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SYNCHRONOUS SUPPLY NETWORK. THE CONCEPTUAL FRAMEWORK

1. The reasons for the supply chain domination in logistics

The conception of supply chain/supply chain management (SCM) has been dominating in the logistics of at least 20 years[*]. Despite a significant lapse of time neither it was submitted for more serious scientific criticism, nor a conception of a similar theoretical significance for logistics development[**]. This is a rather individual phenomenon in science. One may be wondering about the causes for the long-lasting and wide acceptance of the supply chain conception, not finding a more serious alternative for so many years[***]. At least two important and interlinked reasons raise as an ad hoc explanation. The first is of theoretical nature. A simple assumption of a supply chain conception/ SCM, thanks to numerous domestic and foreign authors, has absorbed and continues gradually to absorb elements of many different conceptions of management, among other elements of various approaches: process, resources, network, virtual, lean, reengineering, TQM, knowledge management, risk, etc. In this way, this conception gets systematically updated; it evolves, opens up new fields of research and bypasses scientific criticism[****]. The other reason for the supply chain conception/ /SCM domination in logistics is underlain by the policy of global manufacturing and trading corporations. This conception has been playing a very important strategic functions in the global economy for many years. It facilitates the far-

[*] SCM can be seen as an advanced stage in the development of the conception of a supply chain. The supply chain conception was initially developed under the influence of industrial production needs, including the automotive industry. The closely related conception of SCM (Supply Chain Management) was formed under the influence of experience of the textile industry, food and Wal-Mart's practices. The analysis and genesis of the SCM conception presented, among others: Susan A. Sherer (2005, p. 78). Complementing of the SCM conception are studies and research on the SCO (*Supply Chain Orientation*). See: (Terry, DEFE, Mentzer, 2010). Over the past several years dozens of diagrams have been offered, showing the structure of supply chain and explaining the essence of flows management in the chain. It is enough to look at the Internet resources (search for entry "supply chain images" on the Web).

[**] In recent years, attention of researchers has been focused more on risks and risk management in supply chains than on criticism of the concept itself. The extent of global supply chains, increase in the number of chain links between the participants, risk exposure of IT systems, the threat of terrorism and natural disasters, carries the risk of breaking the chain or a serious disturbance in its cell. Therefore, research on adaptation and resistance of supply chains and networks to sudden, unexpected event is carried out. See, for example: (KeiTse, HuaTan, Chung, Mink, 2011; Greening, Rutherford, 2011, pp. 104-126; Ponomarov, Holcomb, 2009).

[***] The study does not pretend to fully explain all the causes of permanence and scientific accessibility of the supply chain conception / SCM.

[*****] On the Polish ground the latest management conceptions proposed for use in supply chains are usually accepted with enthusiasm, without much scientific criticism and reflection. Academics' attention is focused mainly on their dissemination.

reaching economic expansion and logistical subordination of many regions and countries in the world to the largest corporations. Its systematic development and promotion is in the interest of the most powerful global business players.

The conception of supply chain/SCM due to its economic importance is still the subject of intense scientific practical applications and research (Stank, Dittmann, Autry, 2011, pp. 940-950). These do not mean that there is no alternative, that no such alternatives should be sought and that today supply chain cannot be complemented or substituted by other conceptions of logistics. The transport and logistics business needs in the current development of information technology and electronic media can be satisfied in very different ways, apart from the ones bearing considerable risks and costs for supply chains.

2. Linear and sequential flows in supply chains vs. multilinear and non-sequential flows in supply networks. Features of modern e-networks and their impact on real supply networks

The use of various elements driven from different management conceptions in a supply chain brings many scientific benefits but also raises difficult to solve terminological and classification dilemmas, and blurs the cognitive pathways, leading to different solutions. The simplest example of this, which forms the starting point for further considerations, is widely discussed in Poland and so far the insufficiently solved problem of supply chain *networkability* (Witkowski, 2010, pp. 20-27). Sticking to the supply chain/SCM as the leading logistics conception and defining it as a network of cooperating entities in the successive stages of the manufacturing process do not fully allow for observing distinctiveness and advantages of a network approach as well as the benefits, which can be given by the supply network and its resources to a modern logistics. Looking at the chain and network in the physical or virtual form or at their graphic and virtual mapping it is hard not to notice, however, that these are the objects that differ from each other in terms of look and features[*]. This also applies to supply/logistics chains and networks and the flow of products in these chains and networks. The distinguishing features of the supply/logistics chain and flows in this chain are their linearity and sequencing/phaseability. Product deliveries run consecutively from one well-defined echelon to the next, pursuing further manu-

[*] However, many authors identify a chain with a network. This is especially true of the supply chain. An example would be the understanding of the supply chain as a dynamic network of interrelated organizations, which meet the needs of the client in partnership more effectively. See: (Sheriff Mohamed, 2003, pp. 13-19).

facturing and service operations[*]. These flow characteristics are maintained even after a given chain merged with other chains into a network known in the literature as a network of supply chains or else a network of supply/demand (supply network)[**]. It can be expected, however, that a network formed in such a way, consisting of several supply chains, will also exhibit the characteristics totally different from the characteristics of a chain, typical for a network, especially computerized. They become more evident when analyzing the characteristics of the information flow in computerized networks (websites) and characteristics of social communication on the Internet. Information flows in the network are characterized by non-linearity or multilinearity, nonsequencing, non-hierarchical and simultaneity[***]. Along the networks constructed in virtual space one can move in many directions. There is no fixed sequence in the information flow, there is no single, pre-imposed path/direction of the information flow or order/levels in the relationship between network hubs. These features also transfer to the real, computerized supply network. Thanks to modern software[****] and the use of electronic media real supply networks become more agile in customer service[*****].

In the social communication theory the linear and sequence information flow is associated with traditional knowledge acquisition, while multilinear and

[*] Sequencing means a structured and repeated set of actions performed by another, successive links of supply chain. Linearity means a single bilateral relationship in the supply chain-type "link to link". See: (Świerczek, 2007).

[**] S.A. Sherer thinks that although the supply chain means linear and sequential flow from one link to the next but even there not all products flow sequentially, some flow in parallel (concurrently), for example, the production of microprocessors to Dell computers. In turn the flow of information is not and cannot be sequential because it will only prevent the recognition of market needs. See: (Sherer, 2005).

[***] (WWW8). The simplest forms of non-linearity can be seen wherever a text branches in at least two directions and requires a decision as to the direction of obtaining information.

[****] Support for Agile Software Network Multi-Carriers TMS (Transportation Management and Shipping Solutions) today allows companies like UPS, Fedex, DHL, USPS to manage multiple carriers and supplies to many places in the network, offering solutions and logistics services to thousands of customers, retailers, service and industrial manufacturers in the global e-commerce services, financial services. Agile Network TMS is a tool for reporting and analysis of transport, transport planning optimization and reduction of transport shipments. Conducive to containerisation. It allows a company to handle the millions of cargo and parcels each day. See: (WWW1). These services are targeted at small and medium business. Supply chains managed in such a way, in fact operate under the rules of synchronous supply networks See also ASP offers of applications in agile networks of supply and demand: (Kristionto, Ajmal, Helo, 2011, pp. 107-112).

[*****] Agility is defined as the strategic and operational readiness of the supply chain to change (for example, under the influence of market opportunities) and the ability to respond adequately to these changes (resource mobilization). See: (Hun Li, Goldsby, Holsapply, 2009, pp. 408-424; Yusuf, Gunasekaron et al., 2004, pp. 379-392; Gunasekaron, 2004, pp. 584--595). Other definitions see: (Scholten, Scott, Fynes, 2010, p. 630).

non-sequential acquisition of information and texts reading on the Internet is associated with the use of hypertext (hyperlink)*. By way of analogy the flows in the supply/logistics chain can be compared to the traditional model of reading and thinking process: linear, sequential, and single channel. While the movement of products in today's supply network can resemble reading a hypertext. The order of hypertext reading is different, the network users decide on it, and information can be changed under their influence. There are many possible links between network hubs and tracks of the data/information flow (Figure 1). Seeking or providing information, the user moves in different directions and can freely communicate with any hub**. As it has already been stated, it is expected that flows in real supply networks will imitate the free flow of information in e-networks, and this phenomenon will intensify within the time***. What's more, such networks could be created where the flows would show the features of hypertext almost completely. They are called in this paper the synchronous supply networks.

* Hypertext (hyperlink), a term coined in 1965 by Ted Nelson, a non-linear and non-sequential organization of data, text, broken into fragments, which in many ways are connected by links. This is a text, which branches or operates at the request of a reader. Form of hypertext is the Internet and the Web pages (WWW10). Other definitions are given on: (WWW3; WWW4; WWW7).

** Komunikacja językowa w Internecie (WWW9).

*** The relationship between WEB, Internet networks and real networks, such as road networks, networks of citations in scientific literature, language communication network was pointed at by A. Scharnhorst in 2003. His proposal of a comprehensive network theory arouse under the influence of Web content analysis and the Internet by using the tools of statistics and nonlinear physics. (Scharnhorst, 2003; WWW6). See also: Park, Thelwall, WWW5). In this paper, is more about the gradual acquisition of the real characteristics of the supply network of computer networks and the Internet.

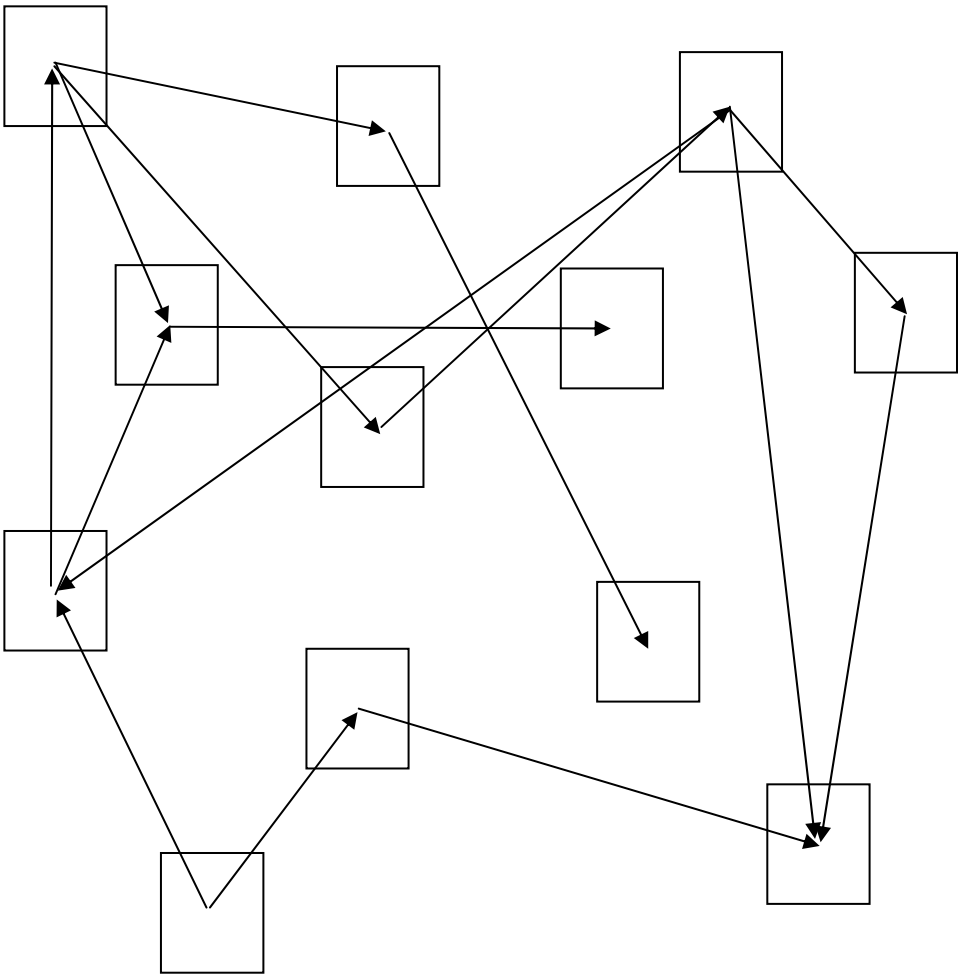

Figure 1. Ordinary hypertext

Source: (WWW10).

3. The conception of synchronous supply network*

A supply chain/SCM is not the only possible modern conception of products flow management from a supplier to a customer. There is still little knowledge about the solutions which, under the influence of the integration of IT and telecommunication solutions and the development of modern information and communication systems, could be an alternative or complement to the sup-

* Compare: (Kempny, 2010, pp. 85-87).

ply chain*. The proposed framework of the conception of synchronous supply network is closely related to the Internet logistics and customer service capabilities, which the 5PL operator model brings (Hanus, Kempny, Kasperek et al., 2010, pp. 74-76). Inspiration and elements of this conception can also be found in many previous logistics solutions. First of all, in the long-known conception of cargo direct delivery, wherever possible and by the shortest route, but also in the modern conception of *virtual inventory***, quick response conception, JIT and other solutions used in the past.

As it has already been stressed, there are a lot of logistical needs, including transport, reported by the business that are not and do not need to be met sequentially***. On the contrary, thanks to IT and electronic media deliveries in logistics networks can run at the same time, at call, to many places/hubs without reserved agreements on chain sequences, namely synchronous. They are based on the rapid movement of cargo from one place to another, each time on a separate order/commission from the consignee, without the involvement of intermediate levels. At one time, all at once, "at call", cargos from many permanent delivery places to many permanent collection places are delivered in the network****. They flow in different directions, to different places/network hubs, not necessarily related to each other by a sequence/production phase, with a predetermined order and an order/stage of production*****. But it must be stipulated that although these supplies are neither repeated nor sequential, it is from these numerous, individual, separate and simultaneous deliveries to different locations/hubs, and if there is such a coincidence in time, there may also arise such chain flow logistics chains. However, they are not created and coordinated in the deliberate manner in advance******.

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* This information is mainly given by the 5PL operator service offers. See: (Hosie, Egen, Ton, Li 2007; Niestrój 2010, pp. 71-85).

** The rules for creating the electronic stocks *cloud* and the management of these stocks and in retailing and big business, using SaaS technology is accessibly explained on (WWW11).

*** Small and medium businesses often report the need for rapid, disposable and cheap transport of goods from point A to point B.

**** These places/network nodes, which provide and receive loads are not understood as a successive providers and a recipients of the supply chain. These are terminals, warehouses, distribution centers, points of origin/receipt, and others. They may belong to or be available to different entities: manufacturers, wholesalers, retailers, logistics providers, a network operator.

***** It is assumed, although this would require empirical verification, that the physical flows in synchronous supply networks, formed of numerous one-off direct supplies will draw cycles or circles. These are typical figures of hypertext. Cycles are, again and again, crossing paths/links, these are returns the nodes, to which lead higher than average the number of links/paths in a given text. Circle is created when the user returns to the same node, followed once again by the same trajectories in a virtual space, in order to leave the circle at one time See: (WWW10).

****** Deliveries/flows in the network are non-linear, non-sequential and non-one-way. A single delivery is linear, however, there can be many deliveries from one hub at the same time. They arrange themselves into multilinear or non-linear flows. The order of deliveries changes with successive orders.

The above description shows that direct deliveries in a computerized supply network are carried out according to certain rules:

- in the logistics network, called in this paper the direct supply network or synchronous, there are many places of cargo delivery/collection, a system of fixed points for giving and receiving goods is in operation;
- the primary way of supplying cargos is the physical direct delivery of goods from a designated permanent place of origin to the permanent collection; there may be many interdependent supplies in the network at any one time;
- there is no relationship between a given supply, and other supplies in the network;
- the supplies from points of origin run in different directions;
- the information center/synchronous supplies operator is responsible for deliveries. Most of the operations performed in the network are informative in character and take place in cyberspace. A computer operator, further referred to as a synchronous supplies operator, creates a physical/ real supply network and assumes responsibility for handling the flow of cargo in such a network*;
- centralization of information on needs, product/cargo and supply network is obligatory;
- the information center/synchronous supplies operator, using advanced software, controls physical flows in the network, plans cargo transport, (creates *a virtual cloud* of cargo to transport), organizes tenders, negotiates contracts and allocates carriers, optimizes the size of the delivery, transportation routes and inventory, develops supply strategies, monitors and balances carriers' accounts;
- the information center/synchronous supplies operator on the basis of orders decides on priorities, according to which the network operates at a time. This can be, for example: a distance, cost of delivery, time of delivery, delivery frequency, ultra flexibility or agility in operations or responsiveness to customer needs, etc. On this basis it optimizes cargo movements;
- the information center/synchronous supplies operator designs and keeps modified/sets up a real network of supply in the selected geographical area. The network and its resources in this area are subject to constant reconfiguration (Hun Li, Goldsby, Holsapply, 2009);
- supply routes (connection between network hubs) are possible to be covered within the 24h, but there can be exceptions to this rule;

* Some activities may be entrusted to the operator 4PL, for example creation and management of logistics/ transport network.

– at the center disposal, in the state of constant readiness, is a pool (*virtual cloud*) of 2PL efficient and reactive carriers (transport emergency)*;
– orders for delivery are reported to the information center around the clock;
– in the network, inventory security system is formed with the participation of all network hubs;
– the information center/synchronous supplies operator does not depend on the network hubs and does not represent their interests, – there are no standing orders for transport; transports are always ordered *on line*;
– any type of product/cargo can be accepted for the transport, including unusual/non-standard cargo. The network can, however, specialize in the transport of selected products;
– synchronous supply network can be formed at any scale, both globally and in the local scale.

The adopted principles of operation are based on the requirements of synchronous supply network and network infrastructure. In order to complete synchronous deliveries in the physical space, the following are needed (Hanus, Kempny, Kasperek et al., 2010, p. 85):

– very well developed physical logistics network, dense and relatively evenly covering a geographical area. Transport infrastructure in this area should promote the optimization of transport without the urgent need for additional or ongoing investment in a point and linear transport infrastructure;
– an integrated information network – with information and control center of transportation virtual warehouses;
– a modern, advanced *agile network TMS software* and software enabling real network visualization and design simulation;
– maintaining high supply readiness of network hubs and the direct supplies from designated storage areas or production lines;
– high availability of logistics resources held by different entities, the possibility of their rapid acquisition and shifting from place to place in the supply network (Kisperska-Moroń, ed., 2009, pp. 108-112);
– a modern linear transport infrastructure/roads and vehicles ensuring transportation to a destination in the shortest possible time;
– automated completion and handling-unloading work as well as other technical facilities, reducing physical operations to a minimum,
– 2PL operationally agile carriers.

These requirements, if impossible to be met, become obstacles in the creation and development of synchronous supply networks.

* Carries efficiency may turn out to be insufficient, reactivity is also compulsory. It is opposed to efficiency. (Hun Li, Goldsby, Holsapply, 2009, p. 413).

4. The operator and carriers in the synchronous supply network

From the former considerations it can be concluded that in completing synchronous supplies are involved (Figure 2):

1. Information center/computer operator called here synchronous supplies operator.
2. Real logistics network in a given geographical area.
3. Virtual network, constituting mapping/visualization of the real network and serves the network redesigning and flow optimization at the same time.
4. 2PL carriers pool, road mainly.

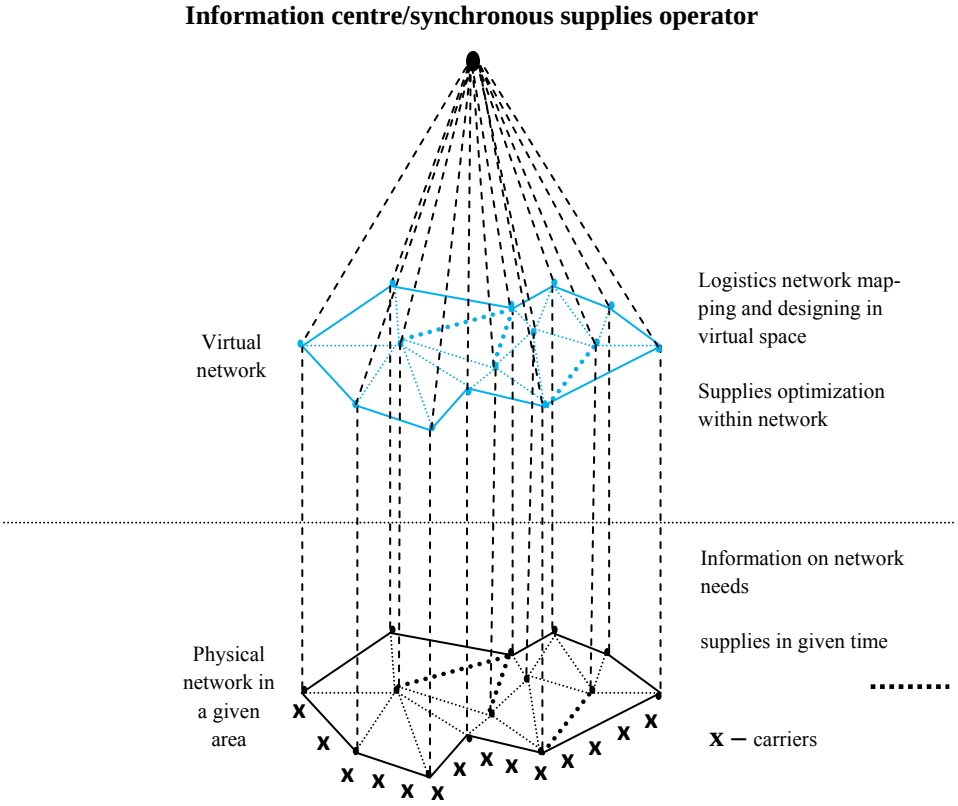

Figure 2. Synchronous supplies control in logistics network

Source: Based on (Hanus, Kempny, Kasperek et al., 2010, p. 86).

4.1. The network operator and its functions

The information center/synchronous supplies operator is a coordinator of the flows in synchronous supply networks. It controls the flow of cargo and manages network resources in a given geographical area[*]. This area can be, for example, city/agglomeration, economic region, the whole country, etc. The operator has information about resources and the demand for cargo transportation across the network. It offers information, what, where and how much is needed at any given moment and to what network places cargo can be delivered. Controls simultaneous, multiple, single movements of cargo from hub to hub. Optimizes routes and freight time, sends information to customers on time delivery.

The operator acts on behalf of various economic and administrative entities in a given area[**]. The network services can be used by: a local government, the producer/industry representative, small and medium-size manufacturing enterprises, trade and services, logistics provider, commercial corporation, another entity – humanitarian organization, non-profit, etc.

The supply network and flows in this network are constantly visible on the monitors of the operator. This allows it to watch over the security of supply and respond to sudden threats and network events (natural disasters, accidents, damage to vehicles, theft, etc.).

Information center/computer operator is not only a coordinator, but also a designer/developer and integrator of synchronous supply networks. It creates network designs, initiates their implementation in physical space and systematically modifies/reconfigures the network.

From the above-mentioned it follows that to the basic functions of the network operator belong: conducting design and dispositional work, cargo control, taking orders, contact/communication with customers, complaints, improvement of TMS software, network configuration, supply control in crisis conditions as well as administrative work (More on the operator and carries functions in: Kempny, 2012).

4.2. Real synchronous supply network and its virtual representation

As it is shown in Figure 2 a synchronous supply network is basically a composite of two logistics network: real and virtual. A synchronous supply network

[*] The network resources include the entire information, transport and warehause infrastructure, transport and storage equipment, inventory. Cross-utilization of network resources is effective regardless of whether a hub participates in a transaction or not (Hanus, Kempny, Kasperek et al., 2010, pp. 82-83).

[**] These entities may be small and medium-sized enterprises. See: (WWW1).

created in a given geographical area is continuously mapped and monitored in virtual space. Physical network hubs are fixed, permanent places of delivery/receipt of goods – terminals, warehouses manufacturers, wholesalers, distribution centers, logistics centers and production lines. Deliveries between network hubs (supply and receipt of goods places) are not dependent on each other, in the sense that these are not involved in operations sequences in the three subsequent phases of the production process (procurement, production, distribution). Everyone individually reports their needs to the information center and sends or receives cargo at the center's command.

Designing and modifying networks in virtual space runs definitely faster than the construction/reconstruction of roads and hubs in physical space. Hence, in order to optimize the transport without much additional investment, the existing physical network should be fairly dense, relatively evenly covering the area. The investments in information technology, transport and storage as well as logistics network development (creating new hubs and the construction of new paths/routes sections) are, however, inevitable. Against this background, the question remains open, whether the synchronous supplies operator should use the supply networks already created by business and global logistics operators or on the basis of the transport, storage and IT infrastructure in a given area should create networks specifically designed for handling these supplies. It seems that both solutions are acceptable, depending on the scale and geographical scope of supplies.

4.3. Virtual transport readiness. Efficiency and responsiveness of carriers

It is assumed that the cargo is mainly transported by road[*]. 2 PL carriers should be available 24/7. The selection of carriers may be entrusted to the 4 PL providers by synchronous supplies operators. The operator can manage the carriers pool as the virtual stocking. Then the virtual *cloud* brings together carriers, who are in different places, at the order of the network operator and ready for taking transport immediately.

With realization this supplies conception it is important to systematically improve the responsiveness and operational efficiency of the carriers. The operational efficiency should be improved by carriers, in cooperation with cargo consigners. These include the implementation of the drop and hook operations, standardization of cargo, transportation and manufacturing synchronization, the ability of containerization and palletization of cargo on the side of consigners, providing sufficient time for cargo, the ability to plan routes in such a way that drivers can spend more time resting at home (Fugate, Davis-Snaruch, Goldsby, 2009, p. 437).

[*] Air transport can also be used if necessary.

Conclusions

Synchronous deliveries in the logistics network are a solution for the future. The possibility of rapid and relatively inexpensive direct shipment of cargo from place to place may be an alternative to sequential deliveries. These deliveries can free operators from the logistic risk posed by the supply chain, reduce costs and delivery times, provide customers/ contractors with relatively cheap and agile logistics services. They may prove to be an attractive way to deliver cargo for the very numerous small and medium enterprises[*].

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[*] However, the obstacle may be insufficient the IT infrastructure in these businesses (Crom, 2005, p. 62). Research hypotheses related to the concept of synchronous supply networks and the results of pilot studies on the need for the use by SMEs of the proposed solutions are included in collective study, entitled: *Nowe generacje operatorów logistycznych na rynku TSL. Ewolucja, zakres świadczonych usług, marketing jako narzędzie konkurencji* (Kierownik projektu: D Kempny. Potencjał badawczy 2011. Tapescript. UE, Katowice 2011) will be presented in a separate publication.

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(WWW9): http://prac.us.edu.pl.

(WWW10): www.techsty.art.pl/hipertekst.htm.

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