USE OF PRECEDENT MATRICES IN SUPPLY CHAINS

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Abstract

Business success is based, among other things, on the ability to manage the company and to affect own position in the networks structures of the supplier-customer relations. Internal, but especially external processes, situated among company and its suppliers have an important role in optimization of business environment. Optimization of the supply chain is one of the tools, it means, that the optimization of a system is created by the business processes of all organizations, which are directly or indirectly involved in satisfaction of the customer requirements. Therefore an optimization must be on the level of producers, suppliers but also transporters, wholesalers and warehouses, retailers and ultimately of the customers. The supply chain is characterized by the reversible flow of material, financial and informational flows among its individual levels. Material flows represent distribution of the new products in direction from suppliers to the customers, after them in opposite direction the products are forwarded especially in process of reverse logistics for servicing, recycling or their disposal; we cannot forget also the financial and information flows. Thus, the supply chain includes the subjects and processes at the various levels. Part of the processes works in parallel; the streams in the chain are divided into network structure. We can say, that the supply chain can represent a multi-level network which does not have to include all levels from producers over consumers.

The paper deals with utilization of the oriented connections in these networks and their possible analysis using the precedent matrices.

Keywords: Supply chain analysis, matrix precedence

1. INTRODUCTION

The importance of the supply chain already follows from the essence of a logistics. According to Drahotský, Řezníček, Pernica, Vaněček and others, the logistics is discipline (see for example, [1, 4, 8]), which deals with the material flow, connected therewith information and financial flow, from raw material supplier, through the manufacturer and other intermediaries, to the final customer. All this with the aim to maximize the satisfying customer needs in achieving the reasonable costs in the whole chain. On the basis of the systemic conception of the logistics, is possible to perceive the logistics as a material, control and information system [5]. Follows from the above is clear, that in process of the moving of the product, important is moving product as well as management and information, related with the product. The main subject of the scientific exploration of the logistics is a logistics chain [6]. The logistics chain is defined as "a set of tangible and intangible flows in progress a number of related articles..." [6, 8]. The purpose is to satisfy the need of the final article. Due to the fact that the individual events form the storyline, the apparatus of graph theory and systems theory could be used conveniently for the analysis behavior of the chains. The logistics chain, as well as the system in general, is assigned and defined based on the demand and supply. For these reasons, active elements can be understood only as a means for transferring the passive elements and in the process relocation of the product to focus on moving of the passive elements only, i.e. subjects that extend through the supply chain. Due to the fact that the movement of the tangible and intangible elements is going on the logistics channels (paths), possible is to define the changes of the elements in time through these paths (movement in direction of the oriented links). Although the logistics system is generally understood as a dynamic [6], the use of the classical

forms of static structural and temporal analysis for monitoring the movement is possible. A subset of the logistics chains is formed of supply and customer chains.

2. SIMPLIFIED MODEL

Supply chain management is one of the strategies of modern management, which deals with the optimization of all activities and systems for security of all business chain (i.e. from delivery of the products/ services through the channels of distribution to the end customer). The aim is to streamline the process, which begins with typing of orders, their processing and evaluation, continues with the manufacturing, delivering of goods/services and ends on the feedback. However, it is necessary to realize, that for the process management is necessary to create a sufficiently simple model, which mainly allows monitoring of passive elements in the system and motion managerial and information flows related to the relevant material flow. It is also necessary to define the model and the relevant analytical apparatus that allows to examine the relations of the elements towards the preceding or subsequent groups of elements, which have common continuity. Basic relations must be further analyzable away from the production to the customer, in terms of management and information and subsequently in the opposite direction.

Those conditions in the simplified form satisfies apparatus of precedence matrix, which allows monitoring groups of previous and follow-up activities to selected and pre-defined set of elements. It is also allows a simple transcription of the classical charts and subsequent computer processing. Among the basic operation realizable these matrices includes simplified multiplication of these matrices, defined by Borje Langefors [3]. This simplified multiplication allows to search the paths of multiple lengths preceding or subsequent to the selected elements. This allows to monitor multiple, indirect links in the logistics chain.

Properties of the matrix, defined for description of the systems allow further to apply relatively strong control mechanisms related to flows and fictitious flows (fictitious edges) in the system.

On the figure 1 is a simplified model of the system, on which are realized the supply chains. It is a system of the articles, by which follows the material flow, it gradually transforms into the requested product and distributes either directly to the customer, or to a place, where the customer can buy it easily.

The individual vertices are formed by active elements of the supply chains. Mutual relations are created based on the time sequence of the individual activities carried out on the passive elements. For simplicity, it is used a time range of one hour, it is assumed that the product moves during the hour to the subsequent hub.

The network graph is defined by vertices A,B,C,D,E,F,G,H,I,J,K,L and M, the A is a manufacturer and M is a customer. The distribution chain in segmentation of 1 hour time interval is composed of 19 time slots.

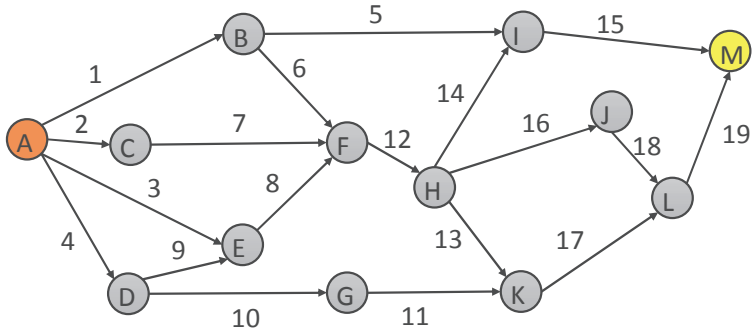

Fig. 1 Demonstration model of the system

3. THE POSSIBILITY OF PRECEDENTS ANALYSIS

Figures 2 and 3 show the basic precedence matrix used for transcription of the system. Among the matrices is valid mathematical relationship expressed by the formulas (1) to (3). For selection of a group of vertices is used selective vector, for which is hold (4), (5). Designation matrices are shown in [3, 7].

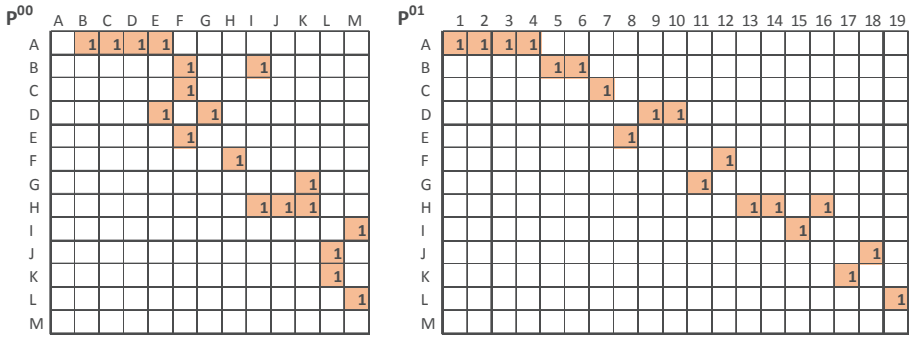

Fig. 2 Nodes as predecessors

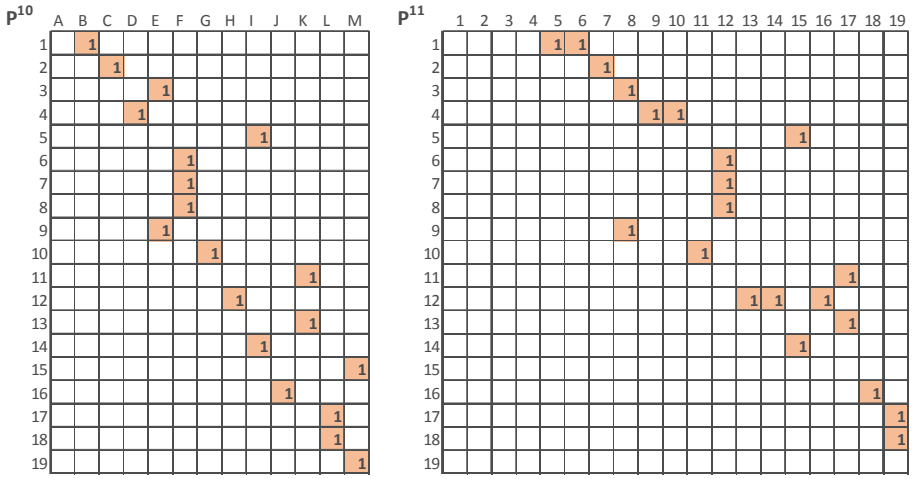

Fig. 3 Lines as predecessors

$$P^{01}P^{10} = P^{00} \tag{1}$$

$$P^{10}P^{01} = P^{11} \tag{2}$$

$$E^{10} = P_T^{01} - P^{10} \tag{3}$$

The operations are described in [3] and [7]. Figure 4 shows an example of finding groups of activities that must be implemented in the chain to be realized activities H and I. A calculation based on (4) shows that the activities of the F and B must be implemented. Similarly, according to (5) can be analyzed independence activities. Figure 5 shows the actions that can be implemented independently of the J and I. The principle of the calculation is based on a calculation of the follow-up activities to the group precursor activities.

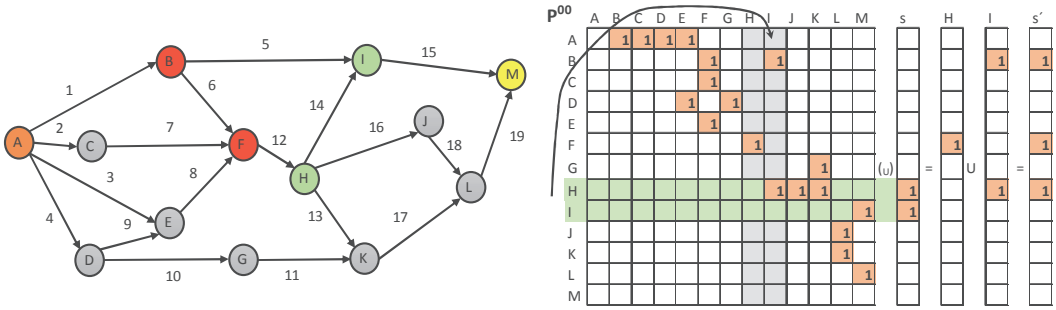

Fig. 4 Preceding events

$$P(\cup)s = s' \tag{4}$$

$$P_T(Ps) \neq s' \ldots P(P_T s) \neq s \tag{5}$$

Multiplying matrices will transform the system into multiple precedence. Figure 6 shows a system in which is a timescale of two hours, the calculation of the others precedents according to [3] shows Figure 7 (Up).

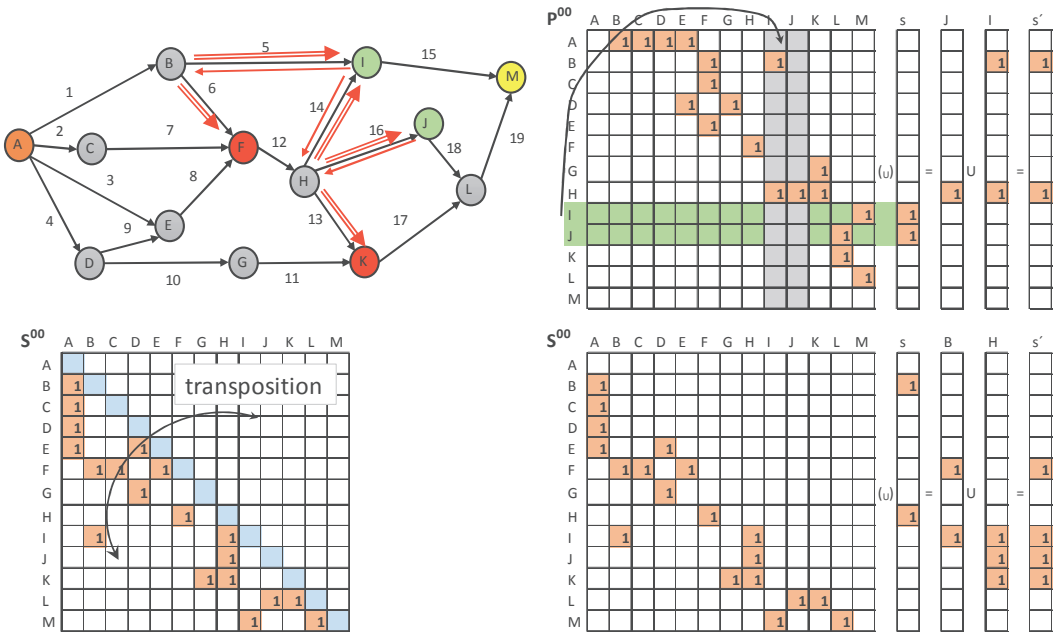

Fig. 5 Independent events

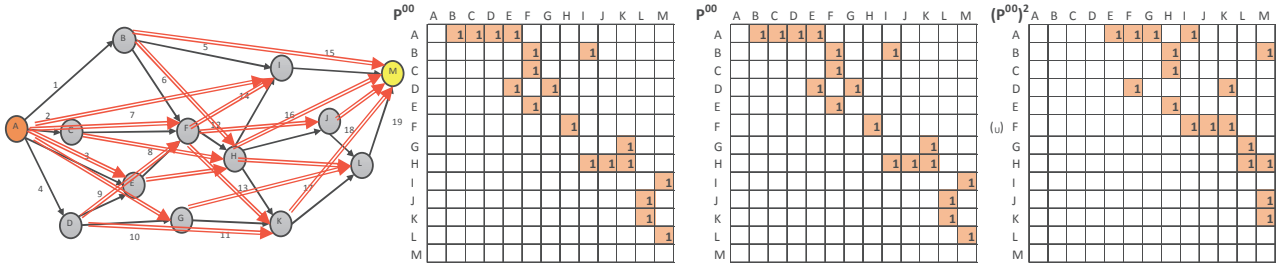

Fig. 6 Time range two hours

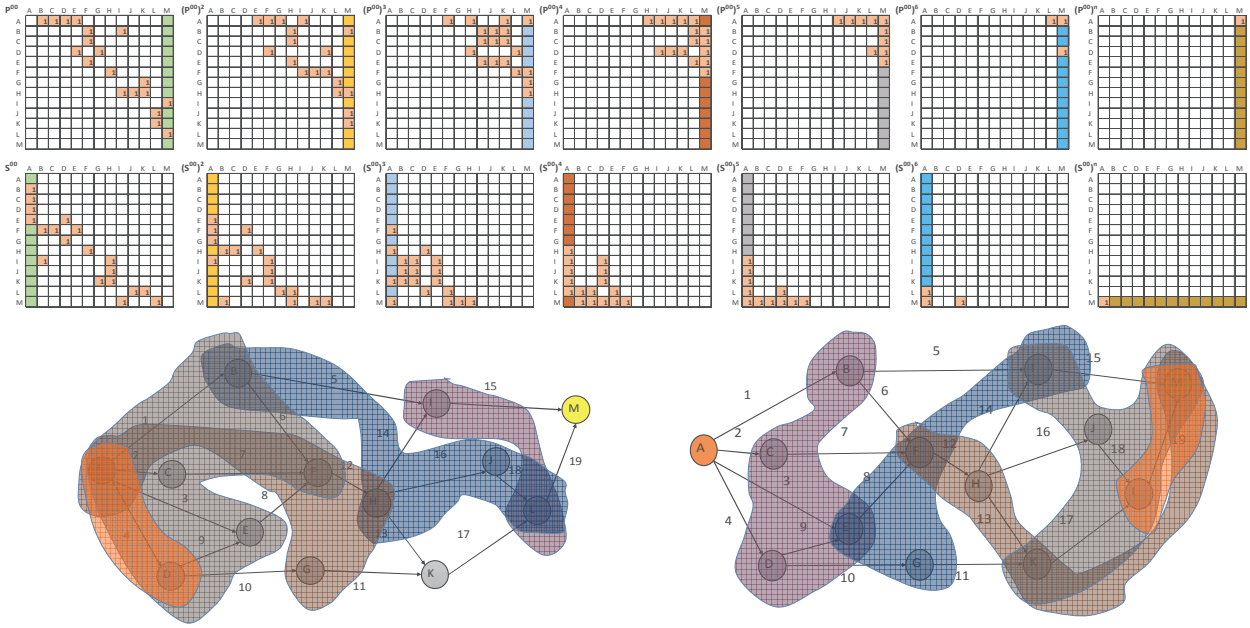

Fig. 7 Multiple precedents, pass through the system backward and forward

Matrix transpose by the main diagonal can describe the subsequent phenomena in the system.

Figure 7 (down, color schemes) shows the penetration movement of goods from manufacturer to the customer and information from customer to the producer after the hourly intervals without time shift (at the time the distribution the customer starts to monitor the elements of the system).

The first row of the matrix shows the powers of precedents matrices P^{00}, $(P^{00})^2$ … $(P^{00})^7$ (a power of matrix shows the length of the path from node A - movement of goods), the second row of the matrix shows the powers of succedence's matrices S^{00}, $(S^{00})^2$… $(S^{00})^7$ (a power of matrix shows the length of the path to node M - movement of information). Left graph shows precedence's, right, shows the succession. Color nodes are labeled with the same path length. The color is determined by the square matrix.

4. CONCLUSION

The paper aims were to show a very simple and yet very effective tool for monitoring and analyzing flow and the movement of passive elements in the supply chain. On a selected group of simple examples has been demonstrated applicability for structural and temporal analysis. The examples shown only part of the possible analyzes, the apparatus can be used to determine the longest paths and for calculations of the frontier watercourses or evaluated systems. Very powerful tool of that apparatus is control mechanisms which can use to apply by these matrices for verification of the implemented proposal system, describing the supply chain. Powerful tools are useful for checking of acyclic phenomena.

Calculations in the systems by using these matrices are marginal nowadays, rather forgotten apparatus. There are more efficient and more sophisticated tools, suitable not only for monitoring and analysis, but also for effective management [2]. This paper does not aim an application or presentation on management systems, the aim was to show the possibility of a very simple apparatus, realizable through the standard software tools such as MS Excel. For a list of referenced analysis is this system adequate and sufficiently effective.

ACKNOWLEDGEMENTS

The article was created based on students grant system project SGS/20/2014 Analysis of the business environment in the region Karvina.

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