A marketing orientation and an improvement in the efficiency of production

systems are an improvement points of major interest for the new Central European democracies that have a long industrial tradition and educated inhabitants, but they are miles away from their West European equals when you compare them in terms of modern industrial management and business management. Based on these facts, let us discuss this problem once again, with both a general approach and by looking at it from a different point of view.

For the future development of human society, it is necessary to increase continuously requested production volume ($V_r$). Each year, more and more material goods should be produced because there are more and more people ($P$) and because of increases in demand ($D$). In general, this could be written as:

$$V_r = f_1(P,D).$$

On the other hand, the possible production volume ($V_p$) depends on the availability of natural resources ($R$), on overall production knowledge ($K$), and on those human resources ($H$) that will be incorporated into production:

$$Vp = f2(R,K,H).$$

The upper functions are monotonically increasing functions defined for all the positive values of the independent variables. If we equalise the requested and the possible production volumes

$$f1(P,D) = f2(R,K,H),$$

then the result that was obtained is a very interesting equation for qualitative consideration. As natural resources ($R$) are restricted and the number of people who will deal with production ($H$) decreases, then the increasing demand for produced goods can be provided only by continuously increasing the knowledge ($K$) implemented in production. Here we are considering overall production-technology knowledge and also knowledge about the efficient management of complex production-business systems. Therefore this is the reason for the extremely close interrelation betwen IS development strategic planning and the ERP selection, design and implementation, according to the methodology presented in this paper.

## 2. Present State of Information System Strategic Planning Methodologies

The strategic planning of information systems has become a very challenging subject for scientists and practitioners in recent years. Research conducted by Berndt and Morrison [1] shows that investment in IT gives a much lower ROI than initially expected. According to recent studies, there are two main reasons for the relatively poor contribution of IT to increasing the efficiency of manufacturing systems, even in situations where the IS works well technically.

First of all, companies use modern IT to automate old, ineffective processes [14]. Therefore, Hammer and Champy advocate that the capabilities of modern IT should be used to radically redesign business processes in order to achieve dramatic improvements in their performance. However, real BPR projects have performed with an unacceptable failure rate of nearly 70% [15]. Thus, IS planning and the application

of modern IT cannot be exclusively performed by IT experts, but it becomes the fundamental problem of the enterprise management [19].

Secondly, it is not generally accepted that ERP should be considered more as a business process rather than a technology initiative [12]. The actual benefits that could be achieved from successful ERP implementation come from what will change within the business processes. Implementing a fully integrated ERP system requires process-oriented organisation and highly synchronised processes throughout the whole organisation.

In the early nineties Earl [10], [11] determined certain rules in IS/IT planning and presented them as five-phased evolution models. Different authors [7], [9], [13], [23] explained the problems concerning the appropriate use of IT and IS planning in business enterprises. Therefore, it might be concluded that up until 1995 the problem of efficient IT usage was recognised, and several papers that were published presented techniques, methods and directions which might be used during the planning stage. However, there was no consistent methodology for the strategic planning of information systems.

Another approach to boost the overall efficiency of business systems appeared in the second half of the nineties with the famous Hammer book [15] that introduced BPR. Soon after, other authors [28], [24], [26], [27] emphasised the relationship between business strategic planning and IS development. At the same time, several methods and techniques were published [25], [28], [29] to enhance successful IS/IT planning in enterprises that had a strategic vision for their development [17], [22]. These methods can be put into three groups. The first group presents the methods that were dedicated to specific problems related to IS planning such as BSP, Ends-Means analysis, and CSF analysis. The second group of methods had already been used in business planning and were just modified for SPIS (e.g. 5F method, SWOT, BCG analysis [20]). The third group of methods was based on BPR (e.g. Value Chain). These groups of methods, along with any others that might be useful for strategic ERP system design and implementation are concisely presented in *Table I* and *Pictures I and II,* and are described in the following sections.

According to previous observations, we have to conclude that ERP system implementations must be part of the IS strategic planning within each particular organisation. This strategic plan has to answer the question *what has to be done to fulfil the organisation's mission and long-term goals,* i.e.:

- *Which business functions are critical for the development and business success of each particular organisation?*
- *Should BPR be performed and how exactly should it be carried out?*
- *Should the ERP system be developed by the organisation's own resources or should it be outsourced?*
- *Should it be developed as special software for a particular organisation, or should it be bought off the shelf and adjusted to particular business processes?*
- *How are the organisation's system performances to be measured before and after BPR?*

For the successful implementation of a new SPIS methodology, an exact definition of the strategic planning of the information system should be adopted. Based on the theoretical elaboration presented in the papers we mentioned earlier we can use the following definition:

**Strategic planning of the information system** (SPIS) is the long-term planning of the useful effects of the information system and the application of information technologies aligned with the strategic planning of the overall business system development. The result of this procedure should be a documented project that contains:

- An organisation model of the existing and re-engineered organisation
- A business process model
- A business data model
- A technical resources model
- A development activity plan for the new IS.

According to this definition, a new SPIS methodology was developed and theoretically elaborated in [2], [3], [4], [5]. At the same time, it was practically implemented in various enterprises with remarkable results. A brief description of the SPIS methodology is presented in the following sections.

## 3. Strategic Planning of an Information System Methodology Framework

A large number of methods and techniques used in the planning and design of information systems have been discussed theoretically and applied practically. It is important for a designer, when designing a particular IS, to fully recognise the goals, characteristics and principles of a business system functioning. Information system strategic planning and designing needs a proper methodology. The methodology proposed in this paper has been developed by choosing, grouping and linking proper methods and techniques, as shown in *Table I.*[1] The proposed SPIS methodology consists of specially chosen and specifically interrelated methods and techniques that are gradually applied to perform individual steps, while modelling the entire information system. The basic SPIS methodology propositions are:

- ***The reason for every aspect of business re-engineering is to improve system performances,***
- ***IS development should realise the goals that were planned,***
- ***The goal realisation level should be measurable.***

[1] Usability of methods:

Very powerful–methods or technique giving clear and strong conclusions about the object system functioning. Should not be avoided in suggested methodology step (e. g. Value chain model in step 2.).

Powerful – method or technique giving clear conclusions about object system functioning from different aspects or verifying reaching results (e. g. Life cycle v. s. Affinity matrix in step 6.).

Useful–method or technique giving a clearer or more detailed approach to observing the object system. Its application is useful, but without new crucial results (e. g. Decision trees and tables in step 7.). It could be avoided.

Table I: SPIS methodology as connections between problem-solving steps and those methods used

| **Problem/step in IS design** | **Methods and techniques** (§ -strategic, # -structured, ¤ -object oriented) | **Inputs and deliverables** *Inputs* / Outputs | **Usability** Very powerful V, Powerful, P, Useful U |
|---|---|---|---|
| 1. Description of business system (BS) | Interviewing | *Missions and goals of current BS* / Business strategy; Business processes (BP) | |
| 2. Evaluation of the impact of new IT on the business system | § Balanced Scorecard<br>§ BCG-matrix<br>§ 5F-model<br>§ Value-chain model | *BP* / Performances of existing BS<br>*Business strategy* / IS development priorities<br>*Business strategy* / Information for top-management<br>*BP* / Basic (primary and support) business processes (BBP) | V<br>P<br>U<br>V |
| 3. Redefinition of business processes | # BSP-decomposition<br># Life cycle analysis for the resources | *BBP* / New organizational units (OU)<br>*Basic system resources* / Business processes portfolio | P<br>P |
| 4. Business system re-engineering | § BPR<br>§ SWOT | *Business Processes Portfolio* / New business processes (NBP)<br>*Business Processes Portfolio*/ SWOT analysis for NBP | P<br>V |
| 5. Estimation of critical information | § CFS analysis (Rockart)<br># Ends-Means analysis | *NBP* / Critical information for NBP<br>*NBP* / Information for efficiency and effectivity improvement | P<br>U |
| 6. Optimization of new IS architecture | # Matrix processes-entities<br># Affinity analysis, Genetic algorithms | *NBP / Business process relationships*<br>*Business processes relationships* / Clusters; Subsystems of new IS | V<br>P |
| 7. Modeling of new "Business Technology" (BT) | # Work flow diagram (WFD)<br># Organizational flow diagram (OFD)<br>#Activity flow diagram (AFD) | *NBP* / Responsibility for NBP<br>*New OU* / Flows between new OU<br>*NBP* / Activities for NBP | V<br>P<br>U |
| 8. Modeling of new business processes, supported by IT | # Data flow diagram (DFD)<br># Action diagram (AD) | *NBP* / NBP supported by IT (IS processes); Data flows; Business Data<br>*IS processes* / Internal logic of IS processes | V<br>P |
| 9. Evaluation of new IS effects | # Simulation modeling | *IS processes* / Guidelines for BP improvements | U |
| 10. Business data modeling | # ERA-model<br>¤ Object-model | *Business Data* / ERA model<br>*Business data* / Objects model | V<br>P |
| 11. Software design | # HIPO- diagram<br>¤ Transition diagram | *IS processes* / Logical design of program procedures (SW)<br>*Data flows* / Events and transactions | V<br>P |
| 12. Detail design of programs and procedures | # Action diagram<br>¤ Object scenario | *Logical design of program procedures (SW)* / Model of program logic<br>*Object model; Events and Transactions* / Objects behavior | P<br>P |
| 13. Data model development | # Relational model; Normalization | *ERA model* / Relational model | V |
| 14. Software development | # CASE tools and 4GL<br>¤ OO-CASE tools | *Model of program logic; Relational model* / Programs and procedures<br>*Object behaviour* / OO-procedures | P<br>P |
| 15. Implementation of new IS | Case-study; Business games | *Programs and procedures* / Performances of new IS | P |
| 16. Evaluation of new BS performances | # Balanced scorecard | *Performances of existing BS; Performances of new IS* / Measure for success | V |

It is impossible in this paper to discuss all the SPIS methodology steps in detail (these parts are discussed in [3], [4], [5]. Here we want to point out the major characteristics of the SPIS methodology:

- The starting point of the SPIS methodology is an analysis of the present business system and a definition of its future mission and main goals;
- The second methodology step examines those function areas where new IT could show the best contribution it can make towards the efficiency of business processes;
- Step 9 (central in relation to all the steps) presents an evaluation of the effects of the new IS on future business processes. This evaluation should be performed using the simulation model (developed from the IS conceptual model) before starting the long-term and complex project of maintaining the IS.
- The 16th step controls and confirms the effects of investment in the new IS/IT.

During the second step, *Evaluation of the impact of new IT on the business system*, system performances and an evaluation of the IT influence on the improvement of business processes are derived together with the information needed for the realisation of business goals. These issues are the basis for the redefinition of business processes supported by modern IT.

The 9th step, *Evaluation of new IS effects,* presents a measurement of the satisfaction with the effects of the proposed IS conceptual model and generates the parameters for the improvement of business processes. If the new IT increases the effectivity of the business system sufficiently, then the process for choosing or developing the new IS could start.

The 15th step, *Implementation of new IS,* deals with the implementation of a specially developed new IS or a chosen ERP system of a known SW producer. So, the stage *Detail design of IS* could be provided or avoided by chosing a proper ERP system during its implementation [16], [21]. The validation of new IS effects will resolve the dilemma: if we did, or did not, perform the proper action to obtain the necessary improvements. The second item, *Evaluation of new business system performances*, deals with the measuring of the performances of the new business system. The performances of the new business system are measured after the implementation of the new IS/IT and are compared to the business system performances that existed before the investment in BPR and ERP/IS.

## 4. SPIS Methodology Meta-Model

The activities described in *Table 1* form the following characteristic stages:

- Formalisation of the Business Model,
- Conceptual Design of the IS Model,
- Detail Design of the IS, and
- Implementation of the new IS.

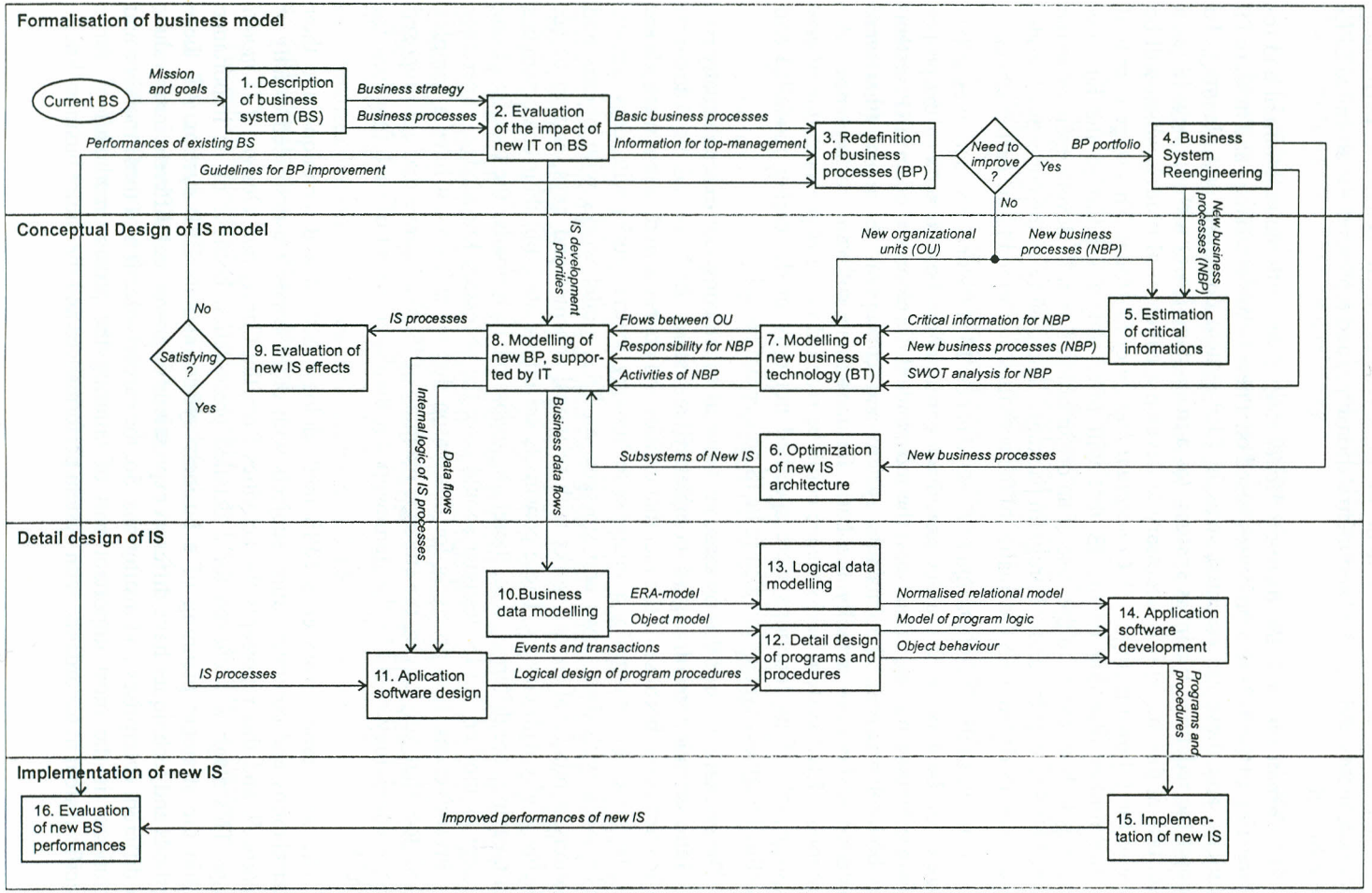
*Picture I* describes the content of these stages (their activities, performing sequence, inputs, deliverables and interrelationships) and represents the so-called SPIS Meta-Model.

The *Formalisation of the Business Model* stage deals with the redefinition and re-engineering of the business processes based on a new business strategy and modern IT solutions, and these are essential steps in ERP system designing and planning. To support the redefined **business system** (as a main stage issue) with the new IS (as a main task at this stage) it is necessary to develop a **conceptual model,** which will be done in the following stage - *IS Conceptual Design of IS Model.* This stage is critical for the further planning of the IS that will offer proper support to the business processes in both cases: in the case of an organisation's own IS development or in the case of buying it as a standard program package. The quality of the conceptual model for the new IS depends on the quality of the activities performed in the earlier stages.

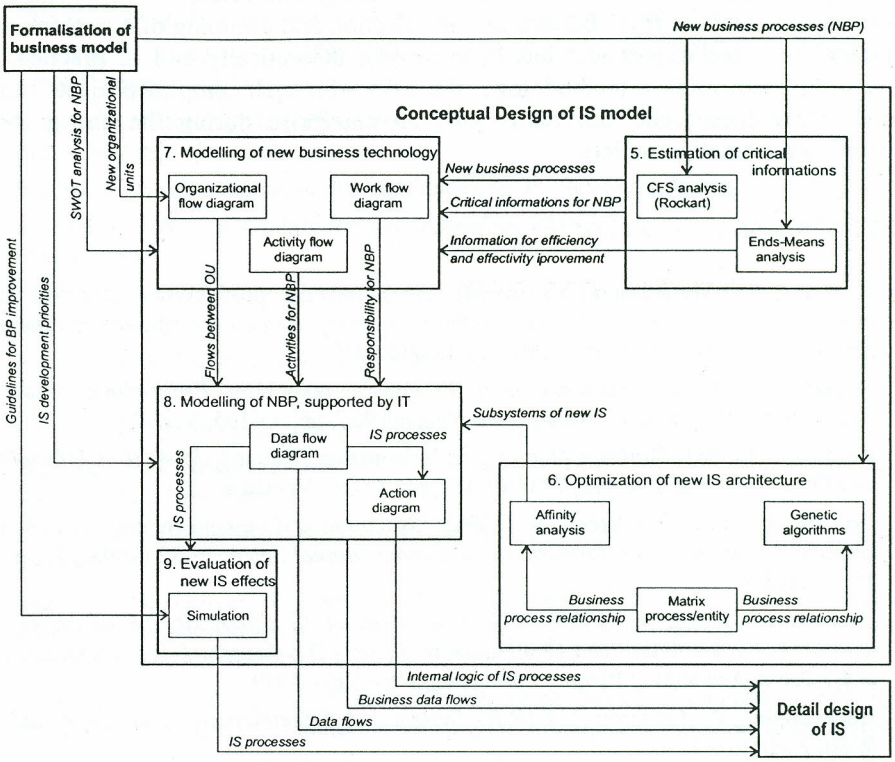
The result of the *Detail Design of IS stage* is new **IS software**. The activities in this stage could be avoided if the decision made earlier about how to achieve the proper software favours buying rather than the independent development of an ERP system. For both alternatives, the business system and conceptual IS model (that were modelled earlier) are actually the basis for measuring software performances. An appropriate **ERP system** performance could be reached in the *Implementation of new IS* stage only if its functions were specified not only in the earlier modelled and redefined business system but also in its IS conceptual model.

The critical points of this process, i.e. those to which computer experts usually pay too little attention or disregard completely, are steps 2, 3, 6 and 9. Additional difficulties occur because of the fact that entities and concepts in different methods are not the same. For example, a business technology matrix works with data classes, DFDs work with data flows and storages, an ERA-model works with objects and relations, a relational model works with relational schemes and keys, and an object scheme works with classes. These constructs are interrelated, but their characteristics and meanings are different. It is, therefore, impossible to formalise the transfer of one concept to another. An IS designer should have the necessary knowledge, experience and inventiveness. It is precisely for this reason that we still do not have a complex CASE tool that fully covers the strategic planning of IS. We believe that our proposed SPIS methodology could be the framework for the development of such functions for ICASE.

The deliverables from each SPIS methodology method and technique and their interrelations and communication subjects with other stages are described exactly in *Picture II*, and this represents the activities from the *Conceptual Design of IS model stage*. This stage was chosen for a detailed presentation because of its importance within the strategic planning of a business system and its ERP system. All these methods and techniques have different expressions of power and different issue values for different enterprises and institutions. So, the careful selection of these methods and techniques is the most important part of tailoring the precise methodology for a specific system in accordance with system performances and the future business line.




Picture I. SPIS Methodology Meta-Model




Picture II: Activities, providing methods and techniques, input and deliverables at the Conceptual Design of IS Model stage

## 5. Conclusion

The importance of production justifies any effort that may increase the efficiency of any kind of production system. That is the reason for the extremely close interrelation between SPIS and ERP selection, design and implementation. In this way the limited resources of all kinds of companies are engaged at the same time in order to reach optimal business results. For these reasons we need the strategic and operative planning for all of the resources of a company.

In order to succeed, enterprises have to change the perception they have of IT as being a way of automating old processes. The real approach is to perform a strategic planning of the information system and to streamline the usage of IT with the business strategy. The whole business system must be analysed and reengineered in order to synchronise the information system and the business processes. To achieve such a high performance target, significant efforts must made. The challenge here is even greater if a company introduces a standard ERP system, since its ability to change is limited.

This paper has presented a complex methodology that relates to SPIS and ERP system implementation. It is obtained by the selection and grouping of a large number of methods and techniques and has been proven theoretically and in practice. By applying the prementiened methodology, the risks with such complex projects can be significantly reduced, and can really lead an enterprise during the change from industrial to information society.

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## STRATEŠKI PRISTUP OBLIKOVANJU I PRIMJENI PRP SUSTAVA

### Sažetak

*Upotreba modernih informacijskih tehnologija (IT) bit će uspješna samo ako je razvoj informacijskog sustava (IS) tijesno povezan s razvojnom strategijom poslovnog sustava. Usprkos činjenici da su sustavi za planiranje resursa poduzeća (PRP sustavi) složeni aplikacijski paketi pune funkcionalnosti, ne mogu se primijeniti odmah "s police". Jedini način maksimalizacije poslovnih učinaka, korištenjem modernih IT za planiranje resursa poduzeća, je putem promišljenog i sveobuhvatnog usklađivanja mogućnosti PRP sustava s razvojnom strategijom poslovnog sustava (PS). Ovakav pristup obično promatramo kao* ***strateško planiranje informacijskih sustava*** *(SPIS). Ne postoji jedinstvena metodologija koju je moguće primijeniti prilikom izvođenja SPIS-a. Postoji nekoliko metoda, tehnika i predložaka koje je moguće inventivno integrirati u svrhu razvoja optimalnog pristupa oblikovanja PRP sustava i procesa uvođenja za svaki pojedini proizvodni sustav. Tako se primjena SPIS-a i PRP-a javlja kao dva usporedna i čvrsto povezana projekta, a glavni njihov rezultat je restrukturirani poslovni sustav podržan modernim IT.*

*Rad prikazuje kako je ovakvu integraciju SPIS-a i PRP-a moguće provesti uz pomoć konzistentne metodologije. Predstavljena metodologija dokazana je i primijenjena na šest opsežnih projekata u vrlo različitim poslovnim sustavima. Na taj način je teoretski pristup potvrđen i proširen novim iskustvima prikazanim u ovom* radu.

**Ključne riječi:** strateško planiranje resursa poduzeća, informacijski sustav, restrukturiranje poslovnih procesa, metodologija.