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Dynamic Aspects of the Strategic Planning of Information Systems

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Abstract

The SPIS methodology provides methods and techniques of developing an information system (IS) that would correspond with the requirements of an organization. The result of its application is the strategic plan of IS development that would meet the future needs. As is the case in the methodology of the strategic planning in general, the primary drawback to the strategic planning of the information system is the lack of efficient control of implementation of the strategic plan, and this is precisely what this research paper deals with. One of the procedures in the measuring of results of an organization, which is also recommended by the SPIS, is the Balanced Scorecard methodology (BSC). However, the BSC concept which the classic SPIS methodology recommends as suitable for the evaluation of performance of the information technology (IT) on the business system and the performance of that new business system, does not take into account the constraint that may lead to non-implementation of the planned activities. Furthermore, the BSC has been criticized for the oversimplified modeling of the cause-consequence relations that do not take into account the time delay and the feedback.

This paper provides results of the research that resulted in identification of two types of constraints that need to be included when determining the optimal IS/IT strategy. Within the context of the system dynamics (SD) approach, the broadening of the problem with the analysis of the strategy implementation dynamics results in the new practical knowledge about the control over the time-dependant values and, consequently, with a proposal that would eliminate the reasons for the abovementioned criticism.

Keywords: Business system, Information system, SPIS methodology, BSC methodology, System dynamics

1. Strategic planning of information systems

One of the questions that modern managers are faced with is how to align the development of IS with the business strategies for achievement of critical business goals of the organization. This is precisely why a great number of papers in the relevant literature are based on opinion surveys, case studies and conceptual studies.

Strategic planning was first introduced to the business information systems in the late 1970s. The researches related to the strategic planning of information systems were primarily focused on the conceptual framework of the very process of the strategic planning of information systems, known as the Strategic Information System Planning (SISP) methodology [17]. SISPcan be defined as a process that identifies the computer based application portfolios which help the organization to execute its business plans and realize

business goals [8]. SISP includes identification of IS applications, development of IT infrastructure, enhancement of the management of IS/IT functions, and detection of IT resources [13]. The SISP methodology has attracted a considerable attention of researchers who have published more than 200 papers on the subject over the last three decades [20], making it one of the greatest challenges in the field of the information systems management [18]. However, the criticism of the SISP methodology points at a gap between the research approach and the practice. In his research [18] Taubner establishes that the SISP methodology is not widely used as a support in the practical implementation, thus ignoring the academic literature [18]. Hevner, Berndt and Studnicki point at the problem of the inter-specification gap amongst the specification requirements and details necessary for the implementation [10]. The Integrated Strategic Information System Planning (ISISP) methodology proposes a combination of topdown and bottom-up methodologies in the context of the SISP [17], which would bridge the said problem.

The existing methods and techniques have lately been used to enhance the strategic planning of information systems in the organizations that have adopted the strategic vision of development [16,22,11,15]. According to Tianmei and Baowe [19], it is possible to classify them in three groups. The first group includes those that deal with specific problems of the IS planning, such as the BSP (Business System Planning) or CSF (Critical Success Factor) analysis. The second group includes methods of strategic planning that are adjusted to the field of information management, such as: the 5F method, the SWOT, the Balanced Scorecard (BSC). The third group of methods is based on the BPR. The comparative review of the above-mentioned methods is given in the paper of Tianmei and Baowe [19].

An example of their consolidation in the form of the methodological approach toward the problem solving steps and their application is given in the working framework of the Strategic Planning of Information system (SPIS) methodology [7]. The SPIS is based on the holistic approach. This means that when planning the IS impacts on the business system, the organization is perceived as an open system which interacts with its environment through its subsystems, with the strategic development of the organization as its ultimate goal.

2. Planning of IS/IT impacts on the business system

Considering the information system as a subsystem within an organization, one should be aware of its role in enhancing the information and material processes in the organization. Generally speaking, the entire functioning of the organization is based on the execution of a number of interconnected processes known as business processes[1] or business technology [4]. By singling out the common features of the process at the management supervision and execution levels, it is possible to identify the subsystems of the same name in mutual interaction. According to [4], the role of the IS at the execution level is to step up work productivity. As for the function of supervision subsystem, its IS should ensure that necessary information are collected from the execution and management subsystems in a timely manner, which will make its role complete and that is, according to [3] to increase the efficiency of the organizational system. In line with the basic function of the management subsystem, and that is the setting of business goals, the purpose of its IS is, according to [3] to ensure the stability of growth and development of the organization. The optimally organized processes and organizational flows, aided by new information technologies, should enable faster adjustment of the organization to the newly arisen circumstances and, consequently, better results of the strategy i.e. implementation of the organization's strategic plan. On the other hand, the application of IS/IT also depends on the environment: the competition, the suppliers, the clients. The development of the role of IS/IT in business systems is marked by the development of criteria for the selection of IS/IT within the framework of the organizational strategy.

[1] Business process is a set of interconnected activities and decisions aimed at accomplishing partial goals, exploiting certain resources and time and being of use to a buyer or service user [2].

2.1. Basic tenets of the SPIS methodology

The relationship between the strategies and the impact of the external and internal environment in the context of the methodology of the strategic information system planning (SPIS) is given in [5]. By drawing a line between the organization's information system development strategy (IS strategies) and the information/technological subsystem development strategy (IT strategies) in the context of the business system and its other business strategies, the IS/IT strategy becomes an inseparable part of the strategic planning of the organization in general. This particular relationship among the strategies was the starting point of the research presented in this paper because it is indicative of the need for a holistic approach to the strategic planning. That is why it is necessary to thoroughly analyze the significance of the IS/IT for each organization individually. In line with the above, ***the strategic planning of information systems may be defined as the long-term planning of beneficial effects of information systems and usage of information technologies in business activities, and as part of the strategic planning of development of the business system as a whole.*** [6].

The SPIS methodology provides a method of developing the IS that will be in harmony with the requirements of the organization.

In earlier papers pertaining to this particular field [16], [23] and [24] SPIS was defined as a general concept intended for the strategic integration of business operations and application of state-of-the-art ICT, based on the case-by-case implementation of the known methods (SWOT, BCG, 5F, Value Chain, etc.). The subsequent development took two different courses. One group of authors [8], [18] and [19] reports on the practical use of the SPIS concept in specific business environments, whereas the other has focused its researches on structuring an integral methodology. This integral SPIS methodology is presented in papers [5] and [7]. It is being conducted in four stages (Formalisation of business model, Conceptual design of IS model, Detail design of IS, Implementation of new IS) and includes 16 steps. The problem that needs to be resolved and the method to be applied were defined for each step. The methodology is defined by way of description and presented as the work flow in the form of tables and diagrams, at which it is precisely defined which output results from the preceding step form input values for one or more of the subsequent steps. Thus defined consistent methodology has been tested in practice and its successful application is described in six relevant case studies.

On the other hand, Business-IT alignment over time is crucial for the success of an enterprise. This is precisely why this paper deals with the dynamic aspect of the strategic planning of information systems, while further researches in that direction depart from the SPIS methodology defined in [5].

The methodology of strategic planning, including the strategic planning of information technology, will not meet the expectations unless an efficient control of implementation of the strategic plan is ensured, and that is the main topic of the research presented in this paper. To accomplish that, the strategic planning of information systems requires an interdisciplinary scientific approach. A synthesized knowledge of mathematics, information science and economy will contribute to a better quality of the strategic planning of information systems.

2.2. Methodology of the Balanced-Scorecard and evaluation of IS performance

The Balanced Scorecard methodology is a popular concept of measuring performance of an organization. Its application allows another feature of the strategic management process in addition to those of planning and organizing, and that is monitoring of the realization of the determined strategic goals. Thus, the determined goals represent those performances of the organization which are indicators of the good «course» of organization's progress towards the realization of the desired vision. The current strategic plan is redefined in accordance with the effects of the undertaken activities.

The first Balanced Scorecard (BSC) method was created by Kaplan and Norton and it was intended to enable enterprises to define their development strategies and to monitor the

outcomes of their implementation [12]. The development of the BSC is based on the empirical experience of a large number of organizations in eliminating the drawbacks of measuring the performance exclusively by financial indicators. As opposed to the other methods, the BSC proposes the so-called "balanced scoring system" which allows assessment of the organization's overall results by means of four different perspectives.

Financial results are measured by using the traditional approach, i.e. by means of traditional indicators, such as: profit, investment return rate, sales increase, etc.

The measures drawn from the perspective of customer relations are determined by analyzing what can be done to keep the existing customers and attract new ones. So, for example, surveys are frequently conducted with respect to consumer goods. The processed survey results serve to assess customer loyalty and satisfaction, which can be presented by the scoring scale providing the ratio between the lost and the newly attracted customers.

The measures drawn from the business process perspective refer to the overall level of organization within a company. The measured values in this group indicate the level of overall organization of the system. It is possible to measure values such as: transaction costs, stock turnover coefficients, the time taken to respond to requests, the capacities utilization rate, etc. The goals that should be achieved in this segment of measuring must be aligned with the enhancement of efficiency and effectiveness of the organization's business processes.

Learning, growth and development will ensure intelligent adaptation of the organization to the changes of the environment and, consequently, ensure further growth and development. In that context it is imperative to make sure that the learning, growth and development within the organization is maintained. This perspective is usually measured by way of the number of production, technology- and business-related innovations, new products and services, etc.

The basic idea of how to expand the perspectives of the organization is included in the BSC concept for IS [14], which provides guidelines for the measuring of IS/IT impact on the achievement of business goals of the organization.

The proposed "BSC for IS" concept is similar to the classical BSC concept. The basic ideas for the reshaping of the BSC perspectives stem from the following [14]:

- The IS project works in favour of not just individual clients, but also of both the end user and the organization as a whole;
- The IS department should be perceived as internal rather than external service provider.

Accordingly, the perspectives for the measuring of IS performances are the following:

- orientation towards customers (end users);
- business values;
- internal processes;
- readiness for the future.

The primary goals of the IS are divided into two types: the goals related to efficiency and the goals related to effectiveness. The efficiency-oriented goals pertain to the processes. It is therefore necessary to consider them through the perspective of internal processes. The effectiveness-oriented goals pertain to the users and therefore are analyzed through the perspective of orientation towards the users and the perspective of business values. Recognizing the need for innovations and learning, the perspective of readiness for the future encompasses technologies and business opportunities, and challenges that will ensure stability of growth and development.

It is the BSC that helps identifying the procedures required "to turn the visions and strategies into real steps" [2]. It is only logical to take into account both the external environment and the future trends of its development. However, the criticism of the BSC comes from those who are not happy with the way in which the cause-and-effect relations are modeled. The simplification of the one-way causality is also pointed out as a flaw [1]. In the real world one-way causality is rarely found. Its simplification leaves out time delays, the accumulation and expenditure of the properties observed through indicators, and the feedback. Despite the fact that, basically, the BSC differentiates the cause from the effect in the sense of terminology, the separation of the cause and the effect in terms of time has not

been fully addressed [1].

3. Optimization of impacts of the IS/IT strategy on effectiveness of the business system

The BSC concept proposed in the classical SPIS methodology for the purpose of evaluating the impact of IT on the business system (step 2 in Table 1) and evaluation of performance of the new business system[7] (step 16 in Table 1) fails to take into account the existing constraints that may cause non-implementation of planned activities. However, the implementation of activities in the real system is likely to be conditioned by various limitations. For that reason the desired level of accomplishment of goals needs to be aligned with potential constraints. The application of the BSC within the scope of the SPIS methodology points at two types of constraints: the available resources and the structure of the measures determined.

3.1. Constraint imposed by available resources

The classic limitation to achieving the desired level of accomplishment of goals is availability of resources required to implement the activities by which these goals can be achieved. Consequently, it is necessary to determine the required resources for the implementation of each activity. At that, one resource may be used in more than one activity. In order to include all necessary resources, the procedure may be formalized in the matrix of resource. The nature of each activity indicates the resources required for its implementation. The identified strategic goals clearly define the measures and the extent of changes that should be carried out through implementation of the planned activities. This means that all required resources may be generated on the basis of activities aimed at achieving the derived strategic goals (DO). The realization of DO eventually leads to the realization of the set strategic goals (SO), the latter representing a transformed vision of the business system.

Let us assume that k DO is determined and the activities required for their realization, and r for the resources required for their implementation. Let us also assume that r_{ij}, where i=1,...,k, and j=1,...,r, represents the share of j^{th} resource in i^{th} activity for a 100% realization of j^{th} goal. In addition, let us assume that $m_R C_i$ represents the relative realization of j^{th} goal, and R_j represent the availability of the j^{th} resource.

Then the set of constraints can be presented by a system of inequations:

$$\begin{cases} r_{11} \cdot m_R C_1 + \cdots + r_{k1} \cdot m_R C_k \le R_1 \\ r_{12} \cdot m_R C_1 \qquad\quad r_{k2} \cdot m_R C_k \le R_2 \\ \quad \vdots \qquad\qquad\quad \vdots \qquad \vdots \\ r_{1r} \cdot m_R C_1 + \qquad + r_{kr} \cdot m_R C_k \le R_r \end{cases} . \tag{1}$$

Each inequation in (1) represents a constraint imposed by the availability of one of the resources. Thus is defined and mathematically recorded a set of constraints over the total level of realization of strategic goals on the basis of availability of resources.

3.2. Constraint imposed by structure of measures

The next type of constraints stems from the very structure of the strategy. The structure of the strategy is graphically presented by the strategic map of goals. The realization of SO is predicted on the basis of the determined structure and the assumed putative impacts of the measures on one another. The level of realization of subordinate goals is a precondition for the realization of the effects of activities conducted with a purpose of realizing the superior goals. To measure the level of realization of the goals, each goal should have its own measure, which implies that the structure of measures corresponds with the structure of goals.

That is why it is possible to describe the structure of the strategic map of measures for each strategic map of goals. The structure of the strategic map of measures can be recorded in the form of a matrix [9]. The matrix elements represent the assumed coefficients of the direct impact of the subordinate goals on the goals at the higher structural level.

The structure of the strategic map is here represented as a matrix of the structure of measure (MSM). Let us then assume that MSM is of the n order, consisting of i columns whose all values equal zero, in other words, of i measures that are not affected by the realization of any other goal (i of the measures to be entered). That means that there exists $n–i$ of calculated measures, in other words $n–i$ of the measures whose values are conditioned by values of the measures of the subordinate goals, in accordance with the cause-consequence chain (CCC). That is why $n–i$ constraint will exist, and they can be presented by a system of inequations: (2).

$$\begin{cases} -1\cdot m_R C_1 + k_{21}\cdot m_R C_2 + \cdots k_{i1}\cdot m_R C_{n-i} \cdots + k_{n1}\cdot m_R C_n \geq 0 \\ -1\cdot m_R C_2 + \cdots k_{i2}\cdot m_R C_{n-i} \cdots + k_{n2}\cdot m_R C_n \geq 0 \\ \vdots \qquad\qquad \vdots \quad \vdots \\ -1\cdot m_R C_{n-i} \cdots + k_{n2}\cdot m_R C_n \geq 0 \end{cases} \cdot \quad (2)$$

The system of inequations (2) contains $n–i$ of inequations, each representing one constraint of the calculated measure. The number of the unknowns equals total number of n measures. Coefficients k_{ij} for $i \neq j$ are taken from MSM.

Calculating with relative values in the presented concept imposes the requirement of non-negativity and maximum value of measure for all relative values of measures, or:

$$0 \leq m_R C_i \leq 1, \qquad \forall i = 1,...,n. \quad (3)$$

This has made it possible to encompass the observed constraints on the basis of which the optimal strategy is determined by using the here presented procedure.

3.3. Optimization of the total level of realization of goals

The main feature of the approach to the development of this model is the one that an organization should be perceived as an integral system. This means that the realization of strategic goals should not be treated partially but rather in the context of realization of the pre-set strategic goals. Such approach points at the fact that the maximum realization of DO is not necessarily optimal. That means that, due to the existence of the above-mentioned limitations, the maximum realization of the arbitrary DO will not necessarily contribute to the maximization of the SO. Namely, given the limitations imposed by available resources and the determined structure of goals, it is necessary to determine the optimal level of realization of the derived goals in order to maximize the level of realization of the pre-set goals.

Determination of the optimal level of realization of the derived strategic goals is a problem which can be addressed by employing linear programming. Generally, the problem of linear programming may refer to the problem of maximum or the problem of minimum. The nature of the problem analyzed here is an integral part of the problem of the maximum linear programming.

Let us assume that l SO is determined. The function whose maximum should be determined, in other words the *goal function*, is described as follows (4).

$$Max\left(\frac{1}{l}\cdot\sum_{j=1}^{l} m_R ZSC_j\right). \quad (4)$$

In this way, by defining:

- goal function given above (4),

- constraints imposed by availability of resources, described in (1),
- constraints imposed by the structure of goals, described in (2),
- requirement of non-negativity and maximum value of the measure described in (3),

the analyzed problem contains all necessary elements needed to apply the method of linear programming in pursuit of the optimal strategy. The achieved result indicates the required levels of realization of all DO which then indicate the maximum level of realization of the SO.

It needs to be reiterated that the starting point of this concept is the presumed influence of the goals on one another. Measurements may show different relationships between goals. This is likely to also change the structure of the strategy and, consequently, the limitations generated thereof. Should that happen, it is necessary to re-examine the limitations and repeat the optimization procedure. Since the entire procedure can be formalized in the form of a matrix calculation [9], this model was named the matrix model.

4. Analysis of the strategic plan implementation dynamics

By expanding the analysis of the dynamics of change of state in the context of system dynamics (SD) approach, it is possible to acquire new practical knowledge needed to control the time-dependant values. The projection of the expected response of the system using the classical and the SD approach is graphically presented in Fig. 1.

The time *x*-axis in Fig. 1 marks the moments in which the sampling of the level of realization of strategic goals is carried out utilizing the matrix model. The choice of the time unit will depend on the duration of the whole strategic period. In order to obtain a description of the momentary behaviour of the system, it is necessary to reduce the determined period to sufficiently small time interval Δt. The time intervalΔt is the simulation step, and it is determined in dependence on the nature of the pre-set strategic goals.

The dynamics of the behaviour of an organizational system is analyzed on the basis of the realization of the pre-set strategic goals. That is why the system's response (*y*-axis) is analyzed on the basis of the relative value (%) of the level of realization of individual strategic goals.

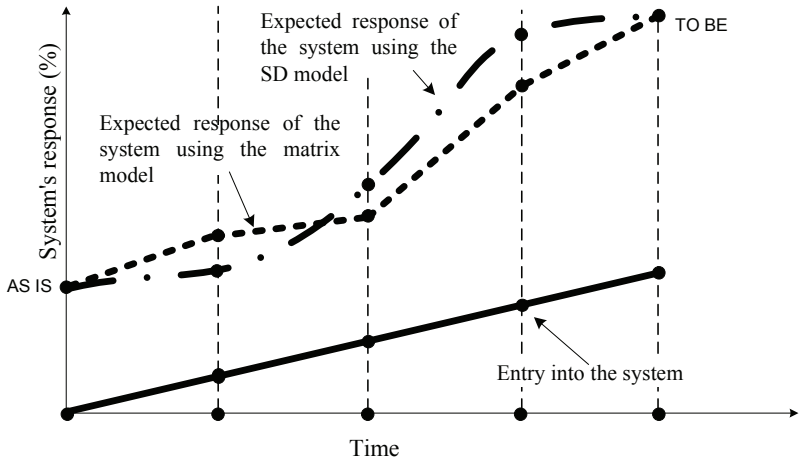


Fig. 1. Expected response of the system using the matrix model and SD model

The expected response of the system using matrix model is based on linear approximations by periods, i.e. on unvaried rates of expenditure of resources and realization of the subordinate goals.

In the case of SD models, the period of approximation is reduced to a minimum. Thus it is possible to count in the delay time which is caused by the momentary availability of resources and by the delayed effects of the realization of subordinate goals. In this case, the

behaviour of the system is likely to correspond to the curve presented in Fig. 1. The possibility of controlling the rates at which resources are expended and activities carried out may result in reduced time of reaching the desired level of realization of strategic goals.

The SD model should ensure optimal dynamics of implementation of activities and allocation of resources with the purpose of minimizing the time needed to achieve the levels of realization of goals, which are calculated on the basis of the proposed optimization model. Given that the strategic plan contains more than one DO and SO, this paper will present a general model of the impacts between resources, DO and SO.

Fig. 2 provides a structural diagram of the cause-and-effect impact within the system of goals. The purpose of the system is to achieve the desired values of SO. The framed section represents the subsystem of DO or the basic simulation module (BSM). The latter includes cause-and-effect links (CCL) used to produce an arbitrary DO. Other presented variables refer to its active environment. It is precisely this active environment that generates limitations to the achievement of the desired state of the goal. It is therefore necessary to analyze its realization in interaction with the system as a whole. Other parts of the environment include the subsystem of resources and the remaining BSM of other derived strategic goals.

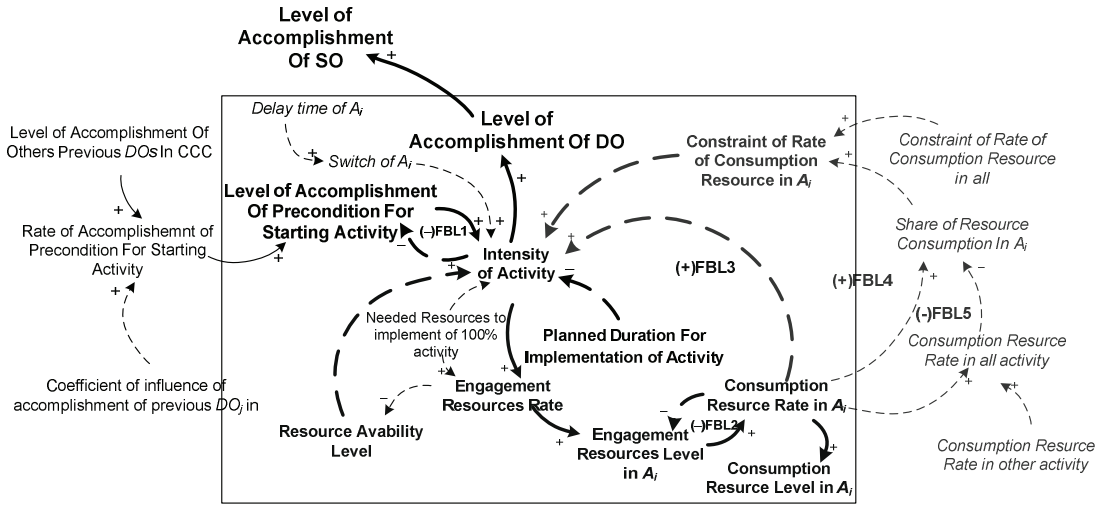


Fig. 2. Basic simulation module (BSM) in the context of SD model

In the classical method, values are calculated at the end of each *n* period. This means that the momentary level of realization of the goal equals the sum of the initial state and the changes made in the previous periods. On the other hand, the change in the level of realization of the goal in the real system is a result of the execution of the respective activity. This means that the rate of realization of the goal in the model equals the intensity of activity, which is the reason why the latter is undertaken in the first place. Theoretically, if the number of periods inclined toward infinity $n\to\infty$, the duration of the period would incline toward zero, or $\Delta t\to 0$. Generally, in that case the relative value of the state of the measure of each i^{th} derived strategic goal DO_i at any arbitrary moment t_0 may be expressed by the following differential equation:

$$mDO_i(t_0) = mDO_i(0) + \int_0^{t_0} A_i(t)\cdot dt\ , \tag{4}$$

where $mDO_i(0)$ is the initial relative value of the measure of the goal DO_i, dt the arbitrarily small time interval, and $A_i(t)$ the intensity of activity in dependence on time. This means that by using (4) it is possible to calculate the level of realization of the i^{th} DO at an arbitrary point of time on the basis of the intensity (rate of implementation) of activity A_i. Since the intensity of activity depends on the availability of resources (Fig. 2), it can be said that by employing equation (4) it is possible to mathematically describe delays in the realization of DO caused

by the lack of resources.

The set goals are exclusively the result of the realization of DO. This means that rather than being subjects of some activities, they are just the result of realization of DO, i.e. the pondered sum of realization $DO_i(t)$ at the observed point of time t. If we denote with coefficient k_{ij} the ponder of the direct effect of the i[th]DO on the j[th] SO, then it is possible to calculate the dynamics of the realization of the set goal SO_j at an arbitrary point of time t on the basis of expression (5).

$$mSO_j(t) = mSO_j(0) + \int_0^t \left(\sum_{i=1}^{l} k_{ij} \cdot \frac{d(DO_i)}{dt} \right) \cdot dt \qquad (5)$$

Expressions (4) and (5) mathematically describe the dynamics of implementation of the strategic plan and consumption of resources which, if too scarce, may cause delays in its implementation. This means that such SD model enables control over the dynamics of implementation and allocation of resources, the purpose of which is to minimize the time required to achieve the level of realization of goals proposed in the matrix model.

The procedure of modelling the observed problem was simplified by defining the OSM. In order to examine the possibilities of reducing the total duration of a strategic cycle, it is necessary to define the minimum time required for each activity to achieve 100% of the goal's value. Through simulations and examinations of possible scenarios it is possible to determine the optimal time duration for each activity. For that purpose it is necessary to employ ready-made program packages for the simulation modelling.

5. Operative usage of presented improvements to the SPIS methodology

The conducted research indicates that the proposed approach may be applied not only in the context of the strategic planning of information systems, but also for the strategic planning in general. The starting point of the research provided in this paper is the SPIS steps at the levels of formalization of a business system and implementation of a new IS. The examined BSC method has the economic character and it is applicable to the strategic planning in general. Today's unavoidable use of IS/IT in different segments of an organization calls for the strategic planning of the performances of the new IT by each of the BSC perspectives [14].

The hypothesis proposing improvements within the SPIS stems from the fundamental thesis that IS is a subsystem within the organizational system. Thus is created a working framework in which the following should be done to achieve the set goals:

- Assess the readiness of the organization for their realization;
- Determine the necessary strategies in alignment with the level of readiness of the organization;
- Determine the activities through which the strategies will be operationalized, and goals by which the level of their realization will be measured;
- Structure relationships among the strategic goals;
- Optimally distribute resources in accordance with the determined structure;
- Establish the dynamics of activities.

To facilitate the implementation and use of the developed improvements in the strategic management of the organization an Activity Flow Diagram-AFD was set up and is presented in Fig. 3. It consists of the following elements: the ***work posts***, describing functional roles (owner, manager and model designer) included in the operative use of the model, the ***activities***, representing a set of actions and decisions of the functional roles, and information flows that describe connections between activities. For an activity to develop normally, it is necessary to ensure the information generated by some other activity. This is how the information flows are obtained. In the explanations provided below, the information flows are given in the *italic* font style, whereas the activities are marked with both *italic* and ***bold*** font style.

At the onset of the new strategic cycle, managers execute the ***definition of vision*** activity. The management submits to the owner the *proposal of vision* for approval. Through

the *approval for vision* activity, the owner compares the *proposal of vision* with the *development policy*. The owner approves the *vision* and forwards it to the management in charge of execution of the ***definition of goals*** activity. If the owner does not accept the *proposal of vision*, he sends it back to the management for revision. The ***definition of goals*** leads to the shaping of *the proposal of goals*. When executing the ***approval for goals***, the owner either accepts the *proposal for goals* or sends it back for revision. Acceptance of the *proposal of goals* turns the goals into the *set strategic goals* that the management will be using in further procedure.

The next activity is the ***identification of SWOT elements*** which results in *S,W,O,T* elements that are used to execute the ***definition of strategies*** activity. Once the management has defined *strategies*, the ***definition of activities*** is carried out. Thus the *strategies* are translated into *activities* required for their realization. For each *activity* the model designer executes the ***definition of goals and measures*** the purpose of which is to monitor its implementation. This is how the *derived strategic goals* are acquired.

Execution of the ***establishment of links among goals*** activity results in the determination of the *matrix of structure of goals* which is translated through the implementation of the ***establishment of links among measures*** activity into the *matrix of the structure of measures* and *matrix of the sum of impacts*. Based on the *structure of measures matrix*, the ***definition of constraints to measures*** activity is executed. In addition to the *constraints imposed by the structure of measures*, it is necessary to also establish other limitations.

For the determined *activities* we need to ***identify necessary resources***. To achieve a 100% realization of the derived goals, we must determine the necessary *resources* for the execution of the activities. The available resources may not satisfy all the needs. It is therefore necessary to determine the *constraints imposed by the availability of resources* by executing the ***determining the limitations of resources*** activity.

The ***definition of goal's function*** activity serves to determine the coefficients of the linear combination of the *set goals*. This makes it possible to define the *function of the goal*, the *constraints imposed by availability of resources* and the *constraints imposed by the structure of the measure*, which represent the inbound flow of the ***optimization of goals*** *activity.* The outbound flow of the same activity gives us *optimal values of measures*, based on which and in addition to the inbound flow of the *sum of impacts matrix,* the model designer performs the design ***of matrix BSC model***. The model designer submits the *matrix BSC model* to the manager for approval. If the elements contained in the *matrix BSC model* do not satisfy the manager, the ***identification of SWOT elements*** activity should be repeated so as to find a new element that will bring to the desired state closer.

If this is not the case, the confirmation of acceptance of the *matrix BSC model* enables the designer to engage in the ***design of SD model of BSC***. The *SD model of BSC* is employed in the ***management of model usage*** activity if the *acknowledgement of the soundness of the model* exists. Results of the ***management of model usage*** are submitted to the owners in the form of *reports on realization of goals*. Based on the *reports on realization of goals*, the owners ***define the development policy*** in the form of information flow of the *development policy*. The *development policy* is implemented in the ***approval for vision*** activity when checking the degree of adjustment of the *proposal of vision* provided by the management.

The *SD model of BSC* needs to be validated. The *obtained* values of *measures* are achieved through the ***measurement of real system values*** activity.

The ***model validation*** activity determines the discrepancies between the *modeled and the real*. The management formalizes the model sustainability in the form of the *acknowledgement of the soundness of the model*. If the model is not satisfactory, the *acknowledgement of the model's malfunction* is provided, in which an ***analysis of delay impacts on realization of goal*** is requested. The positive result of the analysis contains the *new delay values* which may be used to describe the past performance of the organization. *New delay values* are included in the model through employment of the ***design of SD model*** activity. The negative result of the analysis is characterized by the nonexistence of a solution.

In that case it is necessary to conduct an ***analysis of the intensity of influence of the goals on one another***. The positive result of the analysis is characterized by the existence of

new values of direct impact of goals which are included in the ***definition of links among goals*** activity, which implies the new *structural matrix of goals*. It is therefore necessary to repeat the procedure with the new *structural matrix of measures.* If this analysis also fails to

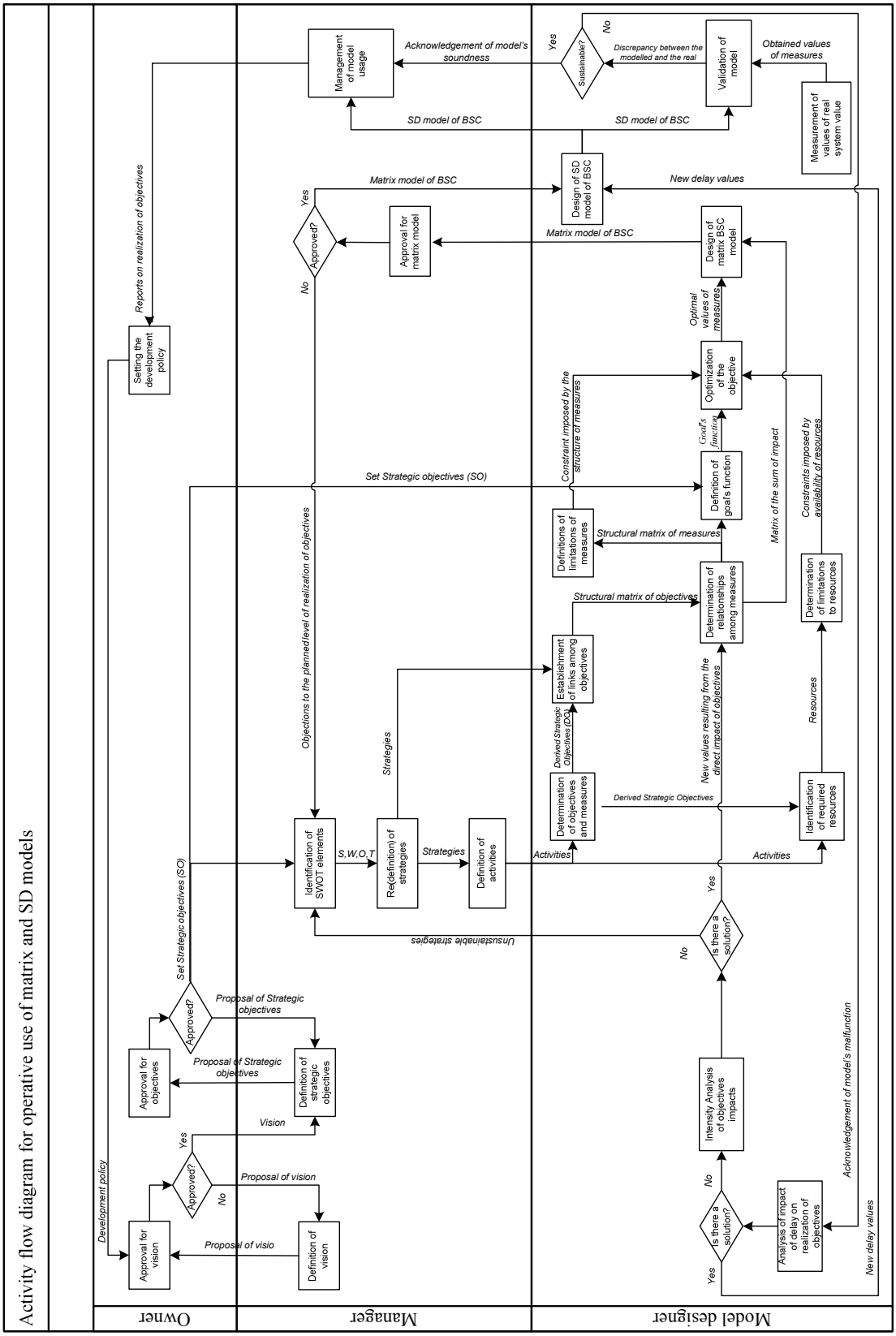


Fig. 3. Activity flow diagram for operative use of matrix and SD models

provide a positive result, it means that there are *unsustainable strategies*. Nonexistence of *unsustainable* strategies may be caused by the changed environment. That is why new SWOT elements, which will contribute to their sustainability, should be identified while at the same time taking into account the *unsustainable* strategies.

6. Improvements made to the SPIS methodology

Based on the analysis of the external and internal business and IS/IT environments, three closely linked strategies may be generated in line with the SPIS: the management strategy, the IS/IT development strategy, and the IT selection strategy. The SPIS methodology-based selection of strategy results in the strategic plan of the IS development that is aligned with the future period of development of the organization. This is precisely the area in which it is possible to apply the achieved improvements. Namely, the circumstances in which the organization functions and affects the environment are changing in that particular future period. That future period can be divided into a sequence of time intervals in which the achieved results are assessed. Each of those intervals makes space for the implementation of the proposed improvements that are aimed at realization of the strategic plan of development of IS in alignment with the new circumstances.

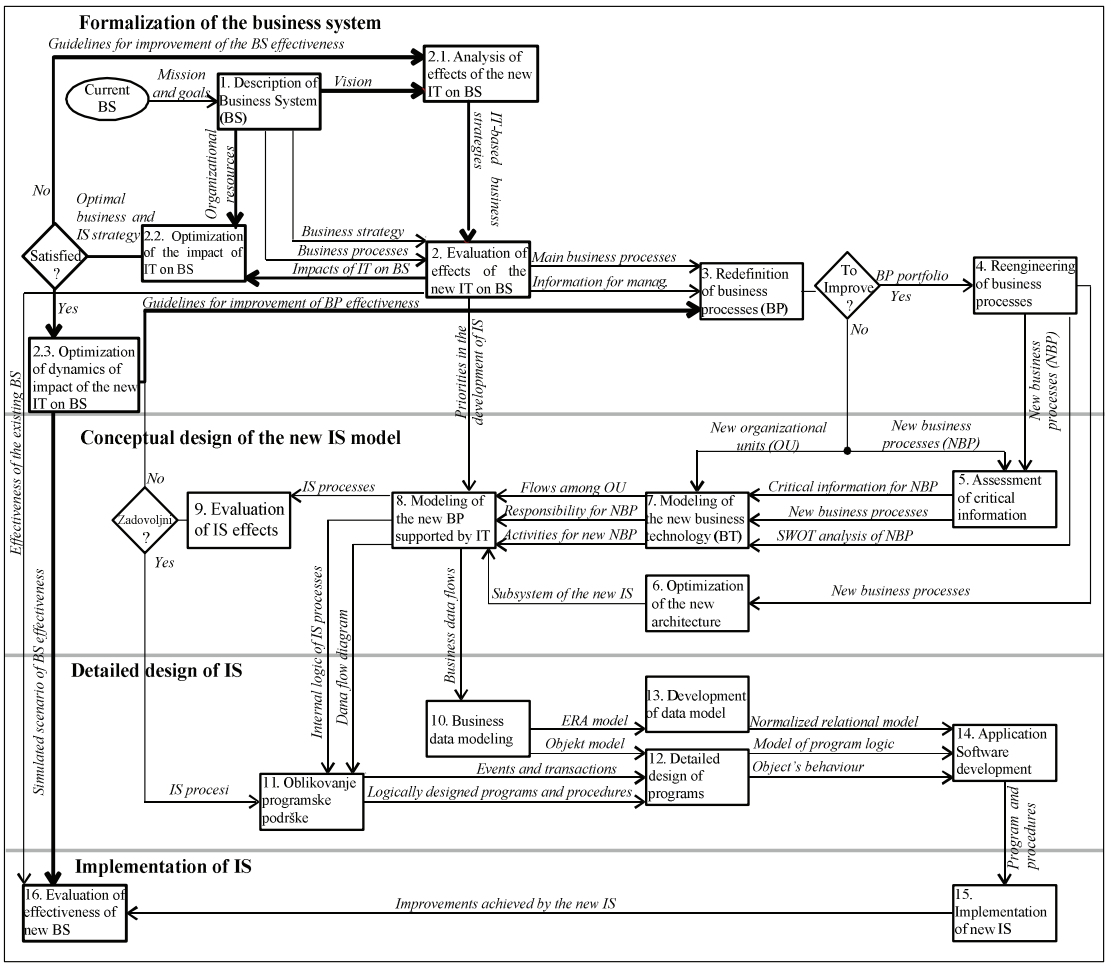


Fig. 4. Improved meta-model of SPIS methodology

Within that context, the achieved improvements result in new problem solving steps of the SPIS methodology meta-model. The improved SPIS meta-model is shown in the work flow diagram provided in Fig. 4. The new and modified problem solving steps of the improved SPIS methodology are given in the bold rectangles. The inbound and outbound results of each problem solving step are marked in the same way.

As can be seen in Fig.4, the achieved improvement refers to the problem solving steps *2. Evaluation of effects of the new IT on BS* and *16.Evaluation of effectiveness of the new BS*. The second step of the SPIS classical meta-model is decomposed to four steps. Based on the vision, the *2.1. Analysis of effects of the new IT on BS* step is carried out.

The defined views on the organizational system, presented in the previous chapter of this paper, make it possible to establish the current state of IS and available IT. Based on the established facts, we determine the strategic role of IS/IT in the context of the business system. This step results in the *IT-based business strategies* which is, at the same time an introduction to the *2. Evaluation of effects of the new IT on BS*[2].

To be able to evaluate the impact of the new IT on the business system, it is necessary to translate the formulated strategies into a set of concrete activities and goals required for their implementation. This is achieved through the improved BSC method that is based on the application of matrix algebra. This step results in the *impact of IT on business system* which is formalized in the shape of the structure of goals matrix. In accordance with the algorithm shown in Fig. 3, the identified mutual impacts of the goals, and the determined needs for the *organizational resources* that would make them possible, preconditions were created for the functional and economic optimization of the impact of the new IT on the business system. The optimization process is integrated in the problem solving step *2.2. Optimization of the impact of the new IT on the business system.*

The optimized impacts of IS in the context of the business strategy and the organizational resources should demonstrate the importance of introduction of a new IS/IT, whose purpose is to accomplish the principal goals of the organization (set goals). The completed optimization is then followed by the measurement of satisfaction with the achieved effects. In the case of dissatisfaction, the *guidelines for improvement of effectiveness* must be defined and procedures repeated from step *2.1.Analysis of the impact of the new IT on BS* onwards. Once satisfaction is found with the results of optimization, the optimal strategy is translated into the system/dynamics model. The development of the system/dynamics model and the optimization of the dynamics of implementation of the strategy is carried out in step *2.3. Optimization of the dynamics of implementation of the new IS.* This step includes investigation into the simulation scenario of its implementation. Simulation serves to design the optimal strategic plan of the IS/IT development in the organization. The time–dependant activities are thus clearly determined for both the present and future time, as well as their impact on the realization of organization's business results. This problem solving step results in the *guidelines for improvement of business processes* and the *simulation scenario of effectiveness of BS*. Based on the guidelines for improvement of business processes, next steps of the classical SPIS are carried out, starting with the problem solving step*3. Redefinition of business processes*. Based on the *improvements achieved by the new* IS, and the simulation scenario of effectiveness, it is possible to continuously monitor and evaluate the realization of effects of the employed IS/IT activities in the context of the business system, and this is carried out in the problem solving step*16.Evaluation of effectiveness of the new BS.* The latter is considered as the core of the dynamic aspect of the SPIS methodology.

Based on the above, it is possible to complete the problem solving steps of the SPIS and also of the methods and techniques of resolving them, as described in Table 1.

7. Implementation of DASPIS methodology in education institutions

This chapter provides an example of implementation of DASPIS methodology at the Faculty of Economics in Split. Presented are only results of certain enhanced SPIS steps that are important for the understanding of extracts of the optimal system/dynamic model of the IS/IT strategy.

The Faculty of Economics, University of Split is engaged in the reform of educational programmes in compliance with the Bologna Declaration. New programs have been designed

[2] The two steps bear the same number because this one supplements the second step of the classical meta-model in the SPIS methodology.

for the University undergraduate, graduate and postgraduate studies of Economics, Business Studies and Tourism, and for the professional study of Small Enterprise Management and

Problem solving steps in SPIS	**Methods and techniques** (§ -strategic, # -structural, ¤ -object oriented)	**Inputs and outputs of the process in the step** ***Input*****/** Outputs	**Usability** Very powerful Powerful Usable
1. Description of the business system (BS)	Interviewing	***Mission and goals of the current BS*** **/** Business strategy; Business process (BP); Organizational resources	
2.1.Analysis of the impact of the new IT on business system	§ pSWOTa	***Vision/*** IT-based business strategies	V
2. Evaluation of the impact of the new IT on BS	§ Balanced Scorecard § Balanced Scorecard based on the matrix algebra § BCG-matrix § 5F-model § Value-chain model	***BP*** **/** Effects of the current BS ***IT-based business strategies /***Impact of IT on BS ***Business strategy***/ IS development priorities ***Business strategy*** **/** Information for the top management ***BP*** **/** Primary and supporting business processes (BBP)	V V P U V
2.2. Optimization of the impact of the new IT on BS	§ Linear programming	***Impact of IT on BS; Organizational resources*** **/** Optimal IS and business strategies	V
2.3. Optimization of the dynamics of implementation of the new IS	§ System dynamics	***Optimal IS and business strategies /*** Simulation scenario of BS; Guidelines for improvements of business processes	V
3. Redefinition of business processes	# BSP-decomposition # Analysis of the life cycle of resources	***BBP*** **/** New organizational units (OU) ***Basic system resources*** **/** Business processes portfolio	P P
4. Reengineering of business system	§ BPR § SWOT	***Business processes portfolio*** **/** New business processes (NBP) ***Business processes portfolio***/ SWOT analysis of NBP	P V
5. Estimation of critical information	§ CFS analysis (Rockart) # Ends-Means analysis	***NBP*** **/** Critical information for NBP ***NBP*** **/** Information for business efficiency and effectiveness improvement	P U
6. Optimization of the new IS architecture	# Matrix processes-entities # Affinity analysis, Genetic algorithms	***NBP*** **/** Business processes relationships ***Business processes relationships*** **/** Clusters; Subsystems of the new IS	V P
7. Modelling of the new Business technology (BT)	# Work flow diagram # Organizational diagram # Action diagram	***NBP*** **/ responsibility for** NBP ***New OU*** **/ Flows among new OU** ***NBP*** **/** NBP activities	V P U
8. Modelling of the new business processes supported by IT	# Data flow diagram (DFD) # Action diagram (AD)	***NBP***/ NBP supported by IT (IS processes); Data flows; Business data ***IS process*** **/** Internal logic of IS processes	V P U
9. Evaluation of IS effects	# Simulation modelling	***IS process*** **/** Guidelines for improvements of BP	U
10. Modelling of business data	# ERA-model ¤ Object model	***Business data /*** ERA model ***Business data*** **/** Object models	V P
11. Design of program support	# HIPO- diagram ¤ Transition diagram	***IS processes*** **/** Logical design of program ***Data flows*** **/** Events and transactions	V P
12. Detailed design of programs and procedures	# Action diagram ¤ Object scenario	***Logical design of program procedure*** **/** Logical models of program ***Object model; Events*** **/** Object's behaviour	P P
13. Data model development	# Relational model; Normalization	***ERA model*** **/** Relational model	V
14. Software development	# CASE tools and 4GL ¤ OO-CASE tools	***Logical model of program; Relational model*** **/** Programs and procedures ***Objects behaviour*** **/** OO-procedure	P P
15. Implementation of IS	Case-study; Business games	***Programs and procedures*** **/** Performance of the new IS	P
16. Evaluation of the new IS performances	§ Balanced scorecard § Balanced Scorecard based on the matrix algebra	***Efficiency of the old BS, Performances of the new IS/*** Measure of success ***Simulation model of efficiency of BS; Performances of the new IS***/Achieved effects of the new IS on BS	V

Table 1. A survey of improvements to the problem solving steps in the SPIS methodology and how to resolve them

Tourism Operations. Enhancement of the quality of the educational process will be a huge step forward for this highly-esteemed institution that is recognized throughout Europe. The so far gained experience in the Bologna Declaration-based reform has clearly pointed at the specific problems and advantages that the Faculty has been struggling with. That is why this chapter determines the IS/IT strategy in the context of the educational process seen as the basic and most complex process implemented in the Faculty and a system/dynamic model as a support to the management of its implementation.

The starting point for the *Analysis of the impact of the new IT on business system* (step 2.1. in table 1.) is the vision of the Faculty, which is transformed into set strategic goals (SSG) (Fig. 5).

The expanded SWOT analysis was applied in order to estimate the level of capacity of the Faculty to accept a new IS/IT and the potential impact of the new IT on the development of the educational process with the ultimate aim to realize SSG presented in the table given in Fig 5. Determined are the *IT based business strategies* and also the activities needed for their implementation which result in measurable goals.

Summarized visions of the Faculty

(according to the electoral platform)

An internationally recognized organization that generates new scientific discoveries in the fields of economics, business economics and tourism and implements them into the economy, using modern educational standards to produce fresh human resources and improve the existing

Set strategic goals (SSG)

(derived from the vision)

*(Read as: *DO1 goal is **to enhance the international recognition** so as to increase the **number of international certificates** from x to y item)*

Goal label	*Course of change*	*Subject of change*	*Name of measure (that measures degree of realization of goal)*	*As is*	*To be*	*Unit of measure*
DO1	Increase	International recognition	Number of international certificates			Item
DO2	Increase	Scientific-research (SR) work	Number of SR papers per teacher per year			(Item/teacher)/ year
DO3	Increase	Efficiency of teaching process	Inverse value of average duration of unemployment			1/year
F1	Increase	Value of commercial projects	Monetary worth of realized projects			HRK
NP1	Increase	Efficacy of teaching process	Inverse value of duration of education multiplied by its cost			1/year*HRK)

Fig. 5. Transformation of the vision into SSG

7.1. Evaluation of the impact of new IT on BS

Evaluation of the impact of new IT on BS was carried out through application of the BSC concept based on the matrix approach (see. [9]). When the interaction among the goals was determined, it actually described the structure of the strategic map of goals which can be graphically presented as in Fig. 6. The rectangles represent determined strategic goals arranged by perspectives. The assigned strategic goals given in the table shown in Fig. 5 are marked by a bold frame.

7.2. Optimization of the impact of the new IT dynamics on BS

As already mentioned in section 1.4, the structure of measures corresponds with the structure of goals. This means that the defined structure of the strategic map of goals determined the constraint imposed by the structure of measures. As a result, the values in expressions (2) i (3) were defined. The function of goal, formally described in expression (4), was derived from four SSGs. In line with step 2.2. from Table 1, and section 1.5, the constraint imposed by available resources were established in order to enable optimization of the total level of realization of goals.

The calculated optimal values are shown in Fig. 7. They quantitatively describe the *Optimal IS and business strategies*.

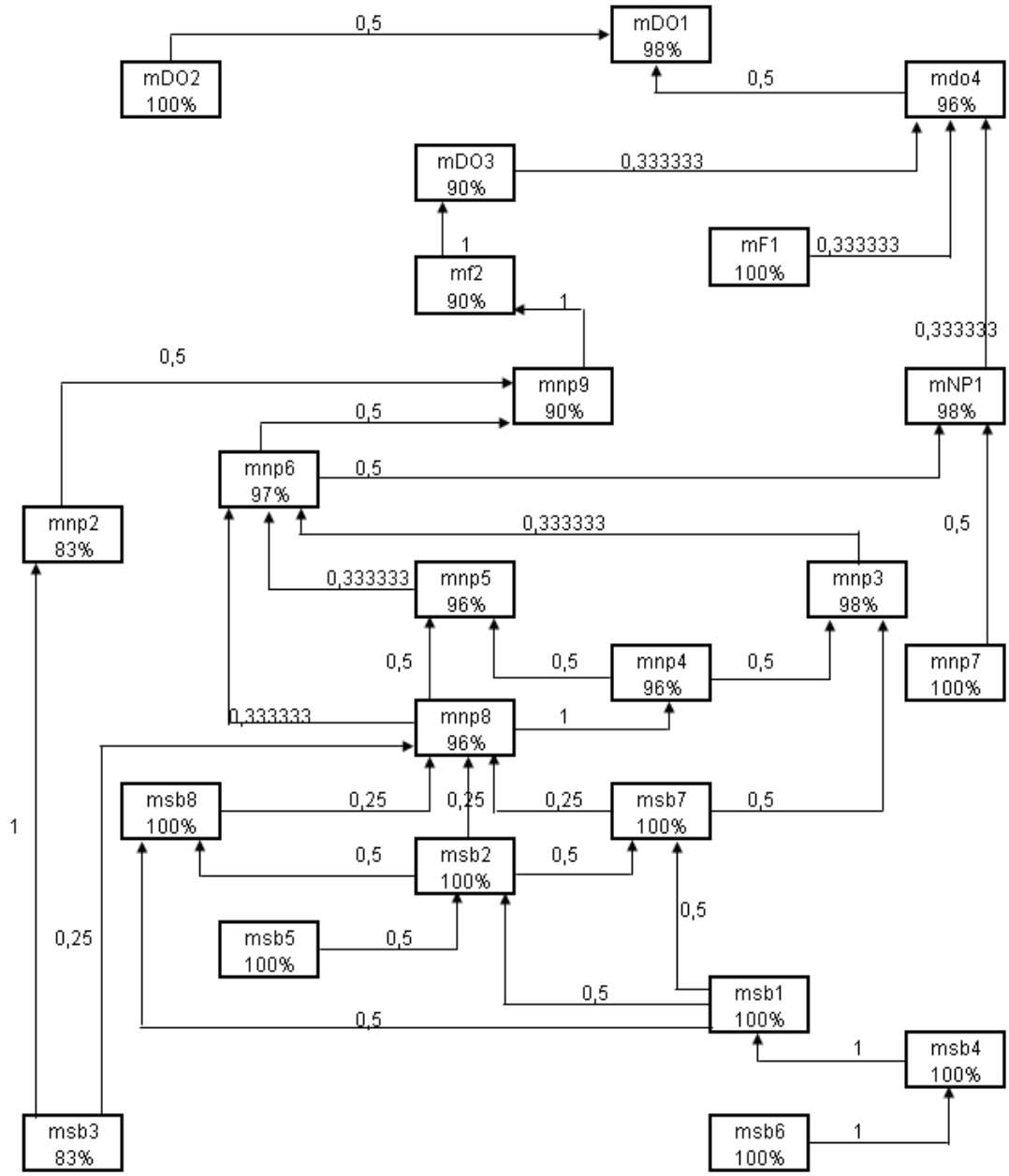


Fig. 7. Strategic map with optimal values of goals realization

The rectangles graphically designate measures of goals (the index of measure shown in Fig 7 matches the index of goal shown in Fig. 6), and the arrows denote the direction and intensity of impacts that goals have on one another. The values within the rectangles denote optimal values of the relative realization of the goals from the strategic map (Fig. 6) and also the maximum values of SSG.

The completed optimization of impacts of IT on the business system in keeping with step 2.3. in Table 1 and the dynamic model of the system presented in section 4, is followed by optimization of the dynamics of implementation of the new IS.

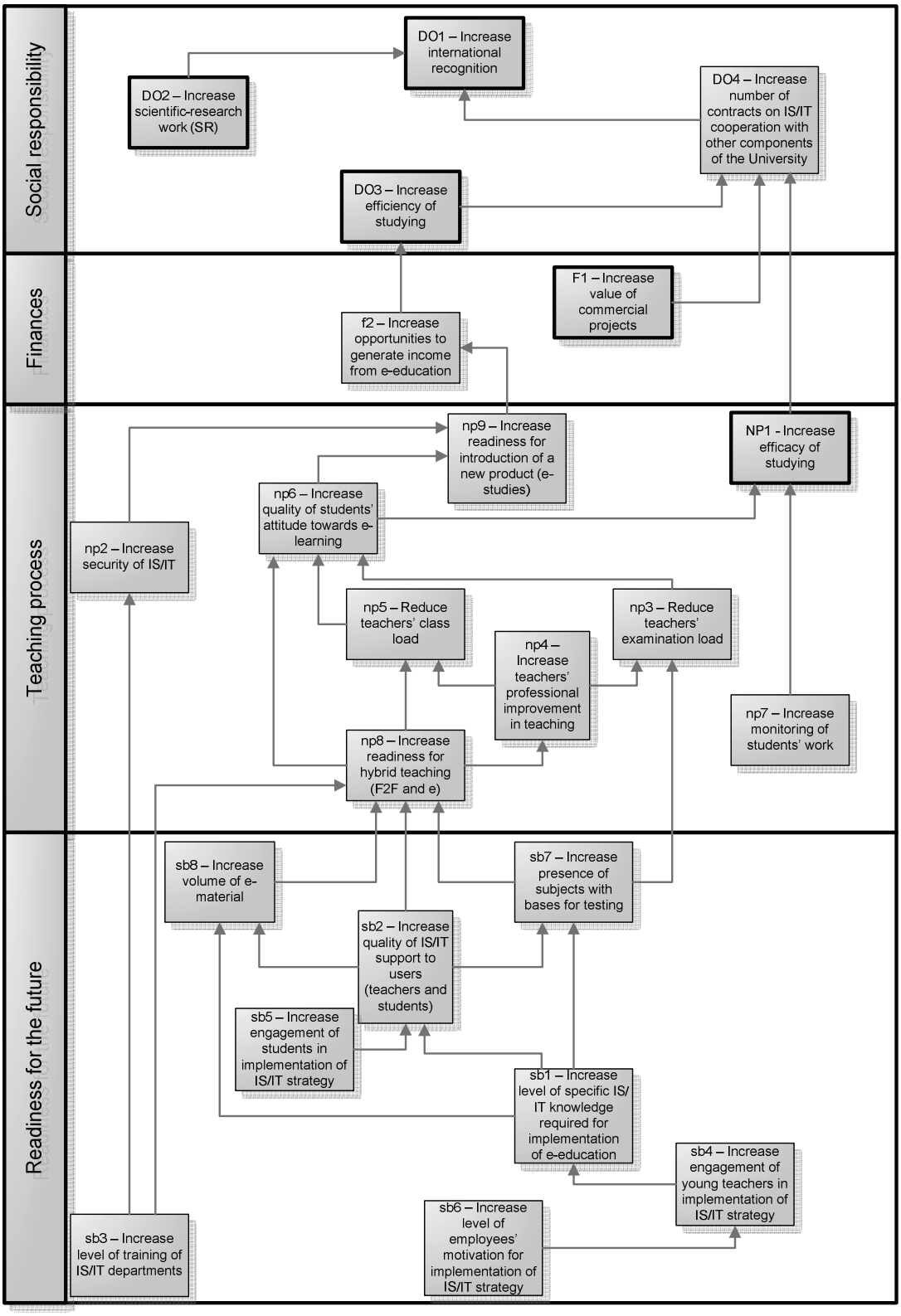


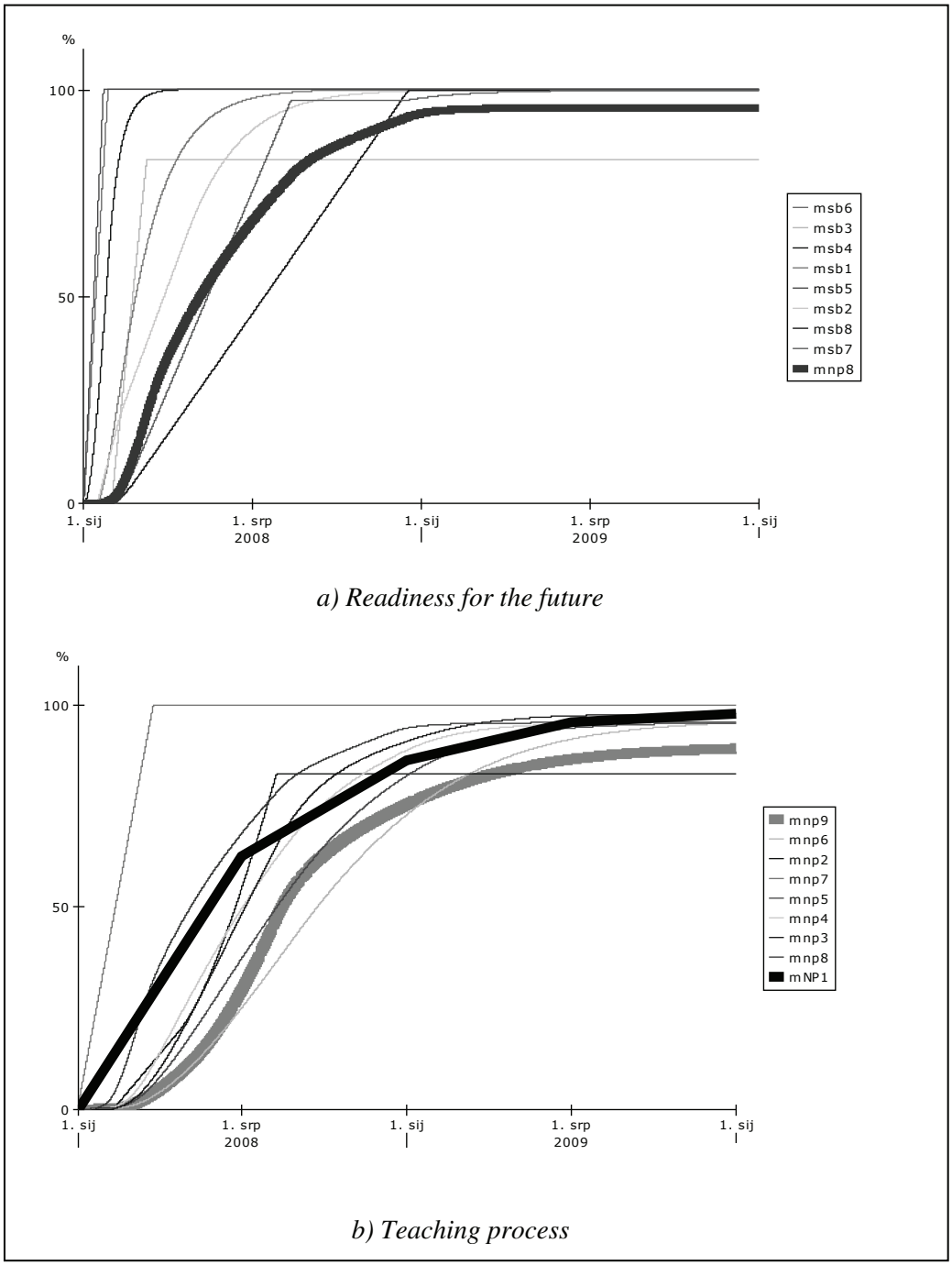
Fig. 6. Strategic map of goals

7.3. Optimization of the dynamics of implementation of the new IS

The procedure is carried out by means of Powersim program package. By employing the basic simulation module shown in Fig. 2, a system/dynamic simulation model of the strategic map is then developed for each calibrated strategic goal from the strategic map of goals (Fig. 6).Once the development of the model is completed through the simulation game, simulation

scenarios are developed and the optimal scenario is determined of the dynamics of implementation of strategic plan defined in step 2.2. Given the constraints imposed by the resources and the structure of the strategic map, a schedule of dynamics of resources consumption is worked out for each activity with the purpose of minimizing the time required for implementation of the strategic plan. The critical restrictive factor in the implementation of activities appears to be the human resources, i.e. the availability of the teaching staff and IT department staff. Optimum lengths of time for implementation of scheduled activities of the strategic plan were achieved by using the optimization tools included in the Powersim package.

Fig. 8. a) and 8 b) show diagrams of the dynamics of realization of strategic goals through two key perspectives in this particular case: *readiness for the future* and *teaching process*.



a) Readiness for the future

b) Teaching process

Fig. 8. Dynamics of realization of strategic goals

Half-year periods are given on the Time axis. The other axis provides values of the goals realization levels. The curves represent the dynamics of goals realization. Since the presented values are relative, the unit of measure is expressed in percentages.

The goals placed at the beginning of the cause-and-effect links do not depend on the realization of any other goal. Since the model has proved that their realization is not conditioned by the limitations of critical resources either, their dynamics is described by linear projection. The bold diagrams designate the dynamics of realization of the *np8-increase readiness for hybrid teaching* goal. Fig 8.a) clearly demonstrates that the major part of realization of this goal should be completed in the first year with an aim to reduce the duration of the strategic plan implementation. This means that, following the foreseen scenario, it should be expected that the Faculty will have replaced the classical with the hybrid teaching method in one year's time.

Fig. 8.b) shows that the greater part of goals within this perspective should be realized in the first three quarters of the year. The dynamics of realization of the *np1-increase efficacy of studying* strategic goal is designated by the diagram colored black and the dynamics of realization of the *np9-increase readiness to introduce a new product (e-study)* is designated by the diagram colored gray. It is the three goals mentioned above that are crucial when explaining examples of implementation of DASPIS to a system observed. Together with other diagrams, the diagrams in Fig. 8 represent optimal simulation scenario of BS effectiveness of the model developed to assist in the implementation of IS strategy.

Thus determined scenarios should be compared in half-year periods with the degree of realization of the strategic goals in the real system. If there are any discrepancies, it is necessary to reexamine, in accordance with the algorithm proposed in Fig. 3, the assumed delays, i.e. assumed impacts among strategic goals in the matrix model.

8. Conclusion

The importance of timely information is particularly manifested in the long-term planning as is the strategic planning of business operations in an organization. Erroneously designed strategies and nonexistence of a system that would control their implementation may be disastrous for an organization. If we add the speed at which the information technology develops, the long-term planning of organization's development is very likely to face a double risk. On the one hand, there is the risk that the business operations are exposed to and, on the other hand, there is the technological risk.

In view of the above, the long-term planning of development of business activities is not possible without a long-term planning of the information technology development. Likewise, the long-term planning of development of information technology is impossible without the long-term planning of development of business activities.

The main goal of this paper is to present the improvement made in the SPIS methodology by introducing the limitations that allow optimization of the dynamics of implementation of the strategic plan for informatization of business systems. The integration of the results presented in chapters 3 and 4 of this paper into the SPIS methodology indicates the possibility of looking into the time related dimension of its implementation. Thus is the following achieved:

- Improvement of the procedure of assessing the IS/IT effects on the realization of the organization's goals;
- Improvement of the procedure of measuring the effects of the new information system on the organizational system.

Such expansion which, in compliance with the system dynamics methodology, enriches the classical SPIS with the time component, may be considered as its dynamic aspect and that is precisely why it is known as the dynamic aspect of the strategic planning of information systems, i.e. DASPIS.

Thus formalized DASPIS methodology enables optimal allocation of resources in an

enterprise in a given time period, including also the role of IS/IT as a potential factor of the organization's development. Starting from business goals, the implementation of the combination of proposed methods provides correspondence between the business goals and the Information Technology (IT) requirements of an enterprise i.e. business-IT alignment.

Appendix: List of abbreviations

SPIS	Strategic Planning of Information System
DASPIS	Dynamic aspect of the strategic planning of information systems
IS	Information System
BSC	Balanced Scorecard
SD	System Dynamics
IT	Information technology
SISP	Strategic Information System Planning
BSP	Business System Planning
CSF	Critical Success Factor
SWOT	Strengths, Weakness, Opportunities and Threats
5F	Five Forces
BSC For IS	BSC methodology concepts adopted for IS
DO	Derived Strategic Goals
SO	Set Strategic Goals
MSM	Matrix of the structure of measure
CCC	Cause-consequence chain
BSM	Basic simulation module
CCL	Cause-consequence link
BCG	Boston consulting group
BPR	Business process reengineering
DFD	Data Flow Diagram
SSG	Set Strategic Goals

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