EXTENSIVE MATRICES FOR ANALYSIS OF DISTRIBUTION CHANNELS

BOTLÍK Josef, BOTLÍKOVÁ Milena

Silesian University in Opava, School of Business Administration in Karvina, Karvina, Czech Republic, EU,
botlik@opf.slu.cz-+; botlikova@opf.slu.cz

Abstract

Distribution logistics covers all warehouse and transport movements of goods from producer to customer, and related information and control activities which are realized through distribution channels. Within these channels, there is predominantly a physical distribution which can be understood as a subsystem of distribution including all operations related with the physical movement of distributed goods. Optimization of physical paths is mainly possible through strategic distribution which is mainly engaged in the design of distribution system, design of warehouse network, choice of transport and handling devices etc. Physically, there is a distribution in network, where structure of entities in the network of suppliers, warehouses, cross-docks and customers is analyzed and optimized. Then, the distribution chain can be realized through nodes and segments, where nodes form a multiple of organization units of producer and of external providers who participate in the process of goods distribution, and segments are physical paths through which the goods move between nodes. In practice, there are extensive systems that cannot be analyzed using standard software tools. The paper shows possibilities of analysis using binary matrices.

Keywords: Distribution logistics, analysis, extensive matrix, binary matrix

1. INTRODUCTION

The systemic approach to distribution channels could be viewed as paths in the distribution network. Distribution by a lot of authors could be seen as a bridge connecting customers with the product. Network analysis is therefore necessary at the outset to specify system elements, define the desired behavior and refine system bonds. On the basis of these relations could be further define the model and perform the appropriate analyzes.

The paper deals with a general model for a specific time and the structural analysis that has broad possibilities for further use. The model is based on a simplified reality and investigates the existence of relationships in the distribution network. Distribution network created interweaving of different elements - producers, distributors, wholesalers, retailers and support organizations [11]. Since the physical distribution system involves a process of ordering goods, handling of goods, warehousing and storage systems, inventory management and location of warehouses, packaging and sorting and transport [1], elements of analysis could also complement these subjects. Finally, according to [14] enter into the process of transport operators between the carrier and the customer, shipper, transport and shipping companies, sales agents or brokers. The complexity of processes is therefore dependent on the type of distribution channels. For example [4] could be distributed from a general point of view divided into direct and indirect (resp. Combined) where for direct distribution to occur between the manufacturer and the end user for immediate contact. Indirect distribution comes between the manufacturer and the end user any intermediary. Indirect distribution multiplies the capacity of distribution channels.

Distribution channel could have one or more intermediary levels. The simplest form of distribution is a direct distribution channel; an indirect distribution channel may have one, two, three and sometimes even more levels. Single-level distribution channel consists of a manufacturer, a broker, which is most commonly retailer and end consumer. Two-level distribution channel consists of manufacturers, the two brokers and the end

consumer. Three multi-level distribution channels and then incorporate further interfaces, which could be, for example, wholesalers, agents, warehouses, processors etc.

The diversity of the distribution network is thus affected entering the functions of distribution intermediaries (commercial, logistics, optional), especially logistics related to the storage, handling and transport. Taking into account the further distinction by type of distribution intermediaries, enter into the process of commercial intermediaries (at constant ownership), intermediaries (wholesale, retail trade, a change of ownership) and supporting interfaces, which in terms of physical distribution are essential intermediaries to support the movement and storage. Distribution intermediaries are among the main factors affecting the distribution channels (along with the nature of the product, the nature of the market environment factors, etc.).

With distribution channels on multiple levels, in practice we see quite often. Every other intermediary who enters between producers and consumers, increasing the cost of goods, extended delivery times and difficult is monitored distribution channel. Although there are classifications organization distribution channels (conventional distribution system, vertical system, horizontal system), this structure is not directly usable for adequate levels in the layout of the model of distribution network.
The system further includes physical distribution of information, planning and control systems, communication in the distribution, handling returned goods and the corresponding compensation and administrative work associated with the system. In the process of system analysis, monitoring and dealing with the physical appearance of the product distributed these activities are irrelevant. Quite extensively the distribution activities processed for example in [6].

Specifics are defined in [13] energy networks, basic common feature is that the manufacturer "sells" its products through an extensive transport network virtually anonymous customer, respectively, after the separation of distribution channels intermediary transmission services, which pays for the withdrawn product additionally according to the amount collected. The customer is not anonymous, but the time of collection, the manufacturer almost do not care who the product is being taken. Between the manufacturer and is not a simple transport "chain", but the transmission network, the system of distribution channels through which the energy in the event that it is between some nodes in the network potential difference. At the ends of these transport networks are connected customers, i.e. customers.

2. EXTENSIVE DISTRIBUTION NETWORK

The complexity of distribution models suggests large distribution network (volume) or large (area) subjects. Complexity leads to the creation of specialized distribution companies with their own networks, exhibiting a large number of sub-elements and local vastness. This creates extreme distribution network to which systems professionals looking for new analytical methods.

For example, from the perspective of the Czech Republic, according to [5] on the date of June 25, 2014 became the company Geis Parcel CZ s.r.o. by taking a 50 % stake in e-shoppartner shareholder and together with the Mediaprint & Kapa Pressegrosso, a leading distributor of print, owns the largest private network of outlets for the vending location of packages in the Czech Republic.

Network e-shoppartner, currently includes more than 420 outlets and has potential for further expansion. It is obvious that such an extensive distribution network will finally comprise thousands to hundreds of thousands of elements. Information on the size of the distribution networks are in some cases inconsistent and evolve, however, suggests a considerable complexity and vastness. For example, the date 03/05/2015 has announced firm Baliczech [7] links with the West Bohemian consumerism cooperatives Plzen, which is part of a network of stores COOP, creating more than 450 sites providing distribution of goods from e-shops for customers throughout the Czech Republic. There is also an extensive network according to [2] Czech distribution company with more than 6,000 distributors and total coverage of the Czech Republic, which are among the strongest company for direct and non-targeted distribution in the country.

Among the largest distribution network include network power systems, which have more specifics. It is a network of interconnected into international structures, having a large number of connection points, structurally linked to regional and geographical structure. For example, according to [3] CEZ, the leading energy group in the Czech Republic and throughout Central and Southeastern Europe and is the largest electricity producer in the Czech Republic as well as a supplier of gas and heat (power distribution ensures, through a separate company CEZ Distribution, Inc. and CEZ Sales Ltd.), the Czech Republic serves nearly 7 million customers and delivers electricity to nearly 3.5 mil. outlets points.

The company RWE (Ing. Miloslav Zaur, RWE GasNet [16]) states that the Czech Republic has built an extensive distribution system where nearly every village with more than 2,000 inhabitants has a connection to the gas, the company operates approximately 5 thousand leased km of gas pipelines and distribution network operator (DNO) recorded a total of 2,500 lease agreements, with about half of the contracts concluded with entities such as city / municipality.

External distribution networks are made up of only distribution companies and energy giants, such as by [12] has an extensive network and Skoda Auto, which only in the Czech Republic there are almost 300 authorized partners, which have to be secured distribution, service and other marketing and logistics activities, while entering into the distribution of other, previously reported activities and entities.

For comparison, the extreme distribution networks might even Parker [10], which supports an unrivaled industrial network of distributors covering approximately 13,000 locations worldwide. Thanks to an extensive network of production companies, trading companies and distribution network brings Parker's products and services to customers in 104 countries.

3. SIMPLIFIED MATHEMATICAL MODEL

For the processing of such data volumes are developed special tools, for example by [9] on the processing network of 100 customers, 100 products and 100 branches, including one million combinations designed highly specialized software Planning Wizard. Extensive distribution systems could handle with standard programs, for example. MS Excel.

The basic problem lies not only in the definition of elements and relationships as well as their interconnection and access to substantial amounts of data. Simple data model allows to describe the system by using a plurality of matrices, wherein the matrix is defined by one (or more time-dependent) for the pair of feature types of the distribution network. In the case of distribution chains may be a matrice manufacturer-carrier, carrier-store, warehouse-carrier, warehouse-customer etc. The number of matricess is given as a Cartesian product of processed entrants into the distribution process (producer, intermediary, agent, carrier, customer etc.). Each subject is further comprised of vector specific elements of the appropriate type (Warehouse_1, Warehouse_2 ... Warehouse_n etc.) Mutual relations in the distribution network are then recorded in these matrices, which is in the row and column of recorded existence (or quantification) interactions (for example, the matrix that expresses the relationship between the carriers and warehouses (rows of the matrix are made up of a list of carriers and a column listing the stores it in the appropriate row and column indicated a logical variable that there is interaction between these entities, or the numerical value which further quantified, for example. the value of the quantity or time). In this case, the matrice reasonably large, that we could handle classical mathematical techniques. For example, multiplying matrices could then at the appropriate enrollment count subsequent and previous happens between actors and thus monitor movements in space and time in the past, resp. planned in the future. For more details of these processes, including interactions to groups of elements (such as the search for a carrier selected group of stocks, finding a wholesaler for a selected group of products, products distributed to a selected group of intermediaries, etc.) specified [8] and [15]. The problem in this model is an incomplete multidimensional data cube, which are identical dimensions matrices and transition of goods between matrixes (see **Fig. 1**).

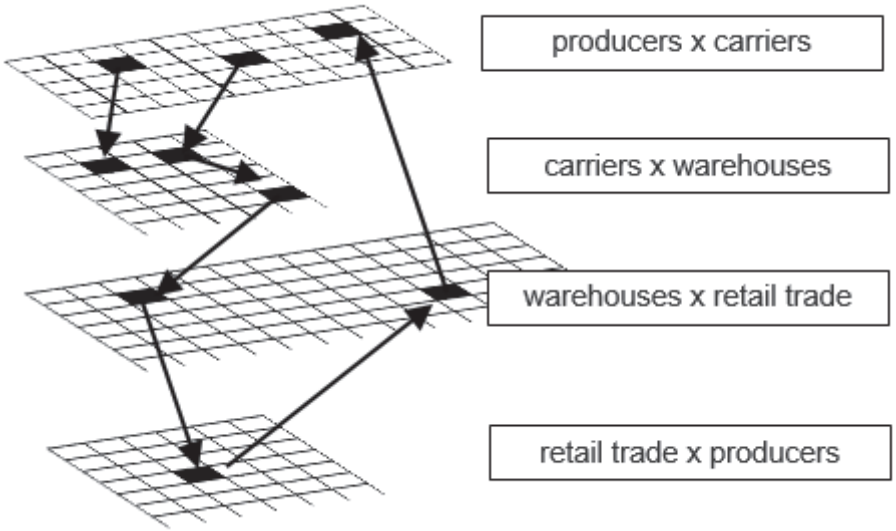

Fig. 1 Transition of goods between matrixes

It shows inconsistency transitions between matrices within the distribution channels. From **Fig. 2**, then the graph shows the structure of a fragment of the process shown network graph, it is apparent incompatibility between elements.

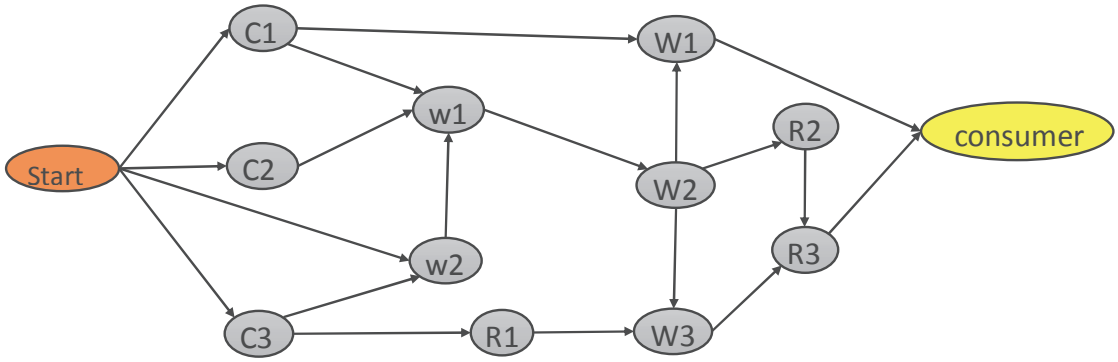

Fig. 2 Inconsistencies in network elements

For simple network model is applicable advantageously can use a general two-layer architecture defined by only two matrices, wherein the values of the matrix and its dimensions are adjusted based on the values and dimensions of the vectors describing the elements of the relevant type. In this case, you could even work with numerical data and a system to identify and describe, for example, the number of hours spent by the product in the warehouse or the distance over which it was delivered.

In some types of analyzes is not necessary to quantify the value, settle for an identifier that indicates the presence of product at a given location at a given time. This simplification does not prevent quantify, that could achieve a multiplicity (to the right for 5 kilometers, as indicated by the presence of the 5 transports per unit distance) or by a vector of values that you identify the occurrence of the event is assigned a value. If we introduce a binary description, we layered architecture model of a given set of matrices transformed into a single, comprehensive matrix in which the rows and columns will be identical set of elements consists of the

sum of all the values of the vectors of individual objects. The problem with these matrices is their subsequent processing. If we use the standard means, for example, MS Excel, then according to the performance of the computer system will limit the size matrix, usable for further processing (such as matrix multiplication) in the interval from 1,000 to about 3,000 members (matrix 1000 x 1000 to about 3000 x 3000 features).

This limitation may be due to the use of binary matrices successfully eliminated if we use specially defined operations.

4. DATA REDUCTION - BINARY MATRIX

The basic idea of data reduction is to replace conventional matrix operations, special operations choice between matrix and vector. The method is based on the theory described for example in [8]. Due to the binary matrices and vectors it is for writing binary values, when possible, instead of writing the whole vector elements of the vector using the indexes with a nonzero value. Subsequent binary operations can be achieved with the same effect, multiplying matrices, respectively, respectively multiplying the matrix and vector. The difference of the result is only that the resultant matrices are again binary and identify again, only the existence of binding (classical multiplication we get a numerical matrix expressing the frequency of existing links, for example, if it could be get from store and to store B in three ways, the result of classical multiplication yields as a result of "3", the result of binary multiplication gives the result as the value "1", which indicates that "may get").

Enrollment matrix display is used predecessor row object to column. Therefore, if there between two objects oriented bond (usually given temporal and spatial continuity) has a true logical value when an element $\mathbf{P}_{ij}$ is the element in row predecessor element in the column. (For example, if the goods are distributed from warehouse_5 to retailer_3, then the matrix will be in line with the index warehouse_5 value "1" in the column with the index belonging retailer_3).

The principle of calculation and the operations are based on the choice of the vector matrix by selection vector. Selective vector selects column vectors of a matrix and then performs a selected vectors selected binary operation. If a unification operation is the result of the operation known as vector matrix composition (sometimes multiplication / logical multiplication of the vector matrix) being a vector that specifies the set of elements preceding selection vector (1). The operation is generally the inverse of (2). If progressively applied as a selection vectors individual columns defined matrix will result in a binary matrix (referred to as power), identifying the links between the pair immediately noncontiguous elements, the degree square matrix indicates the existence of a link of appropriate length.

$$P(\cup)s = s' \tag{1}$$

$$P_T(Ps) \neq s' \ldots P(P_T s) \neq s \tag{2}$$

Fig. 3 is an illustration of the composition of the vector and the resulting vector matrix. Similarly, the principle of calculating the square matrix. It is obvious that the presented operation leads to a considerable simplification and reduction of the data.

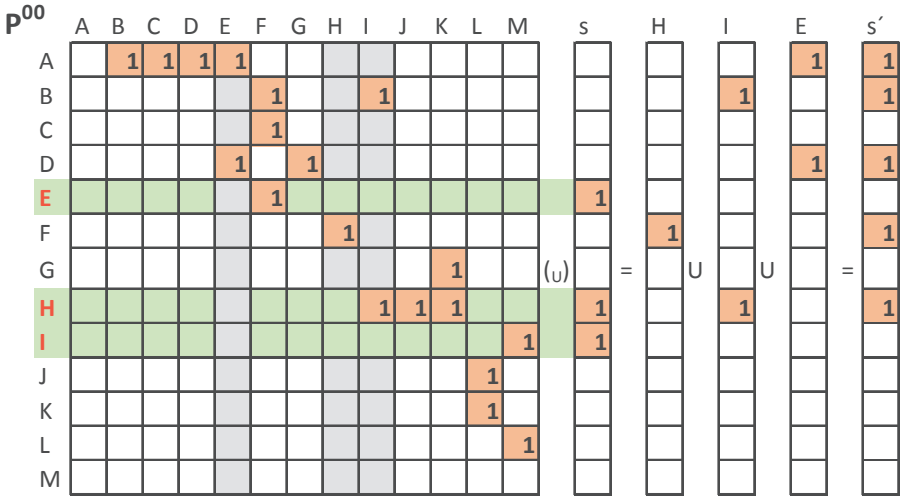

Fig. 3 Composition matrix vector

5. CONCLUSION

The operation was tested on the matrix in the interval 1000 x 1000 elements to 5000 x 5000 elements to the elements which corresponds to moderate extensive distribution networks. Classical methods have resulted in these large arrays to collapse excel, according to the number of values in the array has the dimensions 1000 x 1000 elements, while 20 % use a logical value "1". When using the binary system operations almost managed to 5000 x 5000 matrix elements, which enables processing of relatively large distribution networks using conventional software products. Very inefficient so far shows rather own form of data recording, but you could likely use the original multi-layer recording sub-matrices and their subsequent transformation into an index entry.

The great advantage of the present solution it is possible to define almost any set of links in the system, which can be determined by interactions based on various requirements (the existence of real and fictitious bonds, for example, physical adjacency of two warehouses, the availability of stocks after the relevant communication, membership warehouse to combine greatsupplier, nationality retail customers in the same region with wholesale customers like. The real determination predecessor system is then performed by comparing the value of the corresponding object (for example a warehouse) and adjacent objects according to selected criteria. The entire system can be defined by a set of vectors indicating links to the selected criteria (Binary vector), followed by a set of vectors with real values for the processed objects (e.g. the processing time, kilometers, the number of pieces etc.). The quantitative expression parameters, together with the determination of appropriate links system translates into binary, so that the comparison of adjacent elements based on the relevant links and values elements will determine who is elected in terms of quantity in time or space smaller value. Subsequently, the binding orientation determined by the element with the lower value of the element with the larger value.

From these results, we have shown large variability of the system and relatively simple usability in large distribution systems. The method is based on knowledge of classical systems analysis, so it is versatile and easy to modify.

ACKNOWLEDGEMENTS

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

REFERENCES

[1] BOUČKOVÁ J. Marketing, Praha: C.H. Beck, 2003.

[2] Česká distribuční. Word from the Director. Available online: http://www.distribucni.cz/profil/slovo-reditele.html

[3] Energetická skupina ČEZ. Available online: http://www.cez.cz/cs/o-spolecnosti/skupina-cez/o-skupine-cez/profil-skupiny-cez.html

[4] FORET M., PROCHÁZKA P., URBÁNEK T. Marketing - základy a principy, Praha: Computer Press, 2005.

[5] Geis se stává podílníkem největší privátní sítě výdejních míst v České republice, Available online: http://www.mediaprintkapa.cz/geis-se-stava-podilnikem-nejvetsi-privatni-site-vydejnich-mist-v-ceske-republice/

[6] HÁLEK V. Marketing: Distribuce produktu. Available online: http://halek.info/www/prezentace/marketing-cviceni4/mcvp4-print.php?projection&l=10

[7] Jsem největší v ČR. Available online: https://www.baliczech.cz/novinky-1/jsem-nejvetsi-v-cr

[8] LANGEFORS B. Teoretická analýza informačních systémů. Bratislava: Vydavatelstvo techniocké a ekonomickej literatury Bratislava, 1973.

[9] Logio, Planning Wizard, Pomáháme firmám zlepšit řízení dodavatelských řetězců. Available online: http://www.logio.cz/

[10] PARKER. Distribuční síť. Available online: https://www.parker.com/portal/site/PARKER/menuitem.70af03dcfe9bc972c1e1a762427ad1ca/?vgnextoid=d9fcfeb7a93d5410VgnVCM100000200c1dacRCRD&vgnextfmt=CS

[11] ROGERS L. Business guides - Marketing, Praha: Readers International Prague, 1993.

[12] Škoda Auto. Počet autorizovaných partnerů Auto Škoda v ČR. Available online: http://www.skoda-auto.cz/mini-apps/autorizovani-partneri-skoda

[13] STRAKOŠ V., Energy supply of the population as a logistic process, Acta Logistica, Vol. 2, No. 3, 2012.

[14] ŠTŮSEK J. Základy marketingu v dopravě, Praha: CREDIT Praha, 2002.

[15] UNČOVSKÝ L. et al. Modely sieťovej analýzy, Bratislava: Alfa, 1991.

[16] ZAUR, M., Rozvoj plynárenské distribuční soustavy a nájmy distribučních sítí. Available online: http://smocr.cz/data/fileBank/c36ee0cc-5c41-422f-9891-c91a7e3d2610.pdf