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Production material requirements in material ordering

Abstract. The paper deals with the problems of material ordering business process quantification with the use of linguistic sets, the behaviour of which is regulated by the principle business processes linguistic equation – PBPL. The purpose of this paper is to design an optimal architecture model of the abovementioned business processes related to their structure, features and functionality. In order to fulfil the main task, several objectives should be postulated and achieved. The first objective is closely related to the analysis of the material management business process, the aim of which is to describe the structure of that business process (BP) and principles of its functionality with regard to optimisation of appropriate BP metrics. The second objective is to design an optimal BP model, an integral part of which should be a description of principle aspects related to the implementation of the optimal model. The author has provided information dealing with the application of the PBPL equation in analysis and design of the material ordering business process, which constitutes an integral part of production material requirements. The described structure represents a qualitative proposal, which forms the basis for the development of materials management business processes in terms of design and optimisation. The research was conducted at RM GASTRO, a group manufacturing joint-stock companies with a number of employees equal to 1,000, in June, 2015.

Keywords: Production Material Requirements; Logistics Process; Material; Ordering and Warehouse Processes

JEL Classification: O30; O31; O32

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Умови замовлення матеріалів для виробництва

Анотація. У статті розглянуто проблеми, пов'язані визначенням бізнес-процесу замовлення матеріалів за допомогою використання мовного набору даних, в основу якого покладено рівняння змінних лінгвістичних значень. Основною метою цієї роботи є розробка оптимальної архітектурної моделі вищезазначеного бізнес-процесу з урахуванням особливостей його структури та функціональності. Для досягнення основної мети були сформульовані та виконані проміжні завдання. Перше проміжне завдання було пов'язане з аналізом бізнес-процесу управління матеріальними ресурсами, суть якого полягала в описі самої структури та принципів її функціонування, а також у визначенні тих складових бізнес-процесу, які слід оптимізувати. Друге проміжне завдання полягало у створенні оптимальної моделі бізнес-процесу, невід'ємною частиною якої має бути опис основних аспектів реалізації даної моделі. У статті наведено інформацію відносно практичного застосування рівняння змінних лінгвістичних значень у процесі аналізу та проектування замовлення матеріалів, що є частиною вимог до матеріалів для виробництва

Ключові слова: потреба у матеріалах для виробництва; логістичні процеси; матеріал; замовлення матеріалів та складські процеси.

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Условия заказа материалов для производства

Аннотация. В статье рассмотрены проблемы, связанные с определением бизнес-процесса заказа материалов при помощи использования языкового набора данных, в основу которого положено уравнение переменных лингвистических значений. Основной целью данной работы является разработка оптимальной архитектурной модели вышеназванного процесса с учетом особенностей его структуры и функциональности. Для достижения основной цели были сформулированы и выполнены промежуточные задачи. Первая промежуточная задача была связана с анализом бизнес-процесса управления материальными ресурсами, суть которого заключалась в описании структуры бизнес-процесса и принципов её функционирования, а также определение тех компонентов бизнес-процесса, которые следует оптимизировать. Вторая промежуточная задача заключалась в создании оптимальной модели бизнес-процесса, неотъемлемой частью которой должно быть описание основных аспектов реализации данной модели. В статье предоставлена информация, имеющая отношение к практическому применению уравнения переменных лингвистических значений в процессе анализа и проектирования заказа материалов, что является частью требований к материалам для производства.

Ключевые слова: потребность в материалах для производства; логистические процессы; материал; заказ материалов и складские процессы.

1. Introduction and Brief Literature Review

Due to emerging problems and current global recession, the existing procedures are not sufficient for successful management. Therefore, entrepreneurs and managers need to extend the available methods, which will lead to better management. This can be achieved by introducing new concepts and technologies that may help to achieve the main objectives, mainly to ensure profitability and liquidity of a company. Unlike developed countries like (e.g. the USA and the majority of Western European states), logistics controlling and logistics are often neglected in the Czech Republic. Only some companies, generally the larger ones or branch offices abroad, pay more attention

to these issues. Therefore, this investigation follows a sample of enterprises with no previous selection according to the size or focus of the companies in order to compare the interests of the logistical problems in all sectors (Kanterova, 2012) [9].

In general, logistics creates an integral part of business in any firm or company and plays a role of principle importance. There are many definitions of the term «logistics». However, we may accept the following definition: logistics is «a procedure which deals with planning, allocation and check and control of material and human resources bond within physical distribution of products to customers, supporting of production activities and purchasing operations» (Grell, Stasak, 2011) [3],

which is very similar to the definition of logistics suggested by (Hrazdilova Bockova, 2012) [6]. Further, it should be noted that material management together with purchasing and production logistics, purchasing of materials, their stock-keeping and subsequent processing within the final cycle of production create an integral part of logistics in general. Logistics helps to put into practice the idea of an appropriate strategy as a competitive advantage of enterprises (Gros, 1993) [4]. In the context of globalisation and increased competition, it is essential to extended logistics chains and, therefore, to put a greater emphasis on investing resources in the development and cost saving, as well as on improving the quality of production and provided services. Targeted reduction in transport costs may increase the cost of maintaining inventories in storage. Enterprise should focus not only on isolated logistics processes but also on cost optimisation (Nemec, 2001) [13].

Programs based on new methods, which represent an alternative option to monitor the utilisation of warehouse space, batch processing small orders, inventory cycle time and the obsolescence of production lines may contribute to the improvement of productivity of warehouse operations.

Programs based on new technologies (e.g. optical scanning equipment, automatic labelling machines, conveyor systems or programs as part of training employees, managers and work teams and setting up an incentive system of rewards and bonuses) are equally important. Messner defines information as data on economic phenomena and processes used in decision-making processes [12].

Nevertheless, we would like to use another definition of information in decision-making process while writing the present paper, which was given by Hrazdilova, Bockova, Gabrhelova and Porubcanova [7]. Information is a product resulting from a process; it has its manufacturer (source of information) and its recipient; as a product, it may be subject to operations such as transmission, processing, storage, exchange, purchase or sale (Lis, Lapeta, & Nowak, 2005) [11]. Very often information is confused with data. Even in the Dictionary of the Polish Language, the word «information» is described as «data processed by a computer», and the word «data» is interpreted as «information processed by the computer». It is misleading because, according to the concept written by Sharma, data is the basis of the information pyramid known as the DIKW Hierarchy, where the letters «DIKW» stand for Data, Information, Knowledge and Wisdom (Gu Jifa, 2013) [5]. Furthermore, the process of purchasing materials consists of other subordinated processes such as material ordering and material transport, material transfer to stock and invoice booking and payment. However, stock control and forecast create an integral part of material management, whereas the processes of material ordering and stock control should be subject to optimisation (Berry, Bucchiarone, Gnesi, Lami & Trentanni, 2006) [1].

With the information coming from the environment, a company gains knowledge about what society or the market needs. Due to the obtained information the company knows how to design and plan the actions or processes. Finally, the company has the knowledge of how to reach recipients of their services or products. This «nervous system» allows the company to rise, act and continue to grow (Grabara, Kolcun & Kot, 2014) [2].

According to Kantnerova (2011) smaller companies do not have any logistic departments [8]. They neither deal with logistics activities continuously, nor inform their suppliers about results of their investigation, nor have any certificates of quality. They supply goods mostly to final consumers and use roads and vehicles to transport goods. An important factor is the involvement of workers themselves to meet corporate objectives, which can be achieved by building the appropriate corporate culture and promoting their professional and personal development. However, if there doesn't exist specialised department of logistics, some other department should practice logistic activities.

The purpose of this paper is to design an optimal architecture model of the abovementioned business processes related to their structure, features and functionality. In order to fulfil the main task, several objectives should be postulated and achieved. The *first objective* is closely related to *the analysis of*

the material management business process, the aim of which is to describe the structure of that business process¹ (BP) and principles of its functionality with regard to optimisation of appropriate BP metrics. The second objective is to design an optimal BP model, an integral part of which should be a description of principle aspects related to the implementation of the optimal model.

2. Modelling of Warehousing Business Processes - Standardised Approach

2.1. Architecture Model of Business Process Standardised and Linguistic Approach

A *process model* is used to describe a process by means of automation composed of process modelling and enactment phases. In general, three business modelling approaches and methodologies might be accepted: the business process modelling developed by Prof. A. W. Scheer, which is based on four views related to any business process. They are the functional view, the process view, the data view, the organizational and product-process view. While the above approach is considered to be a *standardised approach*, the approach indicating an increase in the level of automation of business process modelling (BPM) by representing various spheres of an enterprise through languages and semantic WEB services frameworks is viewed as the *semantic approach*. The approach used to extract BR from process specifications written in the form of texts in natural languages (TNL – text in natural language) is denoted as the *linguistic approach* (Stasak, 2010, 2012) [14; 16]. The task of that approach is to define business process structure elements and business metrics based on the text written in a natural language, through which the actual business process is described, provided the linguistic sets contain appropriate linguistic variables (Tobon, Fredy & Franco, 2010) [18].

The linguistic approach to business process modelling provides more sophisticated methods for the quantification of BP if compared with the standardised one based on the application of ARIS, i.e. Architecture of Integrated Information System (Stasak, 2010) [14] and the ARIS Express program (Stasak, 2011) [15]. They are based on application of the equation, which is called the Principle Business Process Linguistic Equation or PBPL (Stasak, 2012) [16]. The PBPL equation has many solutions for different applications and will create a basis for quantification and modelling of warehousing business processes described in this paper.

2.2. Methodology – Warehousing Business Processes Analysis

«Warehousing provides multi-dimensional analyses on cumulated historical business data for helping contemporary administrative decision-making. Nevertheless, it is believed that only about 20% information can be extracted from data warehouses concerning numeric data only, the other 80% information is hidden in non-numeric data or even in documents» (Tschen & Chou, 2006) [19].

The business process denoted as Logistics is considered to be the core business process in this paper. It consists of two main processes called production and material management. The main process is material management. It consists of two sub-processes defined as material ordering and stock control, which should be subject to subsequent optimisation.

Material requirements are usually determined by production process and both of the abovementioned sub-processes are strongly interconnected and have to be investigated as a whole. On the other hand, production requirements related to material assurance are being derived based on production planning results and the process of material ordering is especially sensitive to such results. This is relevant to the process of stock control and forecast. However, such a vision represents a functional view only. The process view is more important for the analysis of warehousing business in order to know the structure and functionality of both processes to be investigated (see Figure 1 and Figure 2).

At first, we shall investigate the **ordering process** alone and its relations to production requirements – Part I – Material Items.

¹The terms «Business Process» and «Process» are considered to be semantically equal in this paper.

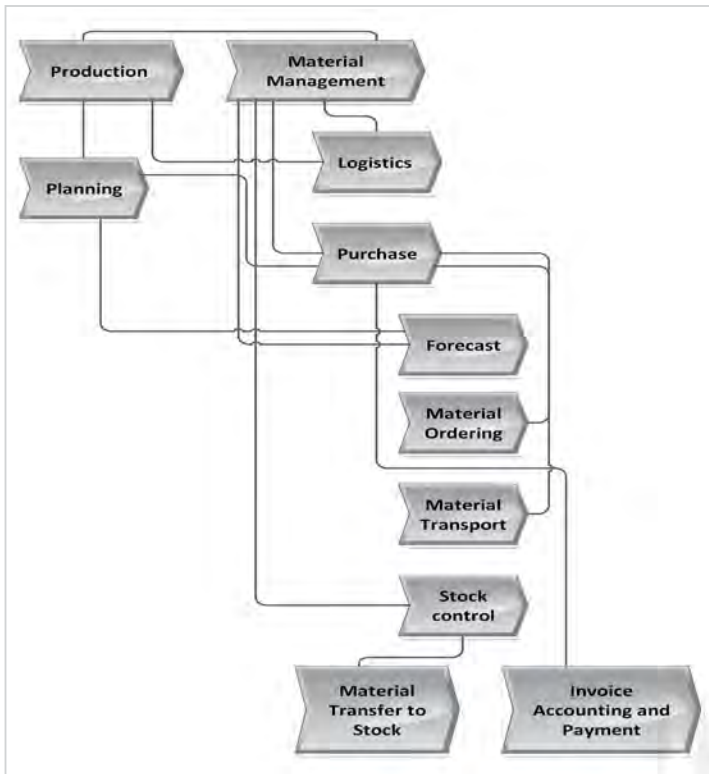


Fig. 1: Warehousing Business Process – Functional View
Source: Compiled by the author

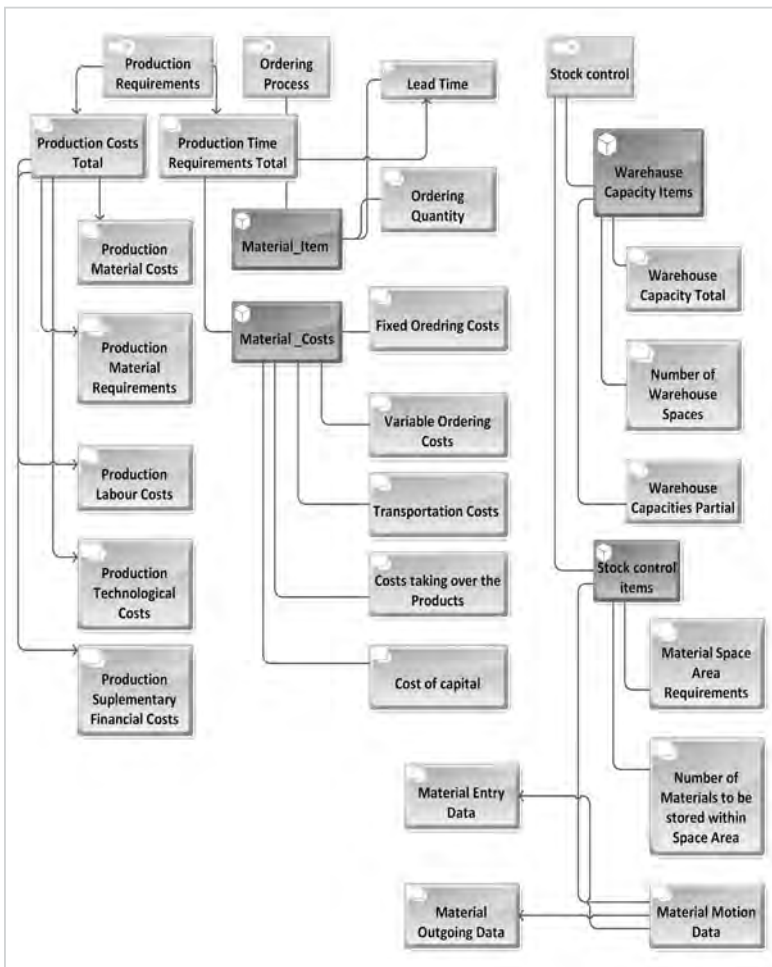


Fig. 2: Warehousing Business Process – Process View
Source: Compiled by the author

Studying Figure 2, we can see a process view related to ordering process and two principle data nodes which represent basic building stones related to the metrics of the ordering process. The first data node denoted as «Material Item» contains two metric measurements: Lead Time (Kljajic, Kofjac, 2004) $\{Ltime(i, j)\}^2$, where $i=1...n$ is a material serial number and $j=1...m$, is a number of material structure items, *Ordering Quantity* [4] $\{Oq(i, j')\}^3$, where $i=1...n$ is the same material serial number and $j'=1...m_2$ of ordered material structure items. Both of the abovementioned items are closely related to the items denoted as «Production Material Requirements – $\{Pmr(i, j^{''''})\}$ » and «Production Time Requirements $\{Ptr(i, j^{''''})\}$ »

With respect to the abovementioned issues, abbreviated forms of the PBPL equation might be postulated via formulas (1) and (2).

$$\{Pmr(i, j^{''''})\} \otimes \{Oq(i, j')\} = Res1a(i, j') \quad (1)$$

$$\{Ptr(i, j^{''''})\} \otimes \{Ltime(i, j)\} = Res1b(i, j') \quad (2)$$

Formulas (1) and (2) create a basis for the design of the material ordering process model.

Now, we shall investigate the **ordering process** alone and its relations to production requirements.

However, it should be taken into consideration that there is one more data node denoted as material costs, which consists of three types of costs: fixed ordering costs $\{Focs(I, j)\}$, variable ordering costs $\{Vocs(I, j)\}$, and transport costs $\{Tocs(i, j)\}$.

These items are represented by linguistic sets, which are a fuzzy set nature and are closely related to «Production Material Requirements – $\{Pmr(i, j^{''''})\}$ » too. With respect to those issues, formulas (3), (4) and (5) can be postulated:

$$\{Pmr(i, j^{''''})\} \otimes \{Focs(I, j)\} = Res1c(i, j') \quad (3)$$

$$\{Pmr(i, j^{''''})\} \otimes \{Vocs(I, j)\} = Res1d(i, j') \quad (4)$$

$$\{Pmr(i, j^{''''})\} \otimes \{Tocs(I, j)\} = Res1d(i, j') \quad (5)$$

3. Results and Discussion

3.1 Warehousing Business Processes Design and Aspects of Optimisation

The material ordering process is considered to be a process of principal importance in view of the following:

- It is closely related to the production business process.
- It determines a measure of material cost, which is closely related to production material costs and to entire production costs subsequently.

The results of the analysis of warehousing business processes postulated in the previous section indicate several relations between the production material requirements and the structure of the material ordering process and its functionality. Hence, the question is how those formulas and relations can be interpreted from practical point of and how they might be applied in the practice?

We shall try to answer this question via the business process denoted as Glass Batch Preparation or the GBP Process. The GBP Process is considered to be an elementary process, which consists of the following func-

² The $\{Ltime(i, j)\}$ is considered to be a linguistic set and is a fuzzy set nature
³ The $\{Oq(i, j')\}$ is considered to be a linguistic set and is a fuzzy set nature

tions: F (1) silica sand processing, F (2) insertion of additives and F (3) mixture homogenisation. The F (2) function might have several subordinated functions closely related to insertion of each additive. On the other hand, the abovementioned business process operates with two inputs: silica sand and additives. However, the production material requirements is significant only when considering process functionality. The second one is the business process real-time running. It means that any BP function runs within discrete or continuous time intervals.

As a result, we have to consider two principal relations:

- Production material requirements versus production process structure and functionality
- Production process functions versus time intervals in which they are running and consuming material resources.

With respect to the above mentioned issues and formulas (1) and (2), further important formulas might be postulated:

$$\{Pmr(i, j^{***})\} \otimes \{Pe(i, j)\} = \{Reslc(i, j')\} \quad (6)$$

$$\{Ptr(i, j^{***})\} \otimes \{Pe(i, j)\} = \{Resld(i, j')\} \quad (7)$$

where the linguistic set $\{Reslc(i, j')\}$ represents a bill of material pattern for a unit of the final product.

The linguistic set $\{Resld(i, j')\}$ represents the business process real-time running pattern, which is closely related to the consumption of material resources when the business process $Pe(i, j)$ is running. However, this is the first part of answering the abovementioned question.

The second part of that is closely related to the material ordering process.

When applying formula (1), provided we replace set $\{Pmr(i, j^{***})\}$ by $\{Reslc(i, j')\}$, formula (8) and formula (9) can be postulated:

$$\{Reslc(i, j')\} \otimes \{Oq(i, j')\} = \{Resle(i, j')\} \quad (8)$$

where the $\{Resle(i, j')\}$ set represents an ordering form pattern from the production material requirement point of view without appropriate time intervals

$$\{Resld(i, j')\} \otimes \{Oq(i, j')\} = Reslf(i, j') \quad (9)$$

where the $\{Resle(i, j')\}$ set represents an ordering pattern from production material requirement point of view and appropriate time intervals.

The results of this study also support the existence of the size effect on the ordering (Takahashi, Ohnuma & Hono, 2003) [17].

4. Conclusion

The purpose of this paper is to design an optimal architecture model of the warehousing business processes related to their structure, features and functionality by quantifying relations among sets concerned to production material requirements and sets concerned to ordering business processes, which create an integral part of material management.

The described structure represents a qualitative proposal, which forms the basis for the development of materials management business processes in terms of design and optimisation. The research was conducted at RM GASTRO, a group manufacturing joint-stock companies with a number of employees equal to 1,000, in June, 2015.

The results of the study provide design solutions, eliminating the shortcomings of the current state pointing to the possibility of further improvement. This vision contributes to the understanding of logistics sub-processes within the enterprise and their relations with other processes giving an approach to the customer through operational research methods linked to the performance of the system as a stabilizing element in the market environment.

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