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Contribution to Linguistic Modeling of Business Process Structure, Functionality and Performance Metrics

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

The paper deals with quantifying and modeling of business process structure, functionality a metrics with the use of linguistic approach, where Principle Business Process Linguistic Equation (PBPL Equation) in basic and extended plays a role of principle importance, while this aspect is considered to be the first one. The second aspect is closely related to concept of relations and algorithms create basis for postulating rules, which regulate behavior of business processes to be investigated and modeled and enable understanding them.
However, before the entire above-mentioned BP model categories, rules and algorithms could be implemented and operated, their adequate conceptual models should be designed. This is considered to be the third significant aspect related to that paper content as well.

Keywords: Business process metrics; business process views; business process rules; linguistic modeling.

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1. INTRODUCTION

Corporate Performance Management (CPM), in its many forms, is a hot topic among multinational business leaders. The issue that has raised its visibility is the need for better management information – not only more complete and more accurate data but also information that is more current and more efficiently delivered. It has been estimated that half of the Fortune 1,000 companies have installed some form of CPM program in an attempt to make sense of the tremendous amount of data they possess. However, not all of them are satisfied with the results. Successfully implementing a CPM program requires an approach that flows from a strategic plan, measures progress against carefully defined goals and rewards employees for behavior and actions that meet those goals and support the strategy [1,2,3,4]. However, the business strategy and strategic plans incl. appropriate key performance indicators (KPI) represent only one side of the coin. The second side is concerned to core, main and supporting business processes running in the firm or company – their structure, functionality and metrics especially, while all of these categories might be investigated and modeled, where modeling with the use of linguistic approach might be applied as well [5]. The presented paper deals with business process modeling with the use of linguistic approach, where modeling of BP metrics plays a role of principle importance.

This paper's main goal is to prepare proposal for establishment of regularities and algorithms concerned to BP modeling provided based on linguistic approach principles, while the proposed regularities and algorithms deal with BP structure, functionality, performance and metrics as well.

In order to achieve that goal, several partial goals should be postulated and fulfilled. The first one is closely related to an appropriate BP structure, functionality and quantification based on application of Principle Business Process Linguistic Equation (PBPL Equation – [4] in basic and extended version.

The second partial goal is concerned to relations and algorithms create basis for postulating rules, which regulate behavior of business processes to be investigated and modeled and enable understanding the above mentioned aspects and categories concerned behavior of those business processes.

However, before the entire above-mentioned BP model categories, rules and algorithms could be implemented and operated, their adequate conceptual models should be designed. This is considered to be the third partial goal of that paper.

2. STATE OF THE ART

2.1 Business Process Metrics -Terms and Principles

A business metric is any type of measurement used to gauge some quantifiable component of a company's performance, such as return on investment (ROI), employee and customer churn rates, revenues, and EBITDA. Business metrics are part of the broad arena of business intelligence, which comprises a wide variety of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions.

Broadly speaking there are four very good reasons for using metrics, these reasons also covered by ITIL in the CSI (continual service improvement) module and known as VDJI. The areas are: (a) to validate soundness and efficiency of decisions (b) to set direction for future activities (c) to provide factual evidence (d) to Intervene, when changes or corrections are needed.

The core parts of metrics include: (a) measurement units, (b) reporting period (c) reporting frequency, (d) the current value of the metric with the latest data, (e) previous values of metrics and (f) trend – this is the change in value over time when comparing it with the actual value to previous values.

Alan Ramias and Cherrie Wilkins postulate basic principles for business process metrics design as follows [6,7]:

- Every process is designed to reliably produce one or more outputs, so, in deciding what metrics to develop, we always focus at first on process outputs, not activities,. The metrics should measure whether the process not only produces the outputs but also that all appropriate expectations are met every time the process is executed.

- Metrics should be applied to all the significant outputs of the process. If the process is order fulfillment, for example, the output is not just the product but also the invoice, the order documentation, and customer information that will be used again for future orders.
- We always start outside the process itself and try to understand the expectations of the receivers of the outputs (external and internal customers) and their expectations should be translated into categories denoted as critical *dimensions of performance.*
- In first developing metrics, we focus on what to measure, not how measurement is going to happen.
- The most useful performance data helps one see trends in performance. So, metrics that can be constructed to yield a trend are the most useful, and most metrics can be formulated this way.
- We seek to identify metrics that will be both leading and lagging indicators of performance. Lagging indicators are the common ones: they provide data on events in the past. But leading indicators provide insight into the future; they center on data that act as an early warning on emerging problems or declining performance. When chosen well, a leading indicator can signal the need for a course correction before the problem gets out of control. The tool we describe below is a great way to identify possible leading indicators.

2.1.1 Business process metrics

Let us consider a superior core business process CB (0, I) e.g. utility glass production, which consists of I subordinated core processes I=1…..n (n- number of subordinated business processes running at strategic management level denoted by symbol 0 (zero), which also indicates a root within business process (BP) hierarchy.

The goal of any selected core business process (BP) is to generate pre-defined outputs based on appropriate inputs, while the pre-defined outputs related to any of the above-mentioned selected business processes contribute to aggregated total KPI indicator, denoted as KPI (0), which corresponds to superior core business process CB (0, I) too. On the other hand, for any business process is an appropriate metrics assigned, while the pre-defined outputs represent so called *BP External metrics.*

However, any business process consists of adequate BP Functions (BPF) F (I, 1), F (I, 2)…….F (I, m_1) (m_1 ⎽number of BPF, the actual business process consists of), while any BPF is responsible for transformation of inputs into pre/defined outposts and an adequate metrics is assigned to them as well.

This type of metrics is denoted as a *BP Internal Metrics.* In the next sections, we shall have a look at both of the above-mentioned metrics types, while they will be represented by appropriate linguistic sets, having pre-defined structure and features.

2.2 Terms and Principles – Linguistic Sets

All business processes (BPs) are being accompanied by adequate texts written in a natural language (TNL text) stored in form of paper or machine readable files described via two principle sets:

- Set of document external signs (e. g. name, date of issue, author, publisher, etc.)
- TNL text, which creates basis for document content or narration

However, the document narration might be concerned to any objective or problem area incl. BP modelling as well. On the other hand, the TNL text creates a matter of principle importance from records management (RM) point of view, while that process might be considered to be a business process as well and can be a subject of BP modelling.

In general, the TNL text set contains elements closely related to semantic, syntactic and grammar units concentrated within appropriate logical sentences V(i), i=1....n. Because of that, the semantic, syntactic and grammar elements represent various lexical or linguistic units, the TNL text set is denoted as a **linguistic set**, which can have a very different structure and various properties.

On the other hand, any V (i) logical sentence represented by {VLS (i, j1)} linguistic set is carrying an adequate semantic meaning, which is closely related to TNL text objective.

2.3 Literary Overview

2.3.1 Generation of business process metric definitions

Defining these metrics manually is rather cumbersome and time-consuming. We have therefore devised a rule-based approach to identify potential metrics in a semi-automated manner. A human operator can then take over parts of or all metrics from this generated temporary metric set, as well as define entirely new metrics.

A general approach is to provide a number of rules, which identify elements of a WS-BPEL process (such as invoke activities, branches or loops), extract some basic information from the element (such as the endpoint or service name for invoke activities) and generate one PPM[1] or QoS[2] metric definition per element [8], [9].

2.3.2 Business process performance metrics-influential factors

Monitoring of business goals and timely measurement of business process performance are important aspects of the BPM lifecycle. Such goals are typically expressed by defining a number of key performance indicators (KPIs) and their target values) [8].

On one hand, any business process is considered to be a dynamic category and it is a basic hypothesis that the experience of modern times is simultaneously the experience of a new time. The relation of the acting and suffering people to historical time has changed in empirical as well as in theoretical terms. ”History itself” has been discovered as something new in relation to the previous experience[3]. A central expression to which, as is well known, only the modern times have genuinely conceptualized, is progress. Progress as historical experience is redeemable only if the people are conscious of their task of arranging or staging this progress. In this respect the concept is a reflective and defines the conditions of possibility but not the empirical course of the progress [4] . However, the term progress is closely related to business process functionality and business process performance as well. On the other hand, the business process functionality and performance progress is represented by adequate semantics, which is closely related to business process history. This type of semantics is denoted as “Semantics of historical time” developed by Reinhart Koselleck, [10,11,12,13].

Those semantic principles might create good basis for design of linguistic sets (see also section B), which are considered to be categories of principle importance from business process linguistic modelling point of view.

Whenever a KPI does not meet its target value, a business analyst wants to know what when wrong, and how to address the issue. This task is supported by business activity monitoring (BAM) technology. It enables continuous, near real-time monitoring of processes based on observation of BP events [14].

However, in BAM the focus is currently set on the ‘what’ rather than the ‘why’ question. BAM does not reveal the ‘hidden’ factors that caused deviations from target KPI values. A KPI measures the success of the process as a whole, while a PPM captures only a single facet of the process (which is usually not interesting in isolation). However, there are simple facts from the business process instance, such as a customer identifier, a product type or information about which branch of a process has been executed (e.g. whether the alternative branch ‘ordering from external suppliers’ needed to be executed).

2.3.3 Monitoring of influential factors

The goal of monitoring is (1) to obtain KPI values and check whether they meet specified targets and (2) to provide metrics for factors which could potentially influence the KPI performance and are thus input to later dependency analysis.

In this phase two principle aspects are considered to be important:

- Monitoring both on process level and service level.

[1] *PPM - process performance metrics*
[2] *QoS - Quality of Service*
[3] *Koselleck, R. The Temporalisation of Concepts available at http://www.jyu.fi/yhtfil/redescriptions/Yearbook%201997/Koselleck%201997.pdf*
[4] *Koselleck, R. The Temporalisation of Concepts available at http://www.jyu.fi/yhtfil/redescriptions/Yearbook%201997/Koselleck%201997.pdf*

- The business processes are implemented as WS-BPEL service compositions running on top of a SOA[5]. Such processes have several dependencies on IT components and their QoS [6] characteristics, which potentially influence business process performance.

- Semi-automated creation of metric definitions:

  - One input to our approach is a comprehensive set of metrics which should be monitored. Even if the user knows which metrics he wants to monitor, the manual creation of these definitions can be a tedious and error-prone task. Therefore, there is a need for a semi-automated approach to creation of potentially interesting metrics, which supports the user by proposing metrics which may be important for monitoring.

2.3.4 Business process performance metrics and measurement

What about key factors and aspects do determine business process (BP) performance, productivity and efficiency? Some speculate that it is a matter of BP resources strictly. However, this is only one side of the coin, while the second side is closely related to leadership, planning and technology together with capability to leverage employee suggestions are considered to be three principal factors, which contribute mostly to innovation performance improvement related to business process running in the firm or company. On the other hand, the effective use of technology followed by ability to forge improvements across functional areas and measurement play a role of principal importance in differentiating performance among institutions (ECAR, 2005). However, there is a set of other factors, which contribute to BP performance improvement as well; while they might be closely related to the firm or company business objectives and objective areas (see also Table 1).

Of course, a stable senior leadership and strategic plan calls for high performance in administrative processes is considered to very significant factors, because senior leaders act as champions in of business process change, while firm or company business units often ask for IT assistance in using technology to improve their BP performance and efficiency.

2.3.5 Requirements for effective measurement of process performance

Now that we have trashed much of the well-intentioned measurement work we have seen out there among process practitioners, it is incumbent on us to provide some requirements for good measurement. These are the requirements we use on our own measurement design work [15,6]:

- Metrics should measure the right things, which are outputs and results, not activities.
- Metrics should measure the relevant variables, or dimensions, of a given output or result. The variables may be the usual ones of time, cost, and quality, or they may be special and unique to a given output, but, in any case, you need to know what those variables are.
- It is often necessary to have multiple metrics correlated to multiple variables (whatever is important to the customer and the business).
- Whatever is measured at the process, sub process, or task level should be traceable upward to business and customer requirements. There should be a clear line of sight from process to total business variables.
- Metrics should track trends, not single snapshot data. Overreaction and under-reaction are both less likely when using trend data.
- Metrics should be assigned at each management level so it is clear who is responsible for tracking, reporting, diagnosing, acting, following up. (We often see cascading measurement systems that skip whole levels of management or have gaps from, say, the business to the job level).
- At least some metrics should be leading indicators of future performance problems. These are singled out for special attention. With these requirements in mind, we will talk next time about building the metrics for a given business process.

[5] *SOA – Service Oriented Architecture*
[6] *QoS - Quality of Service*

Table 1. The factors, which contribute to BP performance improvement categorized by firm or company business objectives and objective areas

Functional Area	Strongest Factor	Next Factor	Third Factor
Finance	Employee suggestions		
Grants	Employee suggestions		
HR	Senior executives	Employee suggestions	
Student	None		
Management information and analysis	Institutional plans	Employee suggestions	Board initiatives
All areas	Employee suggestions		

Source: (ECAR, 2005)

3. RESEARCH METHODS

- Establishment of adequate linguistic sets concerned to actual BP functionality and metrics.
- Establishment of Principle Business Process Linguistic Equation - PBPL Equation (basic and extended version) applied in modeling of BP functionality and performance metrics.
- Application of PBPL Equation in generation of rules related to selected business processes postulated as follows:
  - BP final product quality evaluation
  - Share of BP function metrics items and values related to quality of investigated BP outputs (products)
  - Creation of business process regulation rules represented via TNL text format
- Application of PBPL Equation in design of functional, process, process product and organizational view related to linguistic approach business process models.
- Application of PBPL Equation in design of data (information) and knowledge based view related to linguistic approach business process models.

4. RESULTS

4.1 Focus of the Right Business Process Metrics

In general, the right focus on business process metrics might be determined by three categories: (a) agility, (b) productivity /performance, (c) quality, (d) customer's experience and (d) risks, and an appropriate set of indicators represents any of the above-mentioned categories, while they might be postulated as follows [5]

- Agility – key agility indexes
  - There are 82% of business executives, IT, and business process professionals who believe that agility is critical to measure.
- Productivity /performance – Key performance indicators related to current and future BPM[7] focus
- Quality - Key quality indicators
- Customer's experience - Net promoter scores, Voice of the Customer
  - Only 22% of enterprise use customer's experience measures for decision making
- Risks - Key risk indicators

A detailed description and quantification related to any of the above-mentioned categories requires many texts and images and the presented paper range is limited. As a result of that, we shall deal with problems concerned to modeling of business process productivity and performance metrics indicators in further sections, while a linguistic approach will be applied for those purposes.

4.2 Business Process Performance Metrics

The linguistic set concerned to actual BP functionality and metrics.

Conceptual issues related to utilization of Principle Business Process Linguistic Equation (PBPL Equation) in establishment of BP structure and functionality as well as BP performance metrics are based on several considerations.

[7] *BPM – Business Process Management*

Consideration no. 1: Let us consider business process Pe (i) i=1, 2,.. n (hereinafter known as BP process), where I – is the BP serial number, while BP process consists of BP process functions denoted as F(i, 1), F(i, 2)……F(i, m_1), (hereinafter known as BP functions), which provide partial activities Pa (i, 1), Pa (i, 2),…… Pa (i, m_1), while the following equations might be postulated:

$$F(i, 1) \Rightarrow Pa (i, 1) \quad (1a)$$

$$F(i, 2) \Rightarrow Pa (i, 2) \quad (1b)$$

$$F(i, m_1) \Rightarrow Pa (i, m_1) \quad (1c)$$

and those activities are closely related to investigated BP process as a whole.

However, any BP process function (F(i, 1), F(i, 2)……F(i, m_1)), is defined on that linguistic set as well. In other words, the {Pe (i, j)} linguistic set is common for all F(i, 1), F(i, 2)……F(i, m_1) functions. This is one side of the coin.

On the other hand, the {Pe (i, j)} linguistic set contains elements, which represent pre-defined linguistic units described by text fragments and segments [8] with adequate semantic meaning, while the T_{fr} (i,j) , which consists of text string or segment free T_{sf} (i,j) and text string T_{sem} (i,j), which provides assigning semantic meaning to t_{sf} string or segment [16].

$$\{[T_{fr} (i,j)]\} = \{[T_{sf} (i,j), T_{sem}(i,j)]\} \quad (2)$$

With respect to formulas (1a, 1b, 1c and 2) the following set of equations might be postulated

$$[F(i, 1)] \Rightarrow [Pa (i, 1)] = [t_{fr} (i,1)], [t_{semi} (i,1)] \quad (3a)$$

$$[F(i, 2)] \Rightarrow [Pa (i, 2)] = [t_{fr} (i,1)], [t_{semi} (i,2)] \quad (3b)$$

$$[F(i, m_1)] \Rightarrow [Pa (i, m_1)] = [t_{fr} (i, m_1)], [t_{semi} (i, m_1)] \quad (3c)$$

This consideration postulates relations between BP functions, which provide appropriate BP activities and linguistic sets {[T_{fr} (i,j)]}, {[t_{sf} (i,j), T_{sem}(i,j)]}, which create a common basis for BP functions and BP activities (see also formulas 3a, 3b and 3c) and represent BP horizontal structure elements too.

Consideration no. 2: As mentioned above, Consideration no.1 postulates relations between BP functions, which provide appropriate BP activities and linguistic sets {[T_{fr} (i,j)]}, {[t_{sf} (i,j), T_{sem}(i,j)]}, which create a common basis for BP functions and BP activities. However, there are two supplementary issues, which play a role of principle importance from BP structure and functionality and are denoted as BPFfunc, items and values and BP metrics (denoted as $BPF_{mel,}$ items) as well. On the other hand, they create content of linguistic sets {[$BPF_{func,}$ (i',j'')]} and {[$BPF_{mel,}$ (i',j'')]} too. Subsequent issues create subject of Consideration 3 and are based on utilization of Principle Business Process Linguistic Equation (PBPL Equation) – [4]

The same consideration might be applied related to image as a whole or image fragment

$$\{[T_{img} (i,j)]\} = \{[Img (i,j), T_{semi} (i,j)]\} \quad (4)$$

where

{[T_{img} (i,j)] set – contains image segments (clusters and gasps) with adequate semantic meaning
[Img (i,j)] set – contains image segments (clusters and gasps) without any semantic meaning –image free
[T_{semi} (i,j)] set – text string or segment which provides assigning semantic meaning to image free clusters and gasps.

Principle Business Process Linguistic Equation applied in establishment of BP functionality and performance metrics.

Consideration no. 3: Let us consider the PBPL Equation (abbreviated version) – [16,17,18].

$$\{Petx (i', j'')\} \otimes \{Pe (i. j)\} = \{Res1 (i, j)\} \text{ [19]} \quad (5)$$

Where

{Petx (i', j'')} - is a linguistic set[9] concerned to actual BP input metrics
{Pe (i. j)} - is a linguistic set concerned to actual BP functionality metrics
{Res1 (i, j)} - is a linguistic set concerned to actual BP output metrics.

Before getting started to specify linguistic sets concerned to actual BP functionality and

[8] This type of text string is considered to be text string free denoted as t_{sf} = " text string or segment"

[9] The terms linguistic set and set are of the same meaning within that paper

metrics, let us specify a meaning of indexes i' and j'' and several BP performance models, which might help us to provide that specification. The first one is denoted as **business process enactment model,** which provides means to establish the workload metrics and key performance indicators for each business process[10] class and operates via following steps.

Step no. 1: At first, let us consider business process class represented by {Pe (I,j)} linguistic set, where I =1….n is – BP Class serial number , while an appropriate Core Business Process $\{Pe_{cb}$ (I, j)} represents that BP class and formulas (3.6a and 3.6b) might be postulated

$$\{Pe\ (I',j')\} \in \{Pe_{cb}\ (I, j)\} \quad (6a)$$

$$I' \in I = 1, 2\ldots\ldots n \quad (6b)$$

I – BP Class serial number related to e.g. main BP – Production management , which creates an integral part of the core process denoted as Production.

Step no. 2: Now, let us consider a horizontal structure of business process represented by {Pe (i',j')} linguistic set, where index I' is defined with respect to formula (6b) and index $j'=1,2\ldots.m_1$ indicates a number of functions, the process consists of, while formulas (7a) and (7b) might be postulated

$$I' = (I, F(i',j'')) \quad (7a)$$

$$\{Pe\ (I',j')\} = \{Pe\ [(I, F(i',j'')]\} \quad (7b)$$

Where [F (i', j'')] is a linguistic set, which contains BP function functionality component ($BPF_{func,}$ (i', j'')) and BP function metrics component ($BPF_{mel,}$ (i', j'')).

$$[F(i',j'')] = [(BPF_{func,}\ (i',j'')), (BPF_{mel,}\ (i',j''))] \quad (8a)$$

$$\{Pe\ (I',j')\} = \{Pe\ [(I, [(BPF_{func,}\ (i',j'')), (BPF_{mel,}\ (i',j''))]]\} \quad (8b)$$

and the components related to business process functionality and metrics, which represented by {Pe (I',j')} linguistic set and by formula (8b).

4.2.1 The linguistic set concerned to actual BP input metrics

The linguistic set {Petx (I', j')} represents actual BP input metrics, while index I' represents a serial number relating business process, which is the {Petx (I', j')} linguistic set assigned to and that index should correspond to formula (7a).

On the other hand, index j' – $j'=1\ldots.m_2$ represents a number of objective ($BPOI_{inp}$ (j')) and metrics ($BPOM_{inp}$ (j')) component concerned to actual BP input, while formula (5) might be postulated.

However, there is one more remark, that both of the above-mentioned components are strictly interconnect to adequate business process function (see also formula (9)).

$$\{Petx\ (I', j')\} = \{Petx\ [I', F(i', (BPOI_{inp}\ (j')), (BPOM_{inp}\ (j'))]\} \quad (9)$$

The result represented via formula (9) might be compared with business process **resource performance model** [15], which represents resource configuration within BP functions underlying the evaluated business processes and it provides algorithms to calculate the required performance metrics under the given workload characteristics.

4.2.2 The linguistic set concerned to actual BP output metrics

In order to define the linguistic set concerned to actual BP output metrics, PBPL Equation should be applied, while its abbreviated version is quite sufficient for those purposes –see also formula 7.

When providing substitution formulas (9) and (8b) into PBPL equation formula (10a) might be postulated

$$\{Petx\ [I', F(i', (BPOI_{inp}\ (j')), (BPOM_{inp}\ (j'))]\} \otimes \{Pe\ [(I', [(BPF_{func,}\ (i',j'')), (BPF_{mel,}\ (i',j''))]]\} = \{Res1\ (i, j'')\} \quad (10a)$$

When looking at formula (10a) we can see that the {Res1 (i, j'')} represents **the linguistic set concerned to actual BP output metrics.** The question is: *"How the {Res1 (i, j'')} linguistic set content looks like?".* The answer is seen via formula (3.6b) and further theoretical and practical aspects concerned to {Res1 (i, j'')} linguistic set content will be discussed in the next section of that paper.

$$\{Petx\ [I', F(i', (BPOI_{inp}\ (j')), (BPOM_{inp}\ (j'))]\} \otimes \{Pe\ [(I', [(BPF_{func,}\ (i',j'')), (BPF_{mel,}\ (i',j''))]]\} = \{Res1\ (i, j'')\} \quad (10b)$$

[10] *The terms business process and process are of the same meaning within that paper*

Consideration no. 4: Now, let us have a look at formula (3.7b), we can see that any BP might be represented by {Pe (I',j')} linguistic set, which consist of BP function linguistic sets [F(i',j'')] , while any BP function linguistic set consist of $[(BPF_{func,} (i',j''))]$[11] and $(BPF_{mel,} (i',j''))]$[12] subsets (see also formulas (3.8b). With respect to formulas (1a, 1b, 1c, 7b, 8a and 8b) formula (11) might be postulated.

$$\{Pe\,(i)\} = \prod_{j=1} \{Pe\,(i,j)\} = \prod_{j=1} [F(i,j)] \Rightarrow \prod_{j=1} [Pa\,(i,j)] = \prod_{j=1} [t_{fr}\,(i,j)], [t_{semi}\,(i,j)] \Rightarrow$$
$$\{Pe\,[(I', (BPF_{func,}(i',j'')), (BPF_{mel,}(i',j''))]\} \quad (11)$$

However, this equation enables BP quantifying from functional view, view of activities, which provides any BP function, linguistic modeling view and BP metric point of view as well and creates basis for definition Principle Business Process Linguistic Equation – Extended (E-PBPL Equation)

$$\{Petx\,[I', F(i', (BPOI_{inp}\,(j')) , (BPOM_{inp}\,(j'))]\}$$
$$\{Pe\,(i, j)\} = \{Res1\,(i, j'')\} \quad (12)$$

and plays a role of great importance in generation of rules, which regulate BP functionality and metrics too. Those problems are discussed in further section of that paper.

4.3 Production Business Process Rule Specification

Previous sections deal with BP metrics model, the principles and quantifications of which are derived based on linguistic approach and are applied for generation of rules, which regulate functionality and metrics of the business process to be investigated and modeled, while that generation is running via following steps: (a) definition of rule supporting assumptions (b) design of creation procedure and (c) definition of the rule final version.

In the subsequent sections, there are described algorithms related to the following BP rules:

- Rule no.1 BP final product evaluation
- Rule no.2 share of BP function metrics items and values related to quality of investigated BP outputs (products)
- Rule no. 3 BP TNL Text form regulation rules.

The first rue related to BP final product quality evaluation.

4.3.1 Definition of rule supporting assumptions

The designed rule enables providing BP final product quality evaluation, while a number of products without repair n_1 , a number of products with repair n_2, a number of products waste n_3 is determined based on comparison of α (j') and β (j') values with respect to formulas (13a), (13b).

In order to create a rule related to BP final product evaluation, the BP input and output metrics should be postulated, while formulas (3.13a and 3.13b) might be postulated

$$\{BP\text{-}Input\ Metrics\ Item\} = \{[BPOM_{inp}\,(j'))\ (itm\ (1), (BPOM_{inp}\,(j'))\ value\ (1)], [(BPOM_{inp}\,(j'))\ (itm\ (2), (BPOM_{inp}\,(j'))\ value\ (2))],\ldots\ldots [(BPOM_{inp}\,(j'))\ (itm\ (m_2), value\ (m_2))]\} \quad (13a)$$

$$\{BP\text{-}Output\ Metrics\ Item\} = \{[BPOM_{out}\,(j'))\ (itm\ (1), (BPOM_{out}\,(j'))\ value\ (1)], [(BPOM_{out}\,(j'))\ (itm\ (2), (BPOM_{out}\,(j'))\ value\ (2))],\ldots\ldots [(BPOM_{out}\,(j'))\ (itm\ (m_2),)]\} [(BPOM_{out}\,(j'))\ , value\ (m_2))]\} \quad (13b)$$

Where

$[BPOM_{inp}\,(j'))\ (itm\ (j'), (BPOM_{inp}\,(j'))\ value\ (j')]$ is a linguistic set, the elements of which represent items and values concerned to metrics of BP input material (BP input measured values)

and

$[BPOM_{out}\,(j'))\ (itm\ (j'), (BPOM_{out}\,(j'))\ value\ (j')]$ is a linguistic set, the elements of which represent items and values concerned to metrics of BP input material (BP output measured values)

4.3.2 Rule design of creation procedure

Furthermore let us define ratio values between BP output and input measured values $\{\alpha\ (j')\}$ j'=1….m via formula (14a) and pre-defined standard reference values $\{\beta\ (j')\}$ j'=1….m via formula (14b) and operands {R (j') } j'=1….m via formula (14c)

[11] *BP function functionality components*
[12] *BP function metrics components*

$$\{[BPOM_{out}(j')] / [BPOM_{inp}(j')]\} = \{\alpha(j')\} \quad j'=1\ldots.m \tag{14a}$$

$$\{\beta\} = \{\beta(j')\} \quad j'=1\ldots.m \tag{14b}$$

Operands

$$\{R\} = \{R(j')\} \quad j'=1\ldots.m \tag{14c}$$

4.3.3 Definition of the rule final version

With respect to formulas (11a), (11b) and (11c) a final version of rule which regulates BP final product evaluation (hereinafter known as Rule no.1) is postulated via formula (12)

$$\text{IF } [(\alpha_1, \alpha_2 \ldots\ldots\ldots \alpha_m)\ R\ (j')\ (\beta_1, \beta_2 \ldots\ldots\ldots \beta_m)] = [n_1\text{-without repair}, n_2\text{ - with repair}, n_3\text{ - waste}] \tag{15}$$

Where

n_1-without repair is a number of investigated BP outputs (products), which absolutely correspond to pre-defined values contained within linguistic set $\{\beta(j')\}$ $j'=1\ldots.m$ and might be applied for further processing or sale to customer.

n_2-with repair - is a number of investigated BP outputs (products), which correspond to pre-defined values contained within linguistic set $\{\beta(j')\}$ $j'=1\ldots.m$ with complain and have to be repaired before they might be applied for further processing or sale to customer.

n_3-waste - is a number of investigated BP outputs (products), which absolutely do not correspond to pre-defined values contained within linguistic set $\{\beta(j')\}$ $j'=1\ldots.m$, they might not be applied for further processing or sale to customer and are considered to be waste.

The second rule is closely related to share of BP function metrics items and values related to quality of investigated BP outputs (products).

4.4 Definition of Rule Supporting Assumptions

In order to create a rule concerned to share of BP function metrics items and values related to quality of investigated BP outputs (products) linguistic sets $\{[BPF_{func,}(i',j'')]\}$ and $\{[BPF_{mel,}(i',j'')]\}$ should be postulated, while the items and values contained within $\{[BPF_{func,}(i',j'')]\}$ set represent BP function static, dynamic and status values and the items and values contained within $\{[BPF_{mel,}(i',j'')]\}$ set represent BP function metric values (see also formula 16)

$$\{Pe(i.\ j)\} = \{[(BPF_{func,}(i',j'')), (BPF_{mel,}(i',j''))]\} = \{\text{Grinding [Reel (size, hardness, rpm)], } [\lambda_1, \lambda_2, \text{ and } \lambda_3]\} \tag{16}$$

Where the text string "Grinding [Reel (size, hardness, rpm)[13]]" is assigned to $\{[BPF_{func,}(i',j'')]\}$ set elements and the text string "$\lambda_1, \lambda_2,$ and λ_3 is assigned to $\{[BPF_{mel,}(i',j'')]\}$ set .

4.4.1 Rule design of creation procedure

Now, we shall postulate a measure z_1, which indicates how the business process represented by {Pe (i. j)}, with respect to formula (13), contributes to its own final results [n_1-without repair, n_2 - with repair, n_3 - waste] – hereinafter known as BP total measure z_1,

When looking at formula (3.13), we can see that Pe business process function metric items are closely related to partial BP measures $z_{11,}$, z_{12} and z_{13} postulated as follows (see also formulas 17a, 17b, 17c)

$$z_{11} = [\text{Grinding (Reel)}), \text{(size)}] \tag{17a}$$

$$z_{12} = [\text{Grinding (Reel)}), \text{(hardness)}] \tag{17b}$$

$$z_{13} = [\text{Grinding (Reel)}), \text{(rpm)}] \tag{17c}$$

However, further measures might be derived based on BP total measure z_1 BP partial measure $z_{11,}$ z_{12} and z_{13} with respect formulas (3.15a, 3.15b, 3.15c) as well.

$$\delta_1 = z_{11} / z_1 \tag{18a}$$

$$\delta_2 = z_{12} / z_1 \tag{18b}$$

$$\delta_3 = z_{13} / z_1 \tag{18c}$$

This consideration is concerned with grinding of glass articles; however it might be applied for any articles, where the grinding operation is being required, e.g. when producing metal articles within machinery production. This approach represents a small modification of that

[13] *This type of metrics is denoted as BP function metrics*

consideration, when applying it for other types of articles then the glass articles are.

4.4.2 Definition of the rule final version

With respect to (11a), (11b and (11c) as well as 14a - 11c and Table 2 the Rule no.2 final version might be postulated

$$\text{IF } [(\delta_1, \delta_2 \ldots\ldots\ldots \delta_m)\ R1\ (j')\ (\varepsilon_1\ \varepsilon_2 \ldots\ldots\ldots \varepsilon_m)] \ \&\ [(\alpha_1, \alpha_2 \ldots\ldots\ldots \alpha_m)\ R\ (j')\ (\beta_1, \beta_2 \ldots\ldots\ldots \beta_m)] = [\lambda_1, \lambda_2, \lambda_3] \quad (19a)$$

Where

$$\lambda_1 = n_1 / (n_1 + n_2 + n_3) \qquad \lambda_2 = n_2 / (n_1 + n_2 + n_3) \qquad \lambda_3 = n_3 / (n_1 + n_2 + n_3) \quad (19b)$$

4.5 Business Process TNL Text form of Regulation Rules

4.5.1 Definition of rule supporting assumptions

Issue no.1: When looking at Rule no.1 and no.2, we can see, they are of IF-THAN nature (see also formulas 12 and 16a). However, the rules related BP functionality and metrics might be postulated via structured or unstructured TNL [14] text as well. In order to explain that type of BP functionality and metrics rules, we ought to postulate several issues.

First of all, a structure of BP to be investigated should be quantified via appropriate linguistic sets: $[(BPF_{func,}\ (i',j''))]$ linguistic set – related to investigated BP functionality and $(BPF_{mel,}\ (i',j'')]$ linguistic set – related to investigated BP metrics, while adequate text strings (see also formula (20)

$$[(BPF_{func,}\ (i',j'')),\ (BPF_{mel,}\ (i',j''))]] = [1(\ 1,\ (\text{Grinding (Reel)}),\ (\text{hardness, rpm}))] \quad (20)$$

Issue no. 2 deals with investigated BP inputs represented by linguistic set $(BPOI_{inp}\ (j'))$, the content of which represent elements concerned to BP input objectives (see also formula 21a) and $(BPOM_{inp}\ (j'))$ which represent elements concerned to BP input qualitative indicators.

Equations (21a and 21b) represent a general form of those sets and equations (8a and 8b) indicate examples related to $(BPOI_{inp}\ (j'))$ and $(BPOM_{inp}$ linguistic set element content (see also formulas 8a and 8b)

$[(BPOI_{inp}\ (j'))]$ - the article types, the article classes, the article specifications (21a)

$[(BPOM_{inp}\ (j'))]$ - (itm (1), value (1), (itm (2), value (2)),…… (itm (m_2), value (m_2)) (21b)

4.6 Rule Creation Procedure - Representation of BP rule via PBPL Equation

After having completed the above-mentioned issues, PBPL equation might be applied for representation of rules, which regulate functionality and metrics of the business process to be investigated, while its abbreviated form is applied for those purposes (see also formula 3.4).

4.6.1 Definition of the rule final version

Now, we shall substitute PBPL Equation left side by formulas (3.11a, 3.11b and 3.20) and the result is the structured TNL text, which describes a rule closely related to functionality and metrics concerned to be the BP to be investigated (see also formula 3.22)

{Res1 [(1,1)]}= [(1, 1), (“lead crystal”, “bowls”, “without repair”, z1), (itm (1), value (1), itm (2), value (2)), itm (3), value (3))))] ⊗ [1(1, (Grinding (Reel)), (hardness, rpm))] = [(1, 1), (Grinded (“lead crystal”, “bowls”), (“without repair”, z11), (itm (1), value (1), itm (2), value (2)), itm (3), value (3)), (“with repair”, z12), (itm (1), value (1), itmrep (2), valuerep (2)), itm (3), value (3)), (“waste”, z13), (itmwaste (1), valuewaste (1), itmwaste (2), valuewaste (2)), itm (3), value (3))] (22)

However, the {Res1 [(1, 1)]} linguistic set content enables generating Rule no.3 in form of structured TNL text as well.

When assigning text values to operands ⊗ and “=”with respect to formulas (23a and (23b),

[14] *TNL text – Text in Natural Language e.g. English, Slovak, Czech, etc*

Table 2. Rule no.2 generation supporting values

Measured values δ (j')	Standardized values ε (j')	Operands R1 (j')	Measured values α (j')	Standardized values β(j')	Derived values λ (j')
δ_1	ε_1	R1(1)	α_1	β_1	λ_1
δ_2	ε_2	R1(2)	α_2	β_2	λ_2
δ_3	ε_3	R1(3)	α_3	β_3	λ_3

Source: The author

Rule no.3 might be represented in unstructured TNL text (see also formula 24)

$\otimes \Rightarrow$ "with the use of" (23a)

$= \Rightarrow$"gave" (23b)

{Rule.no.3} = { Grinding of [("lead crystal", "bowls", "without repair", z1), (itm (1), value (1), (itm (2), value (2)), (itm (3), value (3)))],[with the use of], (Grinding (Reel)), (hardness, rpm))], [gave], (Grinded ("lead crystal", "bowls"), ("without repair", z11), (itm (1), value (1), itm (2), value (2)), itm (3), value (3)), ("with repair", z12), (itm (1), value (1), itmrep (2), valuerep (2)), itm (3), value (3)), ("waste", z13), (itmwaste (1), valuewaste (1), itmwaste (2), valuewaste (2)), itm (3), value (3))]} (24)

5. DISCUSSION

PBPL Equation Extended versus BP Model functional and process, information and knowledge based view.

In general, any business process model is based on the following views: (a) functional, process, data, organizational a product-process view. Those views postulated prof. Scheer in his BP modeling methodology, which represents generally accepted as standardized approach among BP modeling methodologies [20,17]. However, this approach might create basis for applying linguistic approach in BP process modeling as well, while a quantification of BP to be modelled is done via PBPL Equation in abbreviated version (see also formula 5), which is also denoted as PBPL Equation – principal (basic) version. Now let us have a look at BP quantification via formula (11) and let us consider assumptions for deriving that equation (see also Consideration no.1 and no.2) and we can see, that equation enables BP quantifying from functional and process view[15] - see also formula (25a) as well as from information point of view[16] – see also formula (25b). When looking at formula (25c), we can see several linguistic sets, which play a role of significant importance in BP knowledge based support, which is considered to be further important view related to BP model design. As a result of that, a set of BP model views might be extended about BP knowledge based view.

$$\{Pe_1 (i)\} = \Pi \{Pe_1 (i, j)\} = \Pi [F(i, j)] \Rightarrow \Pi [Pa (i, j)] \quad (25a)$$

$$\{Pe_2 (i)\} = \Pi \{Pe_1 [(I', (BPF_{func,} (i',j'')), (BPF_{mel,} (i',j''))]\} \quad (25b)$$

$$\{Pe_3 (i)\} = \Pi [t_{fr} (i, j)], [t_{semi} (i, j)] \quad (25c)$$

$$\{Pe (i)\} = \{Pe_1 (i)\} \cap \{Pe_2 (i)\} \cap \{Pe_3 (i)\} = \{Pe (i)\} = \{[F(i, j)], [Pa (i, j)], [BPF_{func,} (i',j'')], [BPF_{mel,} (i',j'')], [t_{fr} (i, j)], [t_{semi} (i, j)]\} \quad (25d)$$

Now, let us substitute the {Pe (i)} set in formula (5) by the right side of formula (11) and formula (26a), (26b) might be postulated, while formula (26a) is concerned to **PBPL Equation – Extended version.**

5.1 PBPL Equation Extended - BP-Model Process Product View

$$\{Petx [I', F(i', (BPOI_{inp} (j')) , (BPOM_{inp} (j'))]\} \otimes \{[F(i, j)], [Pa (i, j)], [BPF_{func,} (i',j'')], [BPF_{mel,} (i',j'')], [t_{fr} (i, j)], [t_{semi} (i, j)]\} = \{Res1 (i, j'')\} \quad (26a)$$

$$\{Res1 (i, j'')\} = \{BP\text{-}Output\ Metrics\ Item\} = \{[BPOM_{out} (j')) (itm (1), (BPOM_{out} (j')) value (1)], [(BPOM_{out} (j')) (itm (2),(BPOM_{out} (j')) value (2))],\ldots\ldots [(BPOM_{out} (j')) (itm (m_2),)]\} [(BPOM_{out} (j')), value (m_2))]\} \quad (26b)$$

[15] Any BP consists of functions, which enable providing appropriate activities

[16] Any BP model Information point of view might be represented via items and values closely related to BP statistic, dynamic and status indicator contained within $\{BPF_{func,} (i',j'')\}$ set and BP metrics items contained within $\{BPF_{mel,} (i',j'')]\}$ set

However, formulas (26a) and (26b) quantify process product process view within BP linguistic modeling as well.

5.2 PBPL Equation Extended - BP Model – Organization View

Furthermore, let us consider the[$BPORG_{units}$ (j')] linguistic set, the elements of which represent units and the linguistic set [($BPORG_{roles}$ (j')] the elements of which represent roles (personalities) of organization structure related to firm or company, where the business process quantified via previous relations and formulas , are running and are process quantified via previous relations and formulas , are running actually. Those sets create inputs for PBPL Equation – Extended postulated via formulas (27a) and (27b).

$$\{Petx\ [l', F(i', (BPORG_{units}\ (j'))\ ,\ (BPORG_{roles}\ (j'))]\} \otimes \{[F(i, j)], [Pa\ (i, j)], [BPF_{func,}\ (i',j'')], [BPF_{mel,}\ (i',j'')], [t_{fr}\ (i, j)], [t_{semi}\ (i, j)]\} = \{Res1\ (i, j'')\} \quad (27a)$$

$$\{Res1\ (i, j'')\} = \{BPORG_{out}\ (j'))\ [(org\_unit\ (j'), org\_role\ (j'))], [F(i, j)], [Pa\ (i, j)], [BPF_{mel,}\ (i',j'')], [t_{frinf}\ (i, j)], [t_{seknow}(i, j)], [(BPRES_{out}\ (j'))\ [(org\_unit\ (j'), org\_role\ (j'))]\} \quad (27b)$$

$\{BPORG_{out}$ (j')) [(org_unit (j'), org_role (j')] - role (personality) operating within firm or company organization unit is responsible for business process function [F(i, j)], which provides activities [Pa (i, j)], quantified via metrics indicators [$BPF_{mel,}$ (i',j'')] and should operate with information support [t_{frinf} (i, j)] and knowledge based support (know how) and is responsible to organization unit and role [($BPRES_{out}$ (j')) [(org_unit (j'), org_role (j')].

5.3 Business Process TNL Text form of Regulation Rules – Comparison with Existing Solutions

In general, BP model elements represented via standardized BPN components might be transferred into TNL text via three principle steps (a) *text planning* - where that information is determined which is communicated in the text. Furthermore, it is specified in which order this information will be conveyed, (b) sentence planning - afterwards, specific words are chosen to express the information determined in the preceding phase. If applicable, messages are aggregated and pronouns are introduced in order to obtain variety (c) surface Realization. Finally, the messages are transformed into grammatically correct sentences.

Now, we shall try to compare how BP regulation rules described in section 3.4.3 might be generated in TNL text version, while the outgoing BP model is represented via BPMN [17] system components. In order to achieve that, the above-mentioned steps should be described in more details.

5.4 Text Planning

In the text planning phase we face three main challenges. *First, we have to adequately infer given linguistic information from process model elements*. For instance, the activity Take down order must be automatically split up into the action take down and the business object order. Without this separation, it would be unclear which of the two words defines the verb [11,21]. When comparing it with section 3.4 content, appropriate linguistic information inferred from process model elements is contained in [($BPF_{func,}$ (i',j'')), ($BPF_{mel,}$ (i',j''))]] linguistic sets (see also formula 20).

5.5 Linearization of the Process Model to a Sequence of Sentences

The second challenge is the linearization of the process model to a sequence of sentences. Process models rarely consist of a plain sequence of tasks, but also include concurrent branches and decision points. In addition to these tasks, it must be decided where techniques of text structuring and formatting such as paragraphs and bullet points should be applied [8].

[11]. When comparing it with section 3.4 content, this might be done via determination of content related to {Petx [l', F(i', ($BPOI_{inp}$ (j')) , ($BPOM_{inp}$ (j'))]} and {Pe [(l', [($BPF_{func,}$ (i',j'')), ($BPF_{mel,}$ (i',j''))]]} linguistic sets (see also formula 10b).

5.6 The Sentence Planning Phase

The sentence planning phase entails the tasks of lexicalization and message refinement. The aspect of lexicalization refers to the mapping

[17] *BPMN – Business Process Modeling Notation*

from BPMN constructs to specific words. It requires the integration of linguistic information extracted from the process model elements and of control structures as splits and joins in such a way that the process is described in an understandable manner. The aspect of message refinement refers to the construction of text. It includes the aggregation of messages, the introduction of referring expressions as pronouns and also the insertion of discourse markers such as afterwards and subsequently [8]. When comparing it with section 3.4 content, this might be done via PBPL Equation (basic version) - see also formula 4. This is described within section 3.4, subsection Rule creation procedure with respect to formula 22.

5.7 Surface Realization

In the context of the surface realization, the actual generation of a grammatically correct sentence is performed. This requires the determination of a suitable word order, the inflection of words, introduction of function words (e.g. articles) and also tasks such as punctuation and capitalization. When comparing it with section 3.4 content, this might be done via formulas 22, 23a, 23b and 24 postulated in 3.4 section and subsection denoted as Definition of the rule final version.

6. CONCLUSION

This paper's main goal was to prepare proposal for establishment of regularities and algorithms concerned to BP modeling provided based on linguistic approach principles, while the proposed regularities and algorithms deal with BP structure, functionality, performance and metrics as well. However, the BP to be investigated and modeled has to be quantified with respect to appropriate manner before and therefore several relations and formulas have been postulated, which enable doing that. They are based on application of PBPL Equation (in basic and extended version) in most cases and are closely related to BP structure functionality and performance metrics.

In this paper, there are postulated three rules as an example, while they have the following practical meaning:

> ***Rule no. 1*** is concerned with BP final product evaluation and creates basis for estimating relations between input material quality and quality of final products represented by number of good, repaired and waste final products.
>
> ***Rule no. 2*** share of BP function metrics items and values related to quality of investigated BP outputs represented by number of good, repaired and waste final products.
>
> ***Rule no. 3*** enables generating BP TNL Texts form the above mentioned regulation rules, which might create good supporting information or knowledge in making decisions related to business process outputs represented by number of good, repaired and waste final products.

Those rules might be transferred into an appropriate application program, which might play a role of a good supporting tool in management that process, which generates the above-mentioned products, while the previous theoretical description creates an adequate basis for design and implementation such application program.

The theoretical basis postulated within this paper created basis for preparation new articles concerned to business strategy design with the use of BP linguistic modelling. Those articles have been sent for publishing. However, this theoretical basis is being applied in preparing concept related to applications concerned to business process linguistic modelling design (vertical and horizontal structure) as well. On the other hand, the above-mentioned theoretical basis might be applied, when designing applications for BP implementation and controlling too. Those applications design and implementation represents a set of steps for the work in the near future.

NOTE

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COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Grell M, Stašák J. Balanced scorecard – Semantic approach, Aspects of Methodology In Ekonomika a manažment: Vedecký časopis Fakulty podnikového manažmentu Ekonomickej univerzity v Bratislave. - Bratislava: Fakulta podnikového manažmentu Ekonomickej univerzity v Bratislave. 2011;8(2):34-46. (Slovak)
   ISSN 1336-3301
2. Investment and Business Performance ECAR Research Study 4; 2005.
   Available:http://techexcel.com/resources/whitepapers/Metrics.pdf
3. Stašák J. Strategy creation versus analysis of business subject internal capabilities linguistic approach. In: Proceeding of the Conferences Present Day Trends of Innovations. Dubnica nad Váhom. 2013; 212-223.
   ISBN 978-80-89400-59-1
4. Stašák J, Vaníčková R, Grell M. Business process modeling linguistic approach – Problems of business strategy design. Universal Journal of Management. 2015; 3(7):271-282.
   DOI: 10.13189/ujm.2015.030702
5. Stašák J. Business process linguistic modeling – Philosophy & Principles. Computer Science and Information Technology. 2015;3(5):198-213.
   DOI: 10.13189/csit.2015.030505
6. Ramias A, Wilkins CH. Performance Improvement ABT Trends Column; 2010. Available:http://techexcel.com/resources/whitepapers/Metrics.pdf
7. Embrace Five Disruptive Trends That Will Reshape BPM Excellence" Forrester report Source: August 29; 2012.
8. Leopold H, Mendling J, Polyvyany A. Generating natural language texts from business process models; 2008.
   Available:http://www.mendling.com/publications/12-CAISE-Text.pdf
9. Wetzsteina B, Leitnerb P, Rosenbergc F, Dustdarb S, Leymanna F. Identifying influential factors of business process performance using dependency analysis. Enterprise Information Systems. 2011;5(1): 79–98.
10. Koselleck R. Futures past. On Semantics of Historical Time translated by K. Tribe Cambridge Mass; 1985.
11. Koselleck R. Vergangene Zukunft in der frühen Neuzeit. in: Ders.: Vergangne Zukunft. Zur Semantik geschichtlicher Zeiten. Frankfurt/Main. 1989;17-37.
12. Koselleck R. The temporalisation of concepts; 1997.
    Available:http://www.jyu.fi/yhtfil/redescriptions/Yearbook%201997/Koselleck%201997.pdf
13. Koselleck R. Vergangene Zukunft: Zur Semantik gesichtlicher Zeiten Frankfurt am Main Suhrkamp; 2000.
    Available:http://medien-geschichte.akbild.ac.at/materialien-ws-09/zeitvolltexte/Koselleck_Erfahrungsraum.pdf/view
    ISBN 3-518-28357-X
14. Wahli U, et al. Business process management: Modeling through monitoring using WebSphere V6.0.2 products. Riverton, NJ: IBM, International Technical Support Organization; 2007.
15. Pittman D. Managing business performance corporate performance management. PricewaterhouseCoopers., Managing Business Performance – The Metrics That... - PwC Australia; 2008. Available:http://www.pwc.com.au/.../managing-business-performance-metrics-2008.pdf
16. Stašák J. A contribution to semantic text analysis. In: Electronic Computers and Informatics ECI 2004, The University of Technology Košice, Department of Computers and Informatics of FEI, 22-24. 9. 2004 Košice – Herľany, SR. 2004;132-144.
    ISBN 80-8073-150-0
17. Stašák J. Application of fuzzy sets apparatus in image semantic analysis. In: Proceeding of 5th International Carpathian Control Conference Faculty of Mechanical Engineering and Robotics AGH-UST Krakow Zakopane, Poland. 2004;255-260. ICCC 2004 Zakopane, Poland, May 25-28; 2004.
    ISBN 83-89772-00-0
18. Stašák J. A Contribution to image semantic analysis. In: Informace na dlani, Albertina Income Praha, s.r.o., Praha; 2004. Electronic version, Infoforum Praha; 2004.
    ISSN: 1214-1429
19. Stašák J. Image databases designed and implemented based on fuzzy set algorithms. In: Proceedings of 6th

International Carpathian Control Conference ICCC. 2005;1:419-430. Miskolc-Lillafured May 24-27; 2005.

20. Staniszkis W. Modelling business process performance. Business Process and Services Computing: 1st International Working Conference on Business Process and Services Computing, BPSC 2007, September 25-26; 2007, Leipzig, Germany; 01/2007.
21. Stašák J. Modelovanie procesov podnikania s využitím aplikačného programu ARIS, EKONOM, Bratislava; 2010.

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