Business Process Linguistic Modeling – Philosophy & Principles

Jozef Stasak

Institute of Technology and Business in Ceske Budejovice, Czech Republic

Copyright © 2015 by authors, all rights reserved. Authors agree that this article remains permanently open access under the terms of the Creative Commons Attribution License 4.0 International License

Abstract This contribution deals with business process modeling problems with the use of linguistic approach, while the special attention is paid to business process modeling based on semantic networks and reference databases. It consists of three important parts. In the first part, a reader may find an answer for question “Why business process modeling based on linguistic approach?”, the second part deals with problems of interconnection among key performance indicators KPIs and business process metrics items and the third part closing that contribution content deals with problems of that business process modeling functionality, which is based on semantic networks and reference databases as well.

Keywords Business Process Linguistic Modeling, Philosophy, Principles, Application

1. Introduction

A **business process** is a logical ordering of people, procedures and technology into work activities designed to transform information, materials and energy into a specified result [15]. On the other hand, process model or definition is used to describe the process by means of automation is composed of process modeling and enactment phases. In general, three business modeling approaches and methodologies might be accepted: business process modeling developed by Prof. A.W. Scheer and is based on four views related to any business process: functional, process, data, organizational and product-process view, while that approach is denoted as *standardized approach* [18], approach of increasing the level of automation of business process modeling (BPM) by representing the various spheres of an enterprise using ontology languages and semantic WEB services frameworks, which denoted as *semantic approach* [20] and approach, which is closed to extraction of business rules (BR), while two approaches have been used to extract BR from process specifications written in form of text in natural language (TNL –text in natural

language) [4]. This approach is denoted as *linguistic approach* [19].

In this contribution, we shall discuss about one of specialized business process (BP) modeling linguistic approach, which is based on semantic networks and reference databases. The contribution main goal is: *to explain a set of functionality principles of that business modeling type and a set of possibilities how that approach may help in determination of BP metrics (on strategic, tactic and operational levels) with respect to KPI indicators defined within business strategy creation and updating.*

In order to achieve the main goal, the following partial goals should be postulated and fulfilled: the first is to answer the question “Why business process modeling based on linguistic approach?” The second question is closed to enterprise architecture and business model problems together with adequate business perspective, while that question might sound: “How to provide an interconnection among KPI indicators and core business process metrics items?” The third question deals with business process modeling – linguistic approach with the use of semantic networks and reference databases, while that question might sound: “How business process modeling – linguistic approach with the use of semantic networks and reference databases does work?” I tried answering those questions within adequate sections of this contribution.

In this contribution, we shall discuss about one of specialized business process (BP) modeling linguistic approach, which is based on semantic networks and reference databases. The contribution main goal is: *to explain a set of functionality principles of that business modeling type and a set of possibilities how that approach may help in determination of BP metrics (on strategic, tactic and operational levels) with respect to KPI indicators defined within business strategy creation and updating.*

In order to achieve the main goal, the following partial goals should be postulated and fulfilled: the first is to answer the question “Why business process modeling based on linguistic approach?” The second question is closed to enterprise architecture and business model problems

together with adequate business perspective, while that question might sound: “How to provide an interconnection among KPI indicators and core business process metrics items?” The third question deals with business process modeling – linguistic approach with the use of semantic networks and reference databases, while that question might sound: “How business process modeling – linguistic approach with the use of semantic networks and reference databases does work?” I tried answering those questions within adequate sections of this contribution.

2. Business Process Linguistic Modeling – Terms and Principles

2.1. Business Process Intelligence versus Business Process Management and Modeling

In principle, Business Process Intelligence (BPI) aspects include business process (BP) management and modeling, incl. their information support within stages related to analysis and design, as well as implementation and operation. In all of the above-mentioned BPI aspects a standardized, semantic and linguistic approach shall be considered and respected.

The outgoing point for all of above mentioned approaches is business process ontology – defined as a general term and term closely related to Business Process Intelligence. Business Process Management and Modeling creates an integral part of Business Process Intelligence.

Business Process Modeling Standardized Approach

Business process modeling standardized approach has been developed by Prof. A.W. Scheer and is based on four views related to any business process: functional, process, data, organizational and product-process view. This approach is based on five platforms: business process analysis and design, business process implementation and business process controlling. However, the Business Strategy Creation Platform creates an integral part of that approach as well. This approach is being supported by a set of application programs, which create an integral part of system [18].

Business Process Modeling Semantic Approach

Semantic business process *management* [19] (SBPM) is a new approach of increasing the level of automation of BPM by representing the various spheres of an enterprise using ontology languages and semantic WEB services frameworks. The goal is to be able to apply machine reasoning for the translation between these two spheres, in particular for the discovery of processes, process fragments and for process composition. However, business process ontology plays a role of great importance within this approach as well. Domain ontology supports process modeling in terms of describing the actual data that is processed during process

execution via this semantic description of the data, business process analysis can be semantically enhanced since the semantic meaning of the data is preserved during all phases of the process lifecycle.

Business Process Modeling Linguistic Approach

This approach is closed to extraction of business rules (BR), while two approaches have been used to extract BR from process specifications written in natural language (TNL text) [4]: a) Linguistic Approach b) Statistical Approach [21]. The goal is to be able to apply machine reasoning for the translation between these two spheres, in particular for the discovery of processes, process fragments and for process composition. The following methods are found and applied over there:

- Methods based on syntactic and semantic analysis [9].
- Methods based on grammatical heuristics [5, 6]
- Methods based on linguistic analysis and linguistic patterns [11].

However, there might postulated one more linguistic approach based on semantic networks and so called reference databases and is denoted as Business Process Semantic Network Modeling (hereinafter known as BPSNM Modeling). This approach is based on two principle issues:

Issue no.1

A structure and functionality of any BP might be described via TNL text, which consists of common logical sentences, while any logical sentence consists of text strings $[T_s(I, j)]$ $i=1\dots n$, (serial number of logical sentence contained within TNL text and $j=1\dots m_1$ (serial number of the text string contained within logical sentence). Each text strings $T_s(I, j)$ has its own semantic meaning assigned via $[T^{sem}(i, j)]$, while formula (1) might be postulated

$$\{\text{Word}(i, j)\} = \{[T_s(I, j)], [T^{sem}(i, j)]\} \quad (1)$$

$$\{\text{Words}(i, j)\} = \Pi_{i,j} \{\text{Word}(i, j)\} \quad (2)$$

$$\{\text{Words}(i, j)\} \subset \{\text{TNL}_{\text{text}}(i, j)\} \quad (3)$$

However, we need an appropriate set such words, in order to describe any business process (Pe) structure functionality, while the $\{\text{Pe}(i, j)\}$ set might be applied for those purposes. Because, the words quantified via sets represented by formulas (1), (2) and (3) and they have a linguistic character, they will be considered to be *linguistic sets* and they will be applied business process (Pe) structure functionality. It means, the $\{\text{Pe}(i, j)\}$ might be approximated via $\{\text{Words}(i, j)\}$ set and formula (4) might be postulated

$$\{\text{Pe}(i, j)\} = \{\text{Words}(i, j)\} \quad (4)$$

On the other hand, any business horizontal structure is being created by set functions, which generate pre-defined outputs based on appropriate inputs, while formula might be postulated

$$\{Pe(i, j)\} = \{[F1(i, j)], [F2(i, j)] \dots [Fn(i, j)]\} = \prod_{k=1}^n [F_k(i, j)] \quad (5)$$

where

$\{[F1(i, j)], [F2(i, j)] \dots [Fn(i, j)]\}$ are functions, an appropriate business process consists of

However, those functions may be described via $\{Words(i, j)\}$ linguistic sets as well, while formula (6) can be postulated

$$\forall [F_k(i, j)] \exists \{Words_k(i, j)\} \Rightarrow [F_k(i, j)] = \{Words_k(i, j)\} \quad (6)$$

It means, any business process (BP) function can be approximated via set of words, which creates an integral part of TNL text. This is the *first* important principle of BP modeling linguistic approach.

However, there is the second important issue as well Any BP function set consists of three principal subsets **[Object (i, j)]**, **[Action (i, j)]** and **[Result (i, j)]** see also formula (7)

$$\{[F_k(i, j)]\} = \{[Object(i, j)], [Action(i, j)], [Result(i, j)]\} \quad (7)$$

and the **[Action (i, j)]** set elements “are responsible for” generation of pre-defined BP outputs based on appropriate BP inputs. The **[Object (i, j)]** subset elements provide interconnection to BP input set and the **[Result (i, j)]** subset elements provide interconnection to BP output set.

Issue No. 2

Linguistic Representation of BP Outputs and Inputs

In general, no BP is able to generate required pre-defined outputs without appropriate inputs. As a result of that, they have to be defined and quantified very precisely. Because of considering the BP modeling linguistic approach, they have to be postulated via linguistic sets as well, denoted as $\{Petx(i, j')\}$, where $i=1 \dots n$ and has the same meaning like in the case of BP linguistic sets and j' is a serial number of linguistic subset $\{Petx(i, j')\}$ consists of (see also formula 8)

$$\{Petx(i, j')\} = \{[Petx(i, 1)], [Petx(i, 2)], [Petx(i, m_2)]\} \quad (8)$$

When applying business process $\{Pe(i, j)\}$ linguistic set to $\{Petx(i, j')\}$ linguistic set, with respect to formula (9), we can get adequate BP functionality results in form of $\{Res1(i, j'')\}$ set

$$\{Petx(i, j')\} \otimes \{Pe(i, j)\} = \{Res1(i, j'')\} \quad (9a)$$

where $j''=1 \dots m_3$

However, the $\{Res1(i, j'')\}$ linguistic set represents two type of business process outputs: primary and secondary outputs, while the $\{Tbex(i, j''')\}$ linguistic set elements represent BP functionality *primary products* and $\{Retx(i, j''''')\}$ linguistic set elements represent BP functionality *secondary products* and formula (9b) might be postulated

$$\{Res2(i, j'')\} = \{Tbex(i, j''')\} \otimes \{Retx(i, j''''')\} \quad (9b)$$

and

$$\{Res2(i, j'')\} = \{Res1(i, j'')\} \quad (9c)$$

Formulas (9a), (9b) and (9c) create basis of PBPL¹ Equation [20]

Example

Let us consider a business (technological) process denoted as Glass melt preparation (GPM process). The principle input component applied for those purposes is raw denoted as Glass batch (GB), which has its own composition and weight and might be represented by linguistic set **{Petx(1, 1)}** – see also formula (10), while the principle output component is glass melt, which has its own weight and composition and viscosity and temperature as well.

$$\{Petx(1, 1)\} = \{[Glass\ batch_1\ (Weight_{11},\ Composition_{11})]\} \quad (10)$$

The GPM process alone is running in two phases.

Phase 1

At first the process Melting₁ is running, where attributes Temperature₁₁, Pressure₁₁ play an important role (see also formula 11b). That process running result (see also formula 16c) is considered to be an intermediate product and creates Object for Melting₂ process.

[F1(i, j)] - Initial glass batch melting – creation of intermediate mixture (glass batch – glass melt)

The above-mentioned action is provided related to object postulated via formula (11a).

$$\{[Object(i, j)]\} = \{[Glass\ batch_1\ (Weight_{11},\ Composition_{12})]\} \quad (11a)$$

$$\{[Action(i, j)]\} = \{[Melting_1\ (Temperature_{11},\ Pressure_{11})]\} \quad (11b)$$

$$\{[Result(i, j)]\} = \{[Result(1, 1)]\} = \{[Glass\ batch_2\ (Weight_{11},\ Composition_{11},\ Temperature_{11},\ Pressure_{11})], [Glass\ melt_1\ (Weight_{12},\ Composition_{12},\ Temperature_{12},\ Pressure_{12},\ Viscosity_{11})]\} \quad (11c)$$

Now, we shall apply PBPL Equation in order to represent and to quantify running the above-mentioned process in Phase 1 (see also 9a) and we shall show results of that application (see also Figure 1)

¹ PBPL – Principle Businesses Process Linguistic Modeling

Business Rule (BR) is a statement that defines or constrains some aspects of the business. Although modern elicitation methods and techniques promote close interaction with stakeholders in order to identify their needs — as well as to obtain a better understanding of both problem and business — requirements engineers usually find themselves analyzing text written in natural language (TNL text), like interview transcripts and documented processes [16]. Usually, the managers responsible for business processes running within actual firm, company or organization are not able and do not have time to study schemas prepared by business analysts and need direct answers for their questions in form of adequate knowledge, the objective-oriented expert systems are considered to be very suitable knowledge based supporting tool for making their decisions. Without developed financial and entrepreneurial awareness are hard to make people creative, active and also competently engage in market processes, ensuring the effective functioning of the national economy [21]. On the other hand, each expert system operates over an appropriate knowledge base (KB), where knowledge contained in that KB are represented via semantic networks created as a result of text or image content semantic analysis. According to the data, most of them did not know about the possibilities of a more environmentally friendly approach to soil enhancement based on the addition of a fertilizer in the form of biochar [12]. This is a further reason why linguistic approach should be applied for business process modeling purposes. In this section, I tried answering the question “Why business process linguistic modeling?” The next sections of that contributions deal with problems how the business process linguistic modeling look like.

Source: The Author

Figure 2. Representation of knowledge concerned to BP Glass melt preparation – Phase 1

When looking at Fig.1 we can see a course of GPM Process (Phase 1) with appropriate metrics indicators and attributes, while it might create basis for knowledge representation, when designing knowledge base, an adequate expert system operates over and deals with business process architecture models.

The way knowledge representation is based on two important components and is going out from TNL text, which describes the business process to be modeled. The first component is denoted as a reference database (RD), where a content of linguistic sets $\{[Petx(i, j)]\}$, $\{[Pe(i, j)]\}$ and $\{[Res1(i, j)]\}$ (see also Fig.2) and the semantic network (SNW), which contains attributes closely related to structure and dynamic of BP to be modeled, while the SNW central linguistic set is denoted as “Action”. The attributes related to BP static view are concerned the BP structure, while the attributes related to BP dynamic view are concerned the BP functionality and state transition. On the other hand, the linguistic sets “Objects” and “Results” contain indicators attributes, pointer to real item values contained within $\{[Petx(i, j)]\}$, $\{[Pe(i, j)]\}$ and $\{[Res1(i, j)]\}$ - see also Fig. 2. However, the similar way of knowledge representation might be applied related to Phase 2 of GPM Process as well.

3. Business Models, Strategy and Sustainable Competitive Advantage

3.1. General Overview

A *business model* articulates the logic, the data, and other evidence that support a value proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value. In short, it's about the benefit the enterprise will deliver to customers, how it will organize to do so, and how it will capture a portion of the value that it delivers. A good business model will provide considerable value to the customer and collect (for the developer or implementer of the business model) a viable portion of this in revenues. But developing a successful business model (no matter how novel) is insufficient in and of itself to assure competitive advantage. Once implemented, the gross elements of business models are often quite transparent and (in principal) easy to imitate and indeed, it is usually just a matter of a few years or if not months before an evidently successful new business model elicits imitative efforts. In practice, successful business models very often become, to some degree, ‘shared’ by multiple competitors. A business

model is more generic than a business strategy. Coupling strategy and business model analysis is needed to protect competitive advantage resulting from new business model design. Business model choices define the architecture of the business expansion paths [2].

3.2. Developing the Business Model

The plan implemented by a company to generate revenue and make a profit from operations is considered to be a business plan. The model includes the components and functions of the business, as well as the revenues it generates and the expenses it incurs. However, the business model dates back to the earliest days of business; it merely describes the way in which a company makes money. A business model can be simple or very complex. A restaurant's business model is to make money by cooking and serving food to hungry customers. A website's business model might not be so clear, as there are many ways in which these types of companies can generate revenue. For example, some make money (or try to) by providing a free service and then selling advertising to other companies, while others might sell a product or service directly to online customers². However, the business model might be interpreted as a description of means and methods a firm employs to earn the revenue projected in its plans as well. It views the business as a system and answers the question, "How are we going to make money to survive and grow³?"

3.3. Examples of Business Models

Business models are necessary features of market economies where there is consumer choice, transaction costs, and heterogeneity amongst consumers and producers, and competition. Profit seeking firms in competitive environments will endeavor to meet variegated consumer wants through the constant invention and presentation to the consumer of new value propositions. Business models are often necessitated by technological innovation which creates both the need to bring discoveries to market and the opportunity to satisfy unrequited customer needs. At the same time, as indicated earlier, new business models can themselves represent a form of innovation. There are a plethora of business model possibilities: some will be much better adapted to customer needs and business environments than others. A selecting, adjusting and/or improving business model is a complex art. Good designs are likely to be highly situational, and the design process is likely to involve iterative processes. New business models can both facilitate and represent innovation e as history demonstrates⁴.

3.4. Business Strategy Creation System – Linguistic Version

²Definition of 'Business Model

<http://www.investopedia.com/terms/b/businessmodel.asp>

³Business model

<http://www.businessdictionary.com/definition/business-model.html>

⁴ Business Models, Business Strategy and Innovation

<http://www.bmcommunity.sitew.com/fs/Root/8jig8-businessmodelsbusinesstrategy.pdf>

In general, the Balanced Scorecard Method is applied for business strategy creation and updating. However, there are two approaches related to that method application. The first one is based on classical principles, where the firm or company mission statement and objectives are closely related to the term denoted as *business strategy goals or aims*, which may be quantified via set of *strategic goal indicators* [8]. Findings - the business model - provide a valuable structural template for mapping the current business model of a firm. However, in developing and discussing strategic options, it acts more as a symbolic artefact stimulating a creative decision-making process than an analytic tool with a clear sequence of steps.

Practical implications - when working with the business model concept in practice, its technical and linguistic legitimacy is initially highly limited. In the process of gaining legitimacy, however, a collective lock-in to the current strategic identity may arise. Managers have to be aware of these limitations and need to achieve an appropriate balance within the organization [8] postulated that the Balanced Scorecard (BSC) method suggests that business performance should be evaluated not only by using financial indicators but also simultaneously considering non-financial indicators. It has been revealed in the review of relevant literature that despite the satisfying levels achieved in conceptual and theoretical dimension of BSC, the method has some deficiencies in terms of implementation on a quantitative basis and that there remain some problems to be resolved subject of this study covered the measurement and evaluation dimension of BSC. With respect to the above-mentioned facts and postulates, the BSC System might play a role not only closely related to the firm or company business performance evaluation tool; however it might be considered to be business model concept representative as well. In general, the BSC System consists of five perspectives: *financial, customers, internal business process and learning and growth perspective*, while one more perspective may be added to those perspectives as well. This perspective is denoted as *technological perspective* and is closely related to business technological support and with problems of governance and risk management too [7].

Business strategy design in form of text written in a natural language and in form of fuzzy sets, which contain appropriate linguistic variables led to deriving of the Principle Business Process Linguistic Equation - PBPL Equation in a general form, having many solutions, when applying it for business strategy design and updating or business process modeling with the use of linguistic approach (see also formulas 9a, 9b and 9c) [21].

A business strategy creation and update creates an integral part of Strategic management level. In principle the Balanced Scorecard Method (BSC) is being applied for those purposes, while Internal Business Process Perspective KPIs and a set of KPIs closely related to further four perspectives play a role of principle importance.

Let us consider a set of KPIs assigned to appropriate BSC perspectives as follows:

$\{KPI_{Fin}\}$ – A set of KPIs closely related to BSC Financial Perspective

$\{KPI_{Cus}\}$ – A set of KPIs closely related to BSC Customer's Perspective

$\{KPI_{Bp}\}$ – A set of KPIs closely related to BSC Internal Business Process Perspective

$\{KPI_{Eg}\}$ – A set of KPIs closely related to BSC Growth and Education Perspective

$\{KPI_{Tech}\}$ – A set of KPIs closely related to BSC Technological Perspective

However, when providing core BP analysis related to Strategic Management Level we have to operate with BSC KPI indicators, while those BP metrics indicators and attribute conformity with KPI set attributes plays a role of principle importance. As a result of that, we need an

algorithm, which enables decomposing the KPI set elements so they could correspond with the business process metrics attributes and a unique set of relations among them would be postulated.

The PBPL equation will be applied for those purposes and therefore an appropriate content of linguistic sets $\{Petx(i, j)\}$, $\{Pe(i, j)\}$ and $\{Res1(i, j)\}$ should be postulated.

Five principle BSC System perspectives should be respected, when determining the $\{Petx(i, j)\}$ linguistic set content: financial, customer's, education and growth, technological and perspective related to internal business processes [7]. Subsequently, a set of appropriate KPI attributes should be prepared and converted into $\{Petx(i, j)\}$ linguistic set elements – see also Table 1.

Table 1. $\{Petx(i, j)\}$ linguistic set elements $i=1 \dots 5, j=1 \dots 6$

Perspective	KPI 1	KPI 2	KPI 3	$\{Petx(i, j)\}$ linguistic set element
Financial KPI-fin	[Hro(1,j=1,2)]= [Assets1 (1,2)]	[Hro (1,j=3,4)]= [Costs1 (1,2)]	[Hro (1, j=5,6)]= [Profit1 (1,2)]	Petx (1, 6)
Customer's KPI-cust	[Hro(2,j=1,2)]= [GrossTurnover2(1,2)]	[Hro(2,j=3,4)]= [Cost2 (1,2)]	[Hro (2, j=5,6)]= [Profit2 (1,2)]	Petx (2, 6)
Internal business processes KPI-ibp	[Hro(3,j=1,2)]= [GrossProduction3(1, 2)]	[Hro(3,j=3,4)]= [Costs3 (1,2)]	[Hro (3, j=5,6)]= [Profit3 (1,2)]	Petx (3,6)
Education & Growth KPI-edg	[Hro (4,1)]= [Gross turnover & Grossproduction4(1, 2)]	[Hro(4,j=3,4)]= [Costs4 (1,2)]	[Hro (4, j=5,6)]= [Profit4 (1,2)]	Petx (4,6)
Technological KPI-tech	[Hro (5,1)]= [Gross turnover & Grossproduction5(1,2)]	[Hro(5,j=3,4)]= [Costs5(1,2)]	[Hro (5, j=5,6)]= [Profit5(1,2)]	Petx (5,6)

Source: The Author

Table 2. $\{Pe(i, j)\}$ linguistic set elements

Core process	$\{Petx'(i, j)\}$ set element	Main process 1	Main process 2
$\{[Core BP_1] =$ Utility Glass Production	[Hro (1,j=1,2)] =[Assets 1 (1,2)]	[Main BP_1_1 (H 1)] Manually oriented	[Main BP_1_2 (H 2)] Machinery oriented
$\{[Core BP_1] =$ Utility Glass Production	[(Gross Turnover)] [(Costs 2)], [(Profit2)]	[Main BP_1_1 (H 1)] Manually oriented	[Main BP_1_2 (H 2)] Machinery oriented
$\{[Core BP_1] =$ Utility Glass Production	[(Gross Production)] (Costs3), Profit3	[Main BP_1_1 (H 1)] Manually oriented	[Main BP_1_2 (H 2)] Machinery oriented
$\{[Core BP_1] =$ Utility Glass Production	[(Gross Production)] (Costs4), Profit4	[Main BP_1_1 (H 1)] Manually oriented	[Main BP_1_2 (H 2)] Machinery oriented
$\{[Core BP_1] =$ Utility Glass Production	[(Gross Production)] (Costs3), Profit5	[Main BP_1_1 (H 1)] Manually oriented	[Main BP_1_2 (H 2)] Machinery oriented

Source: The Author

In general, those attributes are considered to be KPI indicators related to main business processes denoted as Main process 1 and Main process 2, being subordinated to the core process $\{[Core BP_1 (C_1)]\}$. The above-mentioned KPI attributes might be applied for controlling purposes and are concerned to BP functionality and performance of core business processes and play a role of reference values for comparison of metrics attribute values generated by those business processes and calculation of their effectiveness and efficiency. The same approach might be applied, when creating metrics concerned to Core BP_1 (C_1) business process and subordinated main business processes Main 1 and Main 2.

Table 3. Decomposition of KPI indicators generated as a result of BSC System functionality related to core and main business process metrics $\{\{Res1(i'', j'')\}\}$ linguistic set elements -The Beginning

BSC System - Perspective				
Financial	Customer's	Internal BP	Education& Growth	Technological
BSC System Indicators				
KPI (Fin)	KPI (Cust)	KPI (IBp)	KPI (Ged)	KPI (Tech)
$\{[(Assets),(Costs1),(Profit)]\}$	$\{[(Gross\ Turnover)], [(Costs2)], [(Profit2)]\}$	$\{[(GrossProduction)], [(Costs3)], [(Profit3)]\}$	$\{[(GrossTurnover), (Gross\ Production)], [(Costs4), (Profit4)]\}$	$\{[(Gross\ Turnover),(Gross\ Production)], [(Costs5), (Profit5)]\}$
[Core process 1 (C-1)]				
$\{\{Core\ BP_1\ (C-1)\}=\{[Assets1], [Costs1], [Profit1]\}\}$	$\{\{Core\ BP_1(C-1)\}=\{[(GrossTurnover)], [(Gross_Turnover1)], [(Gross_Turnover2)]\}\}$	$\{\{Core\ BP_1\ (N-1)\}=\{[(Gross\ Production)], [(GrossProduction1)], [(GrossProduction2)]\}\}$	$\{\{[(GrossTurnover)]=\{[(Gross_Turnover1)], [(Gross_Turnover2)]\}\}, \{[(Gross\ Production)]=\{[(GrossProduction1)], [(Gross\ Production2)]\}\}\}$	$\{\{[(GrossTurnover)]=\{[(Gross_Turnover1)], [(Gross_Turnover2)]\}\}, \{[(Gross\ Production)]=\{[(GrossProduction1)], [(Gross\ Production2)]\}\}\}$
$\{\{CoreBP_1(C-1)\}=\{[(Costs1)], [(Costs11)], [(Costs12)]\}\}$	$\{\{[(Costs2)]=\{[(Costs11)], [(Costs22)]\}\}\}$	$\{\{[(Costs3)]=\{[(Costs31)], [(Costs32)]\}\}\}$	$\{\{[(Costs4)]=\{[(Costs41)], [(Costs42)]\}\}\}$	$\{\{[(Costs5)]=\{[(Costs51)], [(Costs52)]\}\}\}$
$\{\{CoreBP_1(C-1)\}=\{[(Profit1)], [(Profit11)], [(Profit12)]\}\}$	$\{\{[(Profit2)]=\{[(Profit12)], [(Profit22)]\}\}\}$	$\{\{[(Profit3)]=\{[(Profit31)], [(Profit32)]\}\}\}$	$\{\{[(Profit4)]=\{[(Profit41)], [(Profit42)]\}\}\}$	$\{\{[(Profit5)]=\{[(Profit51)], [(Profit52)]\}\}\}$

Table 3. Decomposition of KPI indicators generated as a result of BSC System functionality related to core and main business process metrics $\{\{Res1(i'', j'')\}\}$ linguistic set elements -The End

$\{\{Res1(i'', j'')\}\}$				
Main business processes		[Main BP 1 1 (H 1)]	[MainBP 1 2 (H 2)]	
KPI (Fin)	KPI (Cust)	KPI (IBp)	KPI (Ged)	KPI (Tech)
$[MainBP_1_1(HL\ 1)], [Assets11], [(Costs11)], [(Profit11)]$	$[MainBP_1_1(HL-1)], [(Gross\ Turnover12)], [(Costs12)], [(Profit11)]$	$[MainBP_1_1(HL)], [(GrossProduction13)], [(Costs13)], [(Profit13)]$	$[MainBP_1_1(HL-1)], [(Gross\ Production14)], [(GrossTurnover14)], [(Costs41)], [(Profit14)]$	$[MainBP_1_1(HL\ 1)], [(GrossProduction15)], [(GrossTurnover15)], [(Costs15)], [(Profit15)]$
$[MainBP_1_2(HL-2)], [Asset12], [(Costs12)], [(Zisk21)]$	$[MainBP_1_2(HL-2)], [(Gross\ Turnover22)], [(Costs22)], [(Profit22)]$	$[MainBP_1_2(HL-2)], [(Gross\ Production23)], [(Costs23)], [(Profit23)]$	$[MainBP_1_2(HL-2)], [(Grossturnover24)], [(Gross\ Production24)], [(Costs24)], [(Profit24)]$	$[MainBP_1_2(HL2)], [(Grossturnover25)], [(GrossProduction25)], [(Costs25)], [(Profit25)]$

The above-mentioned text and tables show how the core business process and their metrics attributes might be decomposed into subordinated main business processes (incl. adequate BP process metrics attributes) and how they correspond to KPI indicators and attributes. However, in Section 4, there is a description of algorithms related to decomposition of selected business process and business process metrics indicators and attributes, with respect to strategic, tactic and operational level of management as well.

3.5. Enterprise Architecture versus Business Process Perspective

The architecture defines the structure of the enterprise through its life-cycle, which starts with the identification of the enterprise followed by conceptual design incl. strategy, mission, vision and values. The overall outline (concept) is necessary to be able to complete a preliminary or architectural tailed design of design, which in turn is necessary to be able to complete the detailed design. The

decisions related to business concept, strategy and the rest of the concept may be captured in descriptions and models. They create basis for detailed design and implementation phase to actually establish the enterprise (buildings, machines, HW, SW, trained people, etc. [2]. The description usually has form of text written in a natural language (TNL text) which might be a subject of an appropriate semantic analysis, as a result of which a set of adequate semantic network and reference databases might be generated, while they may create basis for representation of knowledge contained in the expert system knowledge base.

The Enterprise Architecture Frameworks usually define the life-cycle activities and relations among them on a diagram called Enterprise Reference Architecture, which shows the anatomy of a life cycle of the enterprise. It describes a logical structure of activities, interfaces among them, which provide a data interchange.

In general, any Enterprise Reference Architecture (ERA) shows lifecycle activities in layers or phases postulated as

follows⁵:

- Identification of CIM business entity
- Concept layer (mission, vision and values)
- Definition layer (functional requirements)
- Specification layer
- Detailed design layer
- Manifestation layer
- Operations layer

All of the above-mentioned views might be described via set of logical sentences written in a natural language (TNL Text) stored in one or more TNL text files. A set of such text file might represent partial reference databases (P-RDB) and any of those databases creates an integral part of the complex reference database (C-RDB). The P-RDB or the C-RDB is considered to be an outgoing source for creating semantic networks closely related to appropriate business process models and the facts contained within semantic networks can be directly referred to adequate part of P-RDB.

Let us consider a business process map, which deal with three types of business processes (BP): a) BP – core, b) BP – main, c) BP – supporting. A set of three partial reference databases may represent the above-mentioned BP type groups and C-RDB-BP consists of three above mentioned partial reference databases. The problems relating to Business Process Modeling with the use of Semantic Network and Reference Databases incl. an example concerned to application of that modeling type for marketing business process are discussed within next section.

- BP – managerial – P-RDB-BPM
- BP – core – P-RDB-BPC
- BP – supporting – P-RDB-BPS

4. Business Process Quantification via PBPL Equation and Modeling via Semantic Networks and Reference Databases

In this section, we shall show how the PBPL Equation might be applied for market business process quantification and modeling with the use of semantic networks and reference databases on strategic level, however a set of appropriate aspects relating to that type of modeling for business processes running within tactic and operation management level will be discussed in this section as well.

4.1. Business Process Quantification via PBPL Equation for Marketing Business Process Quantification

The previous sections deal with Business Process Modeling with the use of Semantic Network and Reference Databases and emphasize a qualitative point of view. However, the qualitative point of is considered to be one coin's side only, while the second side is closely related to business process quantification, when applying the business

process modeling based on linguistic approach.

We shall apply that approach to modeling BP Functional and Process View and to Data and Information and Knowledge Based View as well.

4.2. Business Process Architecture Model –Functional View

4.2.1. Core Business Process Decomposition

At present, most of firms, companies and institutions (hereinafter known as firms) are doing best in applying the business process management, which is based on the principle that any business process running in the firm shall have the administrator, while that administrator might be the BP owner, operator or executor. It means the business processes play a role of principle importance in any firm, when providing fulfillment of values closely related to pre-defined KPI business strategy indicators generated as a result of Balanced Scorecard System (BSC System) functionality. As mentioned above (see also section 2.1), the BSC System operates with five perspectives and a set of appropriate KPI indicators corresponds to each of those perspectives.

Although, the business processes play a role of principle importance within fulfillment of appropriate business strategy indicators, their functionality shall be described and quantified via the indicators and attributes, which correspond to KPI indicators and create the *BP metrics*, which includes three subordinated metrics:

- BP Input Metrics
- BP Output Metrics
- Metrics of BP alone

The principles, which create an integral part of BP modeling – linguistic approach will be applied, when preparing concept of the above-mentioned metrics, while the PBPL⁶ equation, the basic form of which is postulated via formulas 9a...9d, represents basis for those purposes.

With respect to the above-mentioned issues the question no.1 should be postulated and answered:

Question: “*How the core business process (core business processes) should be decomposed via PBPL Equation, so that the BP metrics attribute could correspond to appropriate KPI indicators and attributes generated via BSC System*”.

An adequate answer could be found based on the following consideration.

Consideration: Two main business process created as a result of the core business process decomposition.

Let us consider the core business process [Pe] described via TNL text string⁷ and represented by linguistic set {[Pe (i, j)]}, while the following formula might be postulated

$$[Pe] = \text{“Production”} = \{[Pe (i, j)]\} = \{[1], [„Production“], [(m_{1(1)}), (m_{1(2)}), \dots, m_{1(x)})]\} \quad (4-1)$$

⁵ Ibid

⁶ PBPL - The Principle Business Process Linguistic Equation

⁷ The text string can be written in English, German, Slovak, etc.

Where $i=1$ – only one business process is being considered
 $j=1, \dots, m_1$ – number of attributes, which create the BP metrics and that BP metrics is based on five attributes: (“Gross Production”), (“Gross Turnover”), (“Assets”), (“Costs”).

Let us consider the core business process denoted as ["Utility Glass Production"], which is considered to be one of core BP affecting fulfillment of business strategy quantitative indicators. The core BP should be decomposed into two main business processes: [“Manually Oriented”], ["Utility Glass Production"] and [“Machinery Oriented”], ["Utility Glass Production"], while the following attributes determine their metrics (“Gross Production”), (“Gross Turnover”), (“Assets”), (“Costs”).

Now, the core BP decomposition is getting started.

However, before the core BP input metrics should be defined via $\{\text{Petx}(i', j')\}$ linguistic set elements (see also Table 4). After having completed that and applying formula (2-1d), we will get two subordinated main business processes represented by linguistic set $\{\text{Res1}(1, m)\}$, where $m=2$ (see also Table 4).

Now, we shall try decomposing the above-mentioned core business process, which contains its metrics, attributes as well.

However, before the core BP input metrics should be defined via $\{\text{Petx}(i', j')\}$ extended linguistic set elements (see also Table 5). After having completed that we will get two subordinated main business processes represented by linguistic set $\{\text{Res1}(1, m)\}$, where $m=3$ (see also Table 5).

Table 4. The core business process decomposition without BP metrics attribute

$\{\text{Petx}(i, j)\} \otimes \{P(i, j)\} = \{\text{Res1}(i, j')\}$				
$\{\{\text{Petx}(1, j)\}\}$		$\{\text{Pe}(1, 1)\}$	$\{\text{Res1}(1, m)\}$	
$[\text{Petx}(1, 1)]$	$[\text{Petx}(1, 2)]$	Core BP	Operation	$[\text{Result}(1, 1)] =$
Main BP_1_1 (HL-1)	“Manually Oriented”	["Utility Glass Production"]	$\{\{\text{Petx}(1, 1)\}, [\text{Petx}(1, 2)]\} \otimes \{\text{Pe}(1, 1)\} =$	$[\text{Main BP}_1_1 \text{ (HL-1)}], [\text{“Manually Oriented”}], [\text{“Utility Glass Production”}]$
$\{\{\text{Petx}(1, j)\}\}$		$\{\text{Pe}(1, 1)\}$	$\{\text{Res1}(1, m)\}$	
$[\text{Petx}(2, 1)]$	$[\text{Petx}(2, 2)]$		Operation	$\text{Result}(2, 1) =$
Main BP_1_2 (HL-2)	“Machinery Oriented”	["Utility Glass Production"]	$\{\{\text{Petx}(2, 1)\}, [\text{Petx}(2, 2)]\} \otimes \{\text{Pe}(1, 1)\} =$	$[\text{Main BP}_1_2 \text{ (HL-1)}], [\text{“Machinery Oriented”}], [\text{“Utility Glass Production”}]$

Source: The Author

Table 5. The core business process decomposition with BP metrics attributes

$\{\text{Petx}(i, j)\} \otimes \{P(i, j)\} = \{\text{Res1}(i, j')\}$					
$\{\{\text{Petx}(1, j)\}\}$		$\{\text{Pe}(1, 1)\}$	$\{\text{Res1}(1, m)\} (m=1, 2)$		
$[\text{Petx}(1, 1)]$	$[\text{Petx}(1, 2)]$	Core BP	Operation	$[\{\text{Result}(1, 1)\}]$	$[\text{Result}(1, 2)]$
$[\text{“Main BP}_1_1 \text{ (HL-1)”}]$	“Manually Oriented”		$\{\{\text{Petx}(1, 1)\}, [\text{Petx}(1, 2)], [\text{Petx}(1, 3)], [\text{Petx}(1, 4)], [\text{Petx}(1, 5)], [\text{Petx}(1, 6)], [\text{Petx}(1, 7)]\} \otimes \{\text{Pe}(1, 1)\} =$	$[\text{“Main BP}_1_1 \text{ (HL-1)”}], [\text{“Utility Glass Production”}], [\text{“Manually Oriented”}]$	$[\text{Main BP}_1_1 \text{ (HL-1)}], [\text{(Gross Production)}, (\text{Turnover}), (\text{Costs}), (\text{Assets}), (\text{Profit})]$
$[\text{Petx}(1, 3)]$	$[\text{Petx}(1, 4)]$	$\{\text{Pe}(1, 1)\}$			
$[\text{Gross Production}]$	$[\text{Turnover}]$	["Utility Glass Production"]			
$[\text{Petx}(1, 5)]$	$[\text{Petx}(1, 6)]$				
$[\text{Costs}]$	$[\text{Assets}]$				
$[\text{Petx}(1, 7)]$	$[\text{Petx}(1, 8)]$				
$[\text{Profit}]$					

Source: The Author

Table 6. Core Business Processes and Metrics - The Beginning

Core Business Process	Metrics Indicators (Attributes)				
	GP- volume	GP- value	GP_Costs-gp_value	GP-Assets_gt_value	GP-Costs_gt_profit
Production	GP- volume	GP- value	GP_Costs-gp_value	GP-Assets_gt_value	GP-Costs_gt_profit
Sales and Distribution	GT volume	GT value	GT_Costs_gt_value	GT-Assets_gt_value	GT-Costs_gt_profit
Human Resources Management	PER volume	PER value	PER_Costs_per_value	PER-Assets_per_value	PER-Costs_per_profit
Technical and Technological Resources Management	TECH volume	TECH value	TECH_Costs_tech_value	TECH-Assets_tech_value	TECH-Costs_tech_profit
Material Resources Management	MAT volume	MAT value	MAT_Costs_mat_value	MAT-Assets_mat_value	MAT-Costs_mat_profit

Source: The Author

Table 6. Core Business Processes and Metrics – The End

Economic & Financial Management					
ASSETS TOTAL					
GP –Assets_gt_value	GT –Assets_gt_value	PER –Assets_per_value	TECH –Assets_tech_value	MAT –Assets_mat_value	
COSTS TOTAL					
GP –Costs_gt_value	GT –Costs_gt_value	PER –Costs_per_value	TECH –Costs_tech_value	MAT –Costs_mat_value	
ASSETS – COSTS = PROFIT					

4.2.2. Decomposition of Business Processes and Business Process Metrics Attributes Related to Management Levels

Strategic Level

The strategic level management is concerned to core processes mostly and their metrics indicators and attributes play a role of importance in there. The following core business processes are closely related to that management level:

- Economic and Financial Management
- Production
- Sales and Distribution
- Human Resources Management
- Technical and Technological Resources Management
- Material Resource Management

Their metrics indicators and attributes are postulated in Table 6. Furthermore they are decomposed into appropriate main and subordinated processes related tactic and operational level.

Legend

GP – Gross Production
GT – Gross Turnover
PER – Personal Resources Requirements
TECH – Technical and Technological Resources Requirements

Tactic Level

Any business process metrics is represented by set of indicators, which might include several attributes. A difference is only in that, if core, main or subordinated business processes are considered. When considering the core process e.g. Utility Glass Production an appropriate metrics might be assigned, which contains the following attributes: Assets – **Vyn**, costs **Nak** and profit - **Zisk**⁸. However, there will be a difference among decomposition ways of BP metrics indicators and attributes related to strategic, tactic and operational level as well.

Let us consider a core business process Utility Glass Production with metrics attributes as mentioned above. The

Profit indicator value might be determined as a difference between indicator values **Vyn** and **Nak**, while the **Vyn** indicator is closely related to indicators **Hob** – gross turnover and **Hvy** – gross production. The same is concerned to the cost indicator value – **Nak**. Two types of costs will be considered within this section: **N_{hvy}** – costs related to achievement of an appropriate gross production value and **N_{hob}** – costs related to achievement of an appropriate gross turnover value, while formulas (15a) and (15b) might be postulated

$$Vyn = Vyn [(H_{ob}), (H_{vy})] \quad (15a)$$

$$Nak = Nak [(N_{hob}), (N_{hvy})] \quad (15b)$$

Gross Turnover Indicator

The *Gross Turnover Indicator* is closely related to the core process denoted as “Sales and Distribution – SaD”, which consists of the following main business processes: marketing, sale, distribution, while *Gross Turnover Indicator* is bond to SaD core process via Sale –main process.

On the other hand, the value consist of values related to partial Gross Turnover indicator values related to formula (16)

$$H_{ob} = \prod_{i=1}^n [Tg^9(i)] \quad (16)$$

while the above-mentioned partial gross turnover values are determined by those products (articles), the customers are interested in and the following formula might be postulated:

$$\begin{aligned} [T_g(1)] &= [(Cust(1, 1)), (Prdc(1, 1)), [(Cust(1, 2)), (Prdc(1, 2))], \dots, [(Cust(1, m1)), (Prdc(1, m1'))]] \\ [T_g(2)] &= [(Cust(2, 1)), (Prdc(2, 1)), [(Cust(2, 2)), (Prdc(2, 2))], \dots, [(Cust(2, m1)), (Prdc(2, m1'))]] \end{aligned} \quad (17)$$

$$[T_g(n)] = [(Cust(n, 1)), (Prdc(n, 1)), [(Cust(n, 2)), (Prdc(n, 2))], \dots, [(Cust(n, m1)), (Prdc(n, m1'))]]$$

where Cust – Customer, Prdc – Product (Article) Class

On the other hand, any customer might have an

⁸ The text strings, which represent appropriate indicators are written in bold and show their identifiers

⁹ Tg- gross turnover

appropriate set of contracts, while any contract should be determined via *Contract_volume*, *Contract_value*, costs needed for contract assurance – *Cost-con*, gross production volume *GP_vol*, gross production value *GP_val* and costs related to gross production value, needed for contract fulfillment *Costs-gp_value*,

$$\begin{aligned} & m_1 \\ & n \\ \text{Cust}(i, j) = \Pi & [(\text{Contract_volume}(i, j'), (\text{Contract_value}(i, \\ & j'), (\text{Costs-con}(i, j'), (\text{GP_vol}(i, j'), (\text{GP_value}(i, j'), \\ & (\text{GP_Costs-gp_value}(i, j')))] \quad (18) \\ & j=1 \\ & i=1 \end{aligned}$$

When looking at formulas (17) and (18), we can see that between Gross Turnover and Gross production is direct relation, an adequate amount of products (articles) shall be produced in order to achieve an appropriate Gross-Turnover value. As a result of that, we shall investigate Gross-Turnover value decomposition in interconnection with Gross – Production volume and value. The aim of Gross – Turnover attribute and value decomposition is to generate contracts for appropriate customers. However, the PBPL Equation might be applied for those purposes as well.

In order to be possible to apply the PPL Equation, the following issues should be respected Table.

The $\{\text{Contract_volume}(i, j')\}$ linguistic set contains two subordinated $\{\text{Cust}(i, j)\}$ and $\{\text{Prdc}(i, j)\}$ sets, while the $\{\text{Cust}(i, j)\}$ set elements represents customer's data (name, address, city, ZIP code, country) and $\{\text{Prdc}(i, j)\}$ set elements are concerned to those product data, which create an integral part of contract and formula (19) might be postulated

$$\{\text{Contract_volume}(i, j')\} = \{\text{Contract_volume}, [\text{Cust}(i, j)], [\text{Prdc}(i, j)]\} \quad (19)$$

Now, we shall define $\{\text{Petx}_{\text{vol}}(I, j)\}$ set content, which closely related to contract volume and processed via business process represented by $\{\text{Pe}(I, j)\}$ linguistic set. The $\{\text{Res}_{\text{vol}}(i, j')\}$ set content might be generated, when applying formula (9a), while formulas (20a), (20b) and (20c) might be postulated

$$\{\text{Petx}_{\text{vol}}(i, j)\} \otimes \{\text{Pe}(I, j)\} = \{\text{Res}_{\text{vol}}(i, j')\} \quad (20a)$$

$$\{\text{Petx}_{\text{vol}}(i, j)\} = \{[\text{Contract_volume}(I, j)], [\text{Cust}(i, j)], [\text{Prdc}(i, j)]\} \quad (20b)$$

$$\{\text{Pe}(I, j)\} = \{[\text{Production}(i, j)], [\text{Sale}(I, j)]\} \quad (20c)$$

$$\{\text{Res}_{\text{vol}}(i, j')\} = \{[\text{Contract_volume}(i, j)], [\text{Cust}(i, j'), [\text{Prdc}(i, j')]] \otimes \{[\text{Production}(i, j)], [\text{Sale}(i, j)]\} = \{[\text{Sale}(\text{Contract}(\text{Cust}(i, j')))], [\text{Production}(\text{Prdc}(i, j'))]\} \quad (20d)$$

However, any contract volume corresponds to an appropriate contract value, which might be calculated with the use of PBPL Equation as well, while formulas (21a), (21b) and (21c) might be postulated

$$\{\text{Petx}_{\text{val}}(i, j)\} \otimes \{\text{Pe}(I, j)\} = \{\text{Res}_{\text{vol}}(i, j')\} \quad (21a)$$

$$\{\text{Petx}_{\text{val}}(i, j)\} = \{[\text{Contract_value}(i, j'), [(\text{Costs-con}(i, j')), [(\text{Costs-gp_value})]]\} \quad (21b)$$

$$\{\text{Pe}(I, j)\} = \{[\text{Production}(i, j)], [\text{Sale}(I, j)]\} \quad (21c)$$

$$\begin{aligned} \{\text{Res}_{\text{val}}(i, j')\} = & \{[\text{Contract_value}(i, j'), [(\text{Costs-con}(i, j')), [(\text{Costs-gp_value})]] \otimes \{[\text{Production}(i, j)], [\text{Sale}(i, j)]\} = \\ & \{[\text{Contract_value}(i, j)], [(\text{Costs-con}(i, j')), [(\text{Costs-gp_value})]] \otimes \{[\text{Production}(i, j)], [\text{Sale}(i, j)]\} = \\ & \{[\text{Sale}(\text{Contract}(\text{Cost-con}(i, j')))], [\text{Production}(\text{Costs-gp_value})]\} \quad (21d) \end{aligned}$$

$$\text{Res}_{\text{vol}}(i, j') = \{[\text{Sale}(\text{Contract}(\text{Cust}(i, j')))], [\text{Production}(\text{Prdc}(i, j'))]\} \quad (21e)$$

$$\{\text{Res}_{\text{val}}(i, j')\} = \{[\text{Sale}(\text{Contract}(\text{Costs-con}(i, j')))], [\text{Production}(\text{Cost-gp_value})]\} \quad (21f)$$

Gross Production Indicator

Previous section deals with decomposition of Gross Turnover Indicator, which creates an integral part of business process denoted as “Sales and Distribution”. However, a fulfilment of that indicator value is not possible without running the business process denoted as “Production”. As result of that, the $[\text{GP_vol}(i, j')]$ – gross production volume and $[\text{GP_val}(i, j')]$ – gross production value, the gross production volume is determined by product – article types and classes previously (see also formula 22a) and gross production value is determined by gross production costs subsequently (22b). With respect to the above mentioned issues, the following formulas might be postulated:

$$[\text{GP_vol}(i, j')] = [\text{Production}(\text{Prdc}(i, j'))] \quad (22a)$$

$$[\text{GP_val}(i, j')] = [\text{Production}(\text{Costs-gp_value})] \quad (22b)$$

It means, the gross production indicator represented by appropriate linguistic set consists of two subsets $[\text{Production}(\text{Prdc}(i, j'))]$ and $[\text{Production}(\text{Cost-gp_value})]$ – see also formula (22c)

$$\begin{aligned} \{\text{GP}(i, j)\} = & \{[\text{GP_vol}(i, j')], [\text{GP_val}(i, j')]\} = \\ & \{[\text{Production}(\text{Prdc}(i, j'))], [\text{Production}(\text{Cost-gp_value})]\} \quad (22c) \end{aligned}$$

Finally, the PBPL Equation generates two important linguistic sets $\{\text{Res}_{\text{vol}}(i, j')\}$ and $\{\text{Res}_{\text{val}}(i, j')\}$, which indicate Sale business process metrics, which is closely related to customers, their contracts from production point of and from costs related to contract assurance and contact fulfillment as well (see also formula (23a) a (23b)

$$\{\text{Res}_{\text{vol}}(i, j')\} = \{[\text{Sale}(\text{Contract}(\text{Cust}(i, j')))], [\text{GP_vol}(i, j')]\} \quad (23a)$$

$$\{\text{Res}_{\text{val}}(i, j')\} = \{[\text{Sale}(\text{Contract}(\text{Cost-con}(i, j')))], [\text{GP_val}(i, j')]\} \quad (23b)$$

4.3. BP Architecture Model – Process View

4.3.1. Overview

In general, the business process view is considered to be that part of business process (BP) model, which helps in

investigation of business process horizontal structure, which is determined by three linguistic sets subordinated to linguistic $\{Bp(i, j)\}$ $i=1\dots n, j=1\dots m$, while formula (24) might be postulated

$$\{Bp(i, j)\} = \{[Petx(i, j)], [Pe(i, j)], [Res1(i, j)]\} \quad (24)$$

where

$[Petx(i, j)]$ - is a linguistic sub-set, the elements which represent BP inputs, incl. BP input metrics indicators and attributes

$[Res1(i, j)]$ - is a linguistic sub-set, the elements which represent BP outputs, incl. BP output metrics indicators and attributes

$[Pe(i, j)]$ - is a linguistic sub-set, the elements which represent BP functions, incl. BP function metrics indicators and attributes

A set of adequate relations among those linguistic subsets is regulated by PBPL Equation (see also formula 9a).

When operating with process view related to business process architecture model (BPA –model), we have to respects three type of indicators and attributes related to BP metrics

- A_{ts} – *static attributes* – technological device attributes - size (technological device technical parameters, accessories technical parameters, etc.)
- A_{td} – *dynamic attributes* - BP operands (technological device operational parameters)
- A_{tc} – *conversion attributes* – input raw material (IRM) parameters
- A_{tr} – *result attributes* – output product parameters

4.3.2. Business Process Model – Process View

Let us consider a business process Pe , which is represented by linguistic set $\{Pe(i, j)\}$, $i=1\dots n$, (business process serial number) $j=1\dots m_1$ (BP function serial number) and formula (25) might be postulated

$$\{Pe(i, j)\} = \{[F1(i, j)], [F2(i, j)], \dots, [Fn(i, j)]\} = \Pi[F_k(i, j)] \quad (25)$$

n

$k=1$

In general, any BP function may be represented via three linguistic subsets postulated with respect to formula (26)

$$\{[F_k(i, j)]\} = \{[Object(i, j)], [Action(i, j)], [Result(i, j)]\} \quad (26)$$

Furthermore, we shall try applying formulas (24), (25), (26) for modeling of technological business process denoted as “Glass melt preparation – GMP process”, while an outgoing input resource applied for these purposes is Glass batch – with an appropriate $Composition_1$ and $Weight_1$. On the other hand, text strings $Weight_3$, $Temperature_3$, $Viscosity_3$ represent result product - Glass melt, which is considered to be that technological process result product.

The glass melt preparation processes is running in two phases, while formula (27) might be postulated:

$$[Action(1, 2)] = [Melting] = [(Melting_1), (Melting_2)] \quad (27)$$

Phase 1

At first the process $Melting_1$ is running, where attributes $Temperature_{11}$, $Pressure_{11}$ play an important role (see also formula 28b). That process running result (see also formula 28c) is considered to be an intermediate product and creates Object for $Melting_2$ process.

[F1(i, j)] - Initial glass batch melting – creation of intermediate mixture (glass batch – glass melt)

The above-mentioned action is provided related to object postulated via formula (28a).

$$\{[Object(i, j)]\} = \{[Glass\ batch_1(Weight_{11}, Composition_{12})]\} \quad (28a)$$

$$\{[Action(i, j)]\} = \{[Melting_1(Temperature_{11}, Pressure_{11})]\} \quad (28b)$$

$$\begin{aligned} \{[Result(i, j)]\} = \{[Result(1, 1)]\} = \{[Glass\ batch_2(Weight_{11}, Composition_{11}, Temperature_{11}, Pressure_{11})], \\ [Glass\ melt_1(Weight_{12}, Composition_{12}, Temperature_{12}, Pressure_{12}, Viscosity_{11})]\} \end{aligned} \quad (28c)$$

Phase 2

However, the melting process continues as well, while the $Melting_2$ process is getting started and **[F2(i, j)]** – glass melt preparation is being completed.

The phase no.1 result product (see also formula 28c) represents an input object for $Melting_2$ process, where $Temperature_{21}$, $Pressure_{22}$ play a role of principle importance and the Glass batch₂ component disappears and is being converted into the final product denoted as Glass melt₂ with attributes postulated with respect to formula

$$\begin{aligned} \{[Object(i, j)]\} = \{[Glass\ batch_2(Weight_{11}, Composition_{11}, Temperature_{11}, Pressure_{11})], \\ [Glass\ melt_1(Weight_{12}, Composition_{12}, Temperature_{12}, Pressure_{12})]\} \end{aligned} \quad (29a)$$

$$\{[Action(i, j)]\} = \{[Melting_1(Temperature_{21}, Pressure_{22})]\} \quad (29b)$$

$$\{[Result(i, j)]\} = \{[Result(1, 2)]\} = \{[Glass\ melt_2(Weight_{21}, Composition_{22}, Temperature_{22}, Pressure_{22}, Viscosity_{22})]\} \quad (29c)$$

When looking at formulas (25) and (26) formula (30) might be postulated

$$\{[F_2(i, j)]\} = [F1(i, j)], [F2(i, j)] = BP = \text{“glass melt preparation”} \quad (30)$$

The final version of that BP static structure is postulated via formula (31)

$$\begin{aligned} BP = \text{“glass melt preparation”} = \{[F_2(i, j)]\} = \{[F1(i, j)], \\ [F2(i, j)]\} = [Melting] = \{[(Melting_1), (Melting_2)]\} = \\ \{[Melting_1(Temperature_{11}, Pressure_{11})], [Melting_2(Temperature_{21}, Pressure_{22})]\} \end{aligned} \quad (31)$$

It means, the BP = “glass melt preparation” consists of two functions with a set of appropriate metrics indicators and attributes as shown within formula (31).

4.3.3. Business Process Model – Data and Information View

In general, no business process might properly and efficiently without adequate data and information support. Data and Information view is about business process metrics indicators and attributes and business process data and information support as well. The outgoing point is closely related to business process model process view. On the other hand, any business process metrics is closely related to BP Inputs (BP Input Metrics), BP Functions (BP Function Metrics) and BP Outputs (BP Output Metrics). When comparing it with formula (9a and 26) formulas (32a), (32b) and (32c) might be postulated

$$\{[Objects]\} = \text{"BP Input Metrics"} = \{Petx(i, j)\} \quad (32a)$$

$$\{[Action]\} = \text{"BP Function Metrics"} = \{Pe(i, j)\} \quad (32b)$$

$$\{[Result]\} = \text{"BP Output Metrics"} = \{Res1(i, j)\} \quad (32c)$$

When applying PBPL Equation (see also formula 9a) related to the above-mentioned objects, actions and results, the following issues should be postulated

$$\{Petx(1, 1)\} = \{[Glass\ batch_1(Weight_{11}, Composition_{12})]\} \quad (33a)$$

$$\begin{aligned} \{Pe(1, 1)\} &= \{[F_2(i, j)]\} = \{[F1(i, j)], [F2(i, j)]\} = \\ &[Melting] = \{[(Melting_1), (Melting_2)]\} = \{[Melting_1 \\ (Temperature_{11}, Pressure_{11}), [Melting_2(Temperature_{21}, \\ Pressure_{22})]\} \end{aligned} \quad (33b)$$

and results generated (see also formula 33c)

$$\begin{aligned} \{[Res1(1, 1)]\} &= \{[Melting_1(Temperature_{21}, Pressure_{22}), \\ &[Glass\ batch_2(Weight_{11}, Composition_{11}, Temperature_{11}, \\ &Pressure_{11}), [Glass\ melt_1(Weight_{12}, Composition_{12}, \\ &Temperature_{12}, Pressure_{12})]\} \end{aligned} \quad (33c)$$

$$\{[Res1(1, 2)]\} = \{[Glass\ melt_2(Weight_{21}, Composition_{22}, Temperature_{22}, Pressure_{22}, Viscosity_{22})]\}$$

$$\begin{aligned} \{[Res1(i, j)]\} &= \{[Res1(1, 1)], [Res1(1, 2)]\} = \{[Melting_1 \\ (Temperature_{21}, Pressure_{22}), [Glass\ batch_2(Weight_{11}, \\ Composition_{11}, Temperature_{11}, Pressure_{11}), [Glass\ melt_1 \\ (Weight_{12}, Composition_{12}, Temperature_{12}, Pressure_{12}), \\ [Glass\ melt_2(Weight_{21}, Composition_{22}, Temperature_{22}, \\ Pressure_{22}, Viscosity_{22})]\} \end{aligned} \quad (33d)$$

When applying PBPL Equation (see also formula (9b) and (9c), the following result might be postulated:

$$\{[Res2(i, j)]\} = \{[Res1(i, j)]\} \quad (34a)$$

$$\{Tbex(i, j'')\} = \{[Melting_1(Temperature_{21}, Pressure_{22})]\} - BP \{Pe(i, j)\} \quad (34b)$$

Primary Metrics

$$\begin{aligned} \{Retx(i, j''')\} &= \{[Glass\ batch_2(Weight_{11}, Composition_{11}, \\ &Temperature_{11}, Pressure_{11}), [Glass\ melt_1(Weight_{12}, \\ Composition_{12}, Temperature_{12}, Pressure_{12})]\} - BP \{Pe(i, j)\} \end{aligned} \quad (34c)$$

Secondary Metrics

The above-mentioned linguistic sets create principle components of database, which an appropriate information

system operates and provides those BP information support. However, there is another supplementary database component as well, while it is closely related to TNL text, which describes the BP structure, features, functionality and where the above-mentioned indicators, attributes and their values are coming from. This database type is considered to be the **reference database** (see also Fig. 2). On the other hand, the reference database represents a significant element, when creating semantic networks for knowledge representation purposes, while the knowledge is being stored into knowledge base, which an appropriate knowledge based or expert system operates over and provides knowledge base support for BP functionality (see also next section).

4.3.4. Business Process Model – Knowledge Based View

As mentioned within previous section, “No business process might properly and efficiently without adequate data and information support”. However, the similar statement might be postulated as well. “No business process might properly and efficiently without adequate personal support, equipped with appropriate set of knowledge needed for BP operation”. As a result of that, the BP knowledge based support plays a role of principle importance too. Although, BP data and information support is closed to BP static structure, the BP knowledge support is concerned the BP functionality (dynamic) aspects mostly, while those dynamic aspects are concerned to BP state transitions, first of all.

Let us consider the BP represented via linguistic set $\{Pe(i, j)\}$ and denoted as “glass melt preparation”. This process consists of two functions $[F1(1, 1)] = [\text{"Melting1"}]$ and $[F2(1, 1)] = [\text{"Melting2"}]$ and might quantified via formula

$$\{Pe(i, j)\} = \{[F_2(i, j)]\} = \{[F1(1, 1)], [F2(1, 1)]\} \quad (2-23)$$

and the BP functionality dynamics affects component **Action** first of all.

In many cases, that BP responsible manager needs to know how the component **Action** operates really, it means what is happening inside that component. In order to get an appropriate answer, he/she needs adequate knowledge about that. As a result of that, he/she needs a tool or a set of tools, which enable that knowledge representation, while the semantic network (see also Fig. 3a) is considered to be very useful for those purposes. The above-mentioned semantic network has its own structure, which is being created by linguistic sets and subsets and the subset elements contain pointers to items and their values stored in an appropriate reference database (see also Fig.3b). Any knowledge represented by that type of semantic network is considered to be a complex unit determined via unique key (denoted as the Primary Key), which enables a unique identifying of semantic network stored within Knowledge Base (KB), the knowledge based system or expert system operates over. On the other hand, an adequate Inference Mechanism might be applied to those semantic networks, which enables retrieval and presentation of semantic network content and generating new or primary knowledge as well.

Source: The Author

Figure 3a. The semantic network, which represents BP Glass melt preparation functionality

Source: The Author

Figure 3b. Reference Database, which creates an integral part of BP Glass melt preparation functionality knowledge representation

However, there is the second component, which is needed for that knowledge representation as well and is denoted as “Reference Database (RD), the content of which is being created by two types of linguistic sets: $\{[Petx(i, j)]\}$ – linguistic set, the elements of which represent inputs need for BP functionality and $[Res1(1, 1)]$, $[Res1(1, 2)]$, $[Res1(1, 3)]$ linguistic sets, the elements of which represent the BP functionality outputs- see also Fig. 3b. The RD structure is created by the above mentioned linguistic sets stored within compact unit, which is similar to record existing in standard databases see also Fig. 3b.

5. Conclusions

The presented contribution deals business process modeling based on linguistic approach, while the main goal was to explain business process linguistic modeling principles with the use of semantic networks and references. However, both of the above-mentioned elements might represent a way of knowledge representation contained

within objective oriented expert system and the business process model as well. It means such expert system may create not only an important knowledge based supporting tool from business process functionality point of view, however it may contain a set of business process models and d cover a business process architecture model actually. There are several questions, which could be answered via that contribution, while there are more questions being opened and waiting for further processing. I tried explaining why the linguistic approach is suitable for business process modeling purposes and how is interconnected with enterprise architecture business model, Business Strategy Creation System and Business Process Perspective, when considering the linguistic approach to business process modeling, the business process quantification based on PBPL Equation plays a role of principal importance, which might be applied in design of tool for business strategy creation and in design of models based on semantic networks and reference databases too. However, I tried applying the above-mentioned theoretical result.

On the other hand, there is a question of interconnection among KPI sets and sets, which represent the core main and business process metrics items. The problems concerned to the above-mentioned transformation are in a solution stage and this section aim is to show how linguistic approach might be applied for design of tools closely related to business strategy creation and business process modeling on, tactic and operation level. We can say, there are furthermore problems waiting for solution in the near future. They are closely related business process architecture model creation, business process simulation and optimizing models. These problems cover business process design platform. However, there two further platforms, waiting for the solution as well, while they are closely related to business process implementation and business process controlling.

REFERENCES

- [1] ACHOUR, C. and ROLLAND, C. Introducing genericity and modularity of textual scenario interpretation in the context of requirements engineering. Technical Report, Centre de Recherche en Informatique, Université de Paris 1, Paris. In: CREWS Technical Report No. 21.903.
- [2] BERNUS, P., NEMES, L. and Schmidt, G. *Handbook on Enterprise Architecture*. Springer Verlag, Berlin-Heidelberg, 2003.
- [3] BUSINESS RULES GROUP. Defining Business Rules ~ What Are They Really? Guide Business Rules Project, Final Report. Revision 1.3.
- [4] BUCCHIARONE, A. et al. New Quality Model for Natural Language Requirements Specifications. In: *Proc. of the 12th International Working Conference on Requirements Engineering: Foundation for Software Quality (REFSQ'06), June 2006, Luxembourg, Grand-Duchy of Luxembourg, Essener Informatik Beitrage, ISBN 3-922602-26-6*.
- [5] CYSNEIROS, L., MACEDO-SOARES, T. and LEITE, J. Using 9001 to Elicit Business Rules. Proc. of 4th IEEE International Software Engineering Standards Symposium - Brazil - May/1999.
- [6] CYSNEIROS, L. and J. LEITE Eliciting Business Rules through ISO 9000 Documentation: a Domain Oriented Conceptual Model. Proc. of the 3rd Workshop Ibero-Americano em Engenharia de Requisitos e Ambientes de Software – Cancun – Abr. 2000.
- [7] GRELL, M. and 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. ISSN 1336-3301, 2011, 8, (2), 34-46*.
- [8] HACKLIN, F. and WALLNOEFER, M. *Management decision*. 50 (1-2) , 166-188: 2012, CCC:000303029000011 ISSN: 0025-1747
- [9] HARS, A. and MARCHEWKA, J. Eliciting and Mapping Business Rules to IS Design: Introducing a Natural Language CASE Tool. In: Ebert, R.J; Franz, L.: 1996 Proceedings Decision Sciences Institute, 1996., 2, 533-535.
- [10] KŐ, A. - TERNAI, K. A. *Development Method For Ontology Based Business Processes* [http://corvinno.hu/root/web/ebestw.nsf/\(files\)/en-pdf-eChallenges2011_ternai_ko/\\$FILE/eChallenges2011_ternai-ko.pdf](http://corvinno.hu/root/web/ebestw.nsf/(files)/en-pdf-eChallenges2011_ternai_ko/$FILE/eChallenges2011_ternai-ko.pdf)
- [11] MAROUŠEK, J., HAŠKOVÁ, S., ZEMAN, R. and VANÍČKOVÁ, R. Managerial Preferences in Relation to Financial Indicators Regarding the Mitigation of Global Change. *Science and Engineering Ethics*, Dordrecht: Springer, 2015, vol. 21, č. 1, s. 203-207. ISSN 1353-3452. Doi: 10.1007/s11948-014-9531-2.
- [12] MARTÍNEZ-FERNÁNDEZ, J., GONZÁLEZ, J., VILLENA, J. AND MARTÍNEZ, P. Preliminary Approach to the Automatic Extraction of Business Rules from Unrestricted Text in the Banking Industry http://oa.upm.es/4907/1/INVE_MEM_2008_60024.pdf.
- [13] PALL, G. A. *Quality process management*. Englewood Cliffs: Prentice-Hall, 1987. ement. Englewood, Cliffs: Prentice-Hall, 1987.
- [14] PALL, G. A. *Quality process management*. Englewood Cliffs: Prentice-Hall, 1987. ement. Englewood Cliffs: Prentice-Hall, 1987.
- [15] SAWYER, P. and COSH, K. Supporting MEASURE -driven analysis using NLP tools. In: 10th International Workshop on Requirements Engineering, 2004.
- [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, p.132-144, ISBN 80-8073-150-0*.
- [17] STAŠÁK, J., *and Contribution to Image Semantic Analysis AEC In: Informace na dlani, Albertina Income Praha, s.r.o., Praha 2004, ISSN: 1214-1429, electronic version, Infoforum Praha 2004*.
- [18] STAŠÁK, J. *Modeling of Text Semantic with the use of Fuzzy Sets* *Ekonomický vstnik NTUU, KPI, 2006 (3), p.376 – 384*.
- [19] STAŠÁK, J. *Modelovanie procesov podnikania s využitím aplikačného programu ARIS, EKONOM, Bratislava, 2010*.
- [20] STAŠÁK, J., VANÍČKOVÁ, R. and GRELL, M. *Business Process Modeling Linguistic Approach – Problems of Business Strategy Design* *Universal Journal of Management*, 2015 3, (7).
- [21] ŠTÚR, M., VANÍČKOVÁ, R. a KMECOVÁ, I. Finanční gramotnost ako základný pilier konkurenceschopnosti. In *Vysoká škola polytechnická v Jihlavě. Konkurence: sborník příspěvků*. 1. vydání. Jihlava: College of Polytechnics Jihlava, Department of economic studies, Proceedings of 6th annual international scientific conference COMPETITION, 2014. s. 264 - 273, 326 s. ISBN 978-80-87035-91-7.
- [22] TERNAI, K., TÖRÖK, M.: Semantic modeling for automated workflow software generation- An open model. In 5th International Conference on Software Knowledge Information Industrial Management and Applications (SKIMA 2011), Bemevento, Italy, September 8-11, 2011.
- [23] TOBÓN, G.H. AND FRANCO, A.H. *Business Rules Extraction from Business Process Specifications* Written in Natural Language," *Business Rules Journal*, 2010, 11, (7) URL: <http://www.BRCommunity.com/a2010/b543.html>.