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Wydawnictwo SGGW
ul. Nowoursynowska 166, 02-787 Warszawa
tel. 22 593 55 20 (-22, -25 – sprzedaż)
e-mail: wydawnictwo@sggw.pl
www.wydawnictwosggw.pl

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***Heorhiy Cherevko*[1], *Volodymyr Kolodiichuk*[2], *Irina Kolodiichuk*[3]**
[1] University of Rzeszow
[2] Stepan Gzhyckyi National University of Veterinary Medicine and Biotechnologies in Lviv
[3] National Academy of Sciences of Ukraine

Historical and meritorical genesis of logistics

Historyczno-merytoryczna geneza logistyki

Abstract. The aim of the article is to present the results of the research of the possibilities of explaining the content and evolution of logistics formation, determining periods of its development by examining its most important features. Based on the dialectical method of learning objective reality and using a historical approach the retrospective analysis was carried out and the historical and substantive genesis of the logistics category was examined, various interpretations of it have been identified in which the functional, optimization and target aspects are traced. The authors of the article define the concept of logistics as a branch of the theory of management, the subject of which is the study of forms and means of organizational-economic, structural-functional and institutional impact on the process of material and related information movement, financial and service flows from the primary source of raw materials to consumers of final products in order to optimize the specified process and realize the objective function of the logistics system, consisting in synergistic effect obtaining. The periodization of military and economic stages of logistics development on the basis of motivational features with substantiation of intuitive-philosophical, phase-applied and system-integrated periods of its formation is proposed.

Key words: logistics, military and economic sphere, flow, logistics system, logistics periodization

Synopsis. Celem artykułu jest przedstawienie wyników badania możliwości wyjaśnienia treści i ewolucji formacji logistyki, ustalenia okresów jej rozwoju poprzez zbadanie jej najważniejszych cech. Na podstawie dialektycznej metody poznania obiektywnej rzeczywistości i przy użyciu podejścia historycznego przeprowadzono analizę retrospektywną oraz zbadano genezę historyczną i merytoryczną kategorii logistyki, zidentyfikowane zostały różne jej interpretacje, w których śledzone są aspekty funkcjonalne, optymalizacyjne i docelowe. Przez autorów artykułu zostało zdefiniowane pojęcie logistyki jako gałęzi teorii zarządzania, której przedmiotem jest badanie form i środków wpływu organizacyjno-gospodarczego, strukturalno-funkcjonalnego i instytucjonalnego na proces przepływu materiałów i powiązanych z nimi informacyjnych, finansowych i usługowych przepływów z pierwotnego

źródła surowców do konsumentów produktów końcowych w celu zoptymalizowania określonego procesu i realizacji docelowej funkcji systemu logistycznego, polegającej na uzyskaniu efektu synergii. Proponuje się periodyzację wojskowych i ekonomicznych etapów rozwoju logistyki na podstawie cech motywacyjnych z uzasadnieniem intuicyjno-filozoficznego, fazowo-stosowanego i systemowo-zintegrowanego okresów jej powstawania.

Słowa kluczowe: logistyka, sfera wojskowa i ekonomiczna, przepływ, system logistyczny, periodyzacja logistyki

Introduction

The novelty of the logistics approach to material flow management is conditioned by the practice of logistics using in the economic sphere. A retrospective analysis of the origin of this scientific and practical direction clearly showed the historical momentum and fragmentation of the use of the logistic concept in economic systems. Only in the early 1950s, after the scientific substantiation of the American expert in the field of system analysis O. Morgenstern, logistics activity began to be an integral part of the management of some companies. Pointing to the absolute similarity "between the management of the provision of troops and the management of material resources in industry" [Morgenstern 1951], this scientist actually transferred the theoretical and practical achievements of logistics from the military sphere to the economic.

Significant contribution to the theory of research of logistics problems in a market economy, especially in the field of transportation, has been made by wide bunch of scientists, namely: M.R. Linders and H.E. Firon [1999], A. Gadzhinskyy [2000], E. Krykavskyy [2006], M.A. Oklander [2008], Yu. Ponomareva [2005] and others. In scientific definitions of the concept of "logistics" of such scientists as R. Ballou [1987], M. Christofer [2000], J.L. Heskett [1977], J. Magee [1985], R.T. Miles [1987], B.K. Plotkin [1991], A.G. Kalchenko [2006] and others we see some certain pronounced one-sided interpretation of the essence of this definition, related to the fixation of essential features of logistics within a specific professional specialization – management, organizational, financial, technological, etc. Modern economic realities require a comprehensive consideration of logistical activity in the unity of all its content, structural, functional and institutional characteristics, taking into account intermediate tasks and the final goal. Such consideration becomes possible under conditions of systematic approach to logistics applying, within which it is grounded as a system of interconnected concepts and categories, which reflects the essence, meaningful characteristics and principles of organization of logistical activity.

The purpose and methodology of the study

The purpose of the article is to clarify the content and evolutionary process of logistics formation, outlining the periods of its development through its most essential features identification. The subject of the study is the motivational prerequisites of historical events in the development of logistics and in the evolution of its content. In order to

achieve this goal, we have solved the following tasks: basing on the dialectical method of knowledge of objective reality and using the historical approach, to conduct a retrospective analysis and to investigate the historical and meaningful genesis of the logistics category. To substantiate the definition of "logistics" we used the terminological approach, and to periodize the historical stages of the development of logistics on the basis of established features – the method of grouping.

The main results of the study

Objectively evaluating the scientific and practical achievements in the study of the origin of the term "logistics", we can say that the etymology of this concept is not fully understood. Two versions of origin are common: from the Greek word *logistikos* – the art of calculating, of thinking, mastery of counting [Kalchenko 2006]; from the French word *loger* [Ponomaryova 2005, Krykavskyy 2006] – to supply, to house. However, there are other variants, such as the Old German *laubja* – warehouse, storage [Ponomaryova 2005].

The semantics of the concept of logistics are also ambiguous. Applied mathematics was called as logistics in ancient Greece; in the Roman Empire – the activities of providing troops with food and housing; in Byzantium – the process of complex addressing the various problems associated with the transportation and with the army rear supplying [Oklander 2008].

The Roman Empire borrowed much from Ancient Greece, including the term "logistics". Rome used this term to describe the rules for the distribution of food. Accordingly, the employees involved in such distribution were called "logistics" or "logisticians". This term was later used in the military lexicon.

The Byzantine emperor Leon (Leontos) VI (865–912 AD) called strategy, tactics and logistics three categories of military arts [Oklander 2008]. That is, it was going about the ability to coordinate the process of managing material flows in space and time. The position "logistician" in the Byzantine army was an official military specialty.

A significant contribution to the development of military logistics was made by military theorist and historian A-H. Jomini (1779–1869), who believed that the logistics interests included a wide range of issues, including the planning of activities, the technical and food supplying of the armed forces and, based on the results of the generalization of the experience of the Napoleonic wars, defined logistics as "...the bridge between the economy of the nation and the active army" [Oklander 2008]. The dilemma concerning the provision of troops revealed two fundamental problems, namely: redundant provisions and weapons reduced troop mobility; the shortage of provisions and weapons reduced the combat capability of the soldiers.

Published at the end of the 19th century. in the US, Jomini's works were practically embodied in World War II. His theoretical heritage made it possible to organize a steady supply of the army as a result of the coordinated action of the enterprises of the military-industrial complex, trade, and transport in the framework of the implementation of the Law on Lend-Lease, adopted by the US Congress on March 11, 1941.

The pinnacle of military logistics reasonably is considered operations that ensured the supply of the US Army during its landing in Normandy and the subsequent offensive

into Europe. Operation "Red Ball" is still being studied at military schools as a successful example of military logistics. To address the issues of uninterrupted cargo transportation, progressive container shipping methods have been tested for the first time.

It should be noted that the scale of hostilities in the USSR was much larger. Also, it is worth mentioning the evacuation of industrial enterprises, conducted by specialists of the People's Commissariat of Railways in cooperation with other profile agencies. The magnitude of the task was striking as hundreds of industrial enterprises, as well as their workers and family members, were displaced as a result of the threat of the Nazi troops' rapid onset of the thousands of kilometers, including the Urals and Siberia, at the beginning of the war. Perhaps these were too costly logistics processes, but under combat conditions cost optimization was sidelined and the cost of many logistics solutions became too high.

The term "logistics" on the territory of modern Ukraine began to be widely used by specialists only from the late 80's of the 20th century. The realities of a planned economy still required progressive approaches to the organization and management of production, and the best practices of the time involved the use of integrated concepts of supply, production and marketing as the only single material flow. Although, the term "logistics" was consciously (or not consciously) not used. Let's call such a period the existence of latent logistics. The development of the consumer market in Western Europe and North America has led to the use of new methods of optimizing the delivery of products from producer to consumer. As noted above, an employee of the American company RAND Corporation, a specialist in systems analysis, professor O. Morgenstern, for the first time, pointed to the possibility of using the provisions of military logistics in the economy. As noted by M. Oklander [2008], synonymous with the definition of "logistics" (in its meaning as economic science) in literary sources and in practice during its formation were the terms "material resources management", "material and technical supply", "material flow management" and others.

Explaining the conceptual content of logistics revealed a variety of interpretations of the term in a sufficiently unanimous reflection of its essence [Heskett 1977, Magee et al. 1985, Ballou 1987, Miles 1987, Plotkin 1991, Christopher 2000, Kalchenko 2006]. In general, the functional, optimization, and goal aspects in different definitions of logistics can be emphasized. In some of its logistics is positioned as a scientific area of research of structural and functional connections in economic systems, in others – the emphasis is placed on practical issues of managing the flow of materials from their place of origin to consumption.

The graphical method allows us to present our vision (Fig. 1) and the definition of logistics as follows: logistics – it is the branch of management (as science and as kind of practical activity), the object of which is the improvement of forms and means of organizational-economic, structural-functional and institutional influence on the organization of systematically interconnected material and relevant informational, financial and service flows from the primary source of raw materials to consumers of final products for the purpose of optimization of abilities of the specified system and realization of its objective function in synergistic effect obtaining.

Thus, the basic elements of the logistics system are logistics objects (transport, warehouses), logistic entities (buyers, representatives of distribution networks, organizers of

different services), logistics flows (material, information, financial, service) (see Figure 1). The interaction of these elements is ensured through functional interconnections, namely: realization of the organization functions, direct implementation and optimization of logistic activity.

Of course, material flow is the basis of logistics management (see Figure 1). This flow is being modified in its path, passing through the areas of purchase, production, distribution and is delivered to the end consumer in the form of commodity products with relevant consumer parameters. In our definition, the focus is made on functional investigation of this path. But, material flow will not move without information and financial support. Therefore, we attribute information flows to supply flows. The interconnections between the spheres of agri-industrial complex are based on the financial interest of each element, therefore, the incentive for the implementation of logistics functions is the financial flow, which as well as information flows we attribute to supply group.

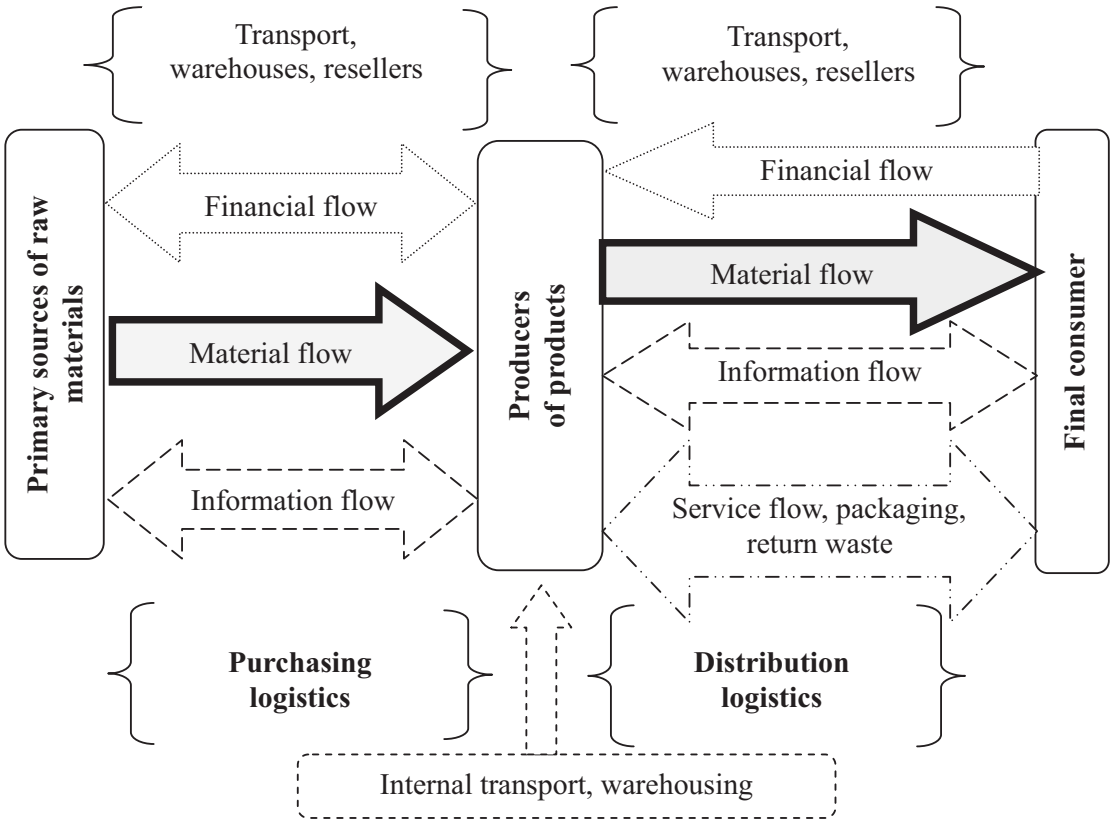

Figure 1. Structural and functional relationships in the logistics system
Rysunek 1. Relacje strukturalne i funkcjonalne w systemie logistycznym
Source: own elaboration.

We also attributed the service flow to the supply group. Increasing of the role of producers' social responsibility for the consumption of their products causes them to form logistic service flows. Consultative-motivational, service-repair, utilization, bonus-price and other accompaniment of consumption and replacement of goods becomes the basic philosophy of many companies, which forms a certain motivational concept of perception

by its consumers. With this, the process of the chain "primary source of raw materials––final consumer" determining is conditional and depends on the level, positions of evaluation and research objectives [Kalchenko 2006].

A significant impetus for the formation of a logistic model of the relationship of market elements was given by the tendency to individualize consumer demand. Therefore, the execution of an individual order is the formation of a logistic system (subsystem), which ultimately requires an individual approach and specific management decisions.

The economic content of the concept of logistics has been shaped historically. In this context, the systematization of the historical stages and periods of this process is of interest (Table 1).

Tabela 1. Okresy rozwoju logistyki
Table 1. Logistics development periods

Stage	Period	The most significant signs	Countries and companions
Military	Intuitive-philosophical: 5th–4th centuries BC–the end of 17th century	the objective need for organized distribution of food supplies;	Ancient Greece, Roman Empire and others
		rear support of the needs of the army in the period of ancient wars;	
		use in the meaning of mathematical logic;	G. Leibniz
	Phase-applied: the beginning of the 18th century–the middle of the 20th century	scientific substantiation of elements of logistics in military affairs (planning, technical and food supply of military operations, construction of transport connections, fortifications, etc.);	A. Jomini
		practical implementation of logistical methods within the framework of the Law on the land lease (March 11, 1941) of the operation "Red Ball" (landing of the US Army in Normandy and the subsequent offensive into Europe), the evacuation of industrial enterprises from the occupied territories of the USSR to the Urals and Siberia);	US, USSR
Economic		logistical distribution of manufactured products (system: manufacturer's finished product warehouse – final consumer);	O. Morgenstern
	System-integrated: 1951 year–present time	extension of logistics functions into production and supply areas; systematic approach to the formation of logistics chains; dynamic development of facilities for moving material flows (transport); development of infrastructural support of information, financial and service flows; qualitatively new level of formalization of logistics tasks on the basis of modern communication technologies and hardware.	USA, Europe

Source: own elaboration.

The first stage, of course, contradicts the modern conception of logistics, since it envisaged logistical management in the system "finished goods warehouse – final consumer". If consumer's demand does not meet the supply of producers, this approach

can be justified in an economy where there is a shortage of goods. Under conditions of product overproduction, the market approach is based on the study of solvent demand, which forms an appropriate system of production organization with appropriate quantitative and qualitative parameters, which in turn requires appropriate logistics of resources supplying. Accordingly, the modern stage satisfies these conditions, is dynamic and implements in the logistic sphere all the achievements of scientific and technological progress of mankind.

Conclusions

Logistic activity, which is an objective condition for enterprises adapting to the environment, based on practical experience, is in many cases ahead of scientific thought. The practical activity of economic entities creates an analytical basis for scientific research, the results of which should be the criterion levers of influence on economic processes, which will subsequently be of practical use.

Ultimately, as a scientific area, logistics emerged only in the middle of the 19th century and fully realized its practical implementation during the II World War.

The evolutionary process of transition of logistics from the military sphere to the economic one is caused by the development of the consumer market in Western Europe and North America as well as by the development of scientific and technological progress and integration processes in the industry, strengthening the international division of labor and increasing the competitiveness of the economic environment, the development of productive forces of society and the entry into the information era.

Clarifying the conceptual content of the term "logistics", which was forming during the identified in the study stages and periods of its development, has revealed various interpretations that trace the functional, optimization and purpose aspects, but it is indisputable to recognize and understand the objective existence of this type of activity as "not artificial" and "not contrived", but quite natural scientific direction that requires research in order to study the features of the relationship of market elements and the development of the necessary tools for the further management of production and marketing processes organization.

In our opinion, logistics is a branch of management (as science and as kind of practical activity), the object of which is the improvement of forms and means of organizational-economic, structural-functional and institutional influence on the organization of systematically interconnected material and relevant informational, financial and service flows from the primary source of raw materials to consumers of final products for the purpose of optimization of abilities of the specified system and realization of its objective function in synergistic effect obtaining.

The results of the study of the basic stages of the development of logistics as the field of activity and the area of science are allowing to form a periodization of this evolutionary development, which, unlike the existing one, is carried out on the basis of motivational specifics with substantiation of intuitive-philosophical, phase-applied and system-integrated periods of its formation.

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Correspondence addresses:

prof. Heorhiy Cherevko, PhD habil.
(https://orcid.org/0000-0003-4339-0152)
University of Rzeszów
Institute of Economics and Finances
Ćwiklińskiej St. 2, 35-601 Rzeszów, Poland
e-mail: gcherevko@ukr.net

prof. Volodymyr Kolodiichuk, PhD habil.
(https://orcid.org/0000-0003-2757-6299)
Stepan Gzhyckyi National University of Veterinary Medicine
and Biotechnologies
Lviv, Uukraine
e-mail: v-a-k@ukr.net

Irina Kolodiichuk, PhD
(https://orcid.org/0000-0001-5110-3905)
National Institute of Regional Research after M. I. Dolishnii
National Academy of Sciences of Ukraine
e-mail: ira1166@ukr.net

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Aleksandra Chlebicka
Warsaw University of Life Sciences – SGGW

Distribution channels used by fruit and vegetables producer organizations in Poland

Kanały dystrybucji wykorzystywane przez organizacje producentów owoców i warzyw w Polsce

Abstract. Fruit and vegetable production is an important branch of Polish agriculture. In recent years, the fruit and vegetable market has undergone significant changes concerning in particular the structure of the distribution channels. Growers establish producer organizations (PO's) to increase their bargaining position vis a vis large retail chains and processing companies. Knowledge on the way producer organizations operate on the market is limited. Firstly, the aim of the study is to fill this gap, first of all, by indicating the distribution channels used by PO's in Poland. Secondly, an attempt was made to answer the question whether producer organizations supplying retail chains differ from other entities. The study showed that PO's used various distribution channels. The most important ones were wholesale markets, retail chains (super and hypermarkets, discount chains) and processing companies. It turned out that PO's selling to retail chains were relatively larger in terms of the value of produce delivered by producers-members and more prone to source fruit and vegetables from farmers who are not their members. The study was conducted using unpublished governmental data on the population of PO's active in the fruit and vegetable sector in Poland in 2017.

Key words: distribution channels, fruit and vegetables, producer organizations

Synopsis. Produkcja owoców i warzyw jest ważną gałęzią polskiego rolnictwa. W ostatnich latach, rynek owoców i warzyw przeszedł znaczące zmiany, w szczególności dotyczące struktury kanałów dystrybucji. Plantatorzy ustanawiają organizacje producentów (OP), aby zwiększyć swoją pozycję przetargową wobec dużych sieci detalicznych i firm przetwórczych.
Wiedza na temat funkcjonowania OP na rynku jest ograniczona. Po pierwsze, celem badania jest wypełnienie tej luki, przede wszystkim poprzez wskazanie kanałów dystrybucji wykorzystywanych przez OP w Polsce. Po drugie, podjęto próbę odpowiedzi na pytanie, czy OP zaopatrujące sieci detaliczne różnią się od innych podmiotów. Badanie wykazało, że OP korzystały z różnych kanałów dystrybucji. Najważniejsze z nich to rynki hurtowe, sieci detaliczne (supermarkety i hipermarkety, sieci dyskontowe) oraz firmy przetwórcze. Okazało się, że organizacje producentów sprzedające do sieci detalicznych były stosunkowo większe pod względem

wartości produktów dostarczanych przez producentów-członków i bardziej skłonne do pozyskiwania owoców i warzyw od rolników, którzy nie są ich członkami. Badanie zostało przeprowadzone przy użyciu niepublikowanych danych rządowych dotyczących populacji organizacji producentów działających w sektorze owoców i warzyw w Polsce w 2017 roku

Słowa kluczowe: kanały dystrybucji, owoce i warzywa, organizacje producentów

Introduction

Poland is a significant European fruit and vegetables producer, occupying the third or the fourth position in terms of production volume and area. Fruit and vegetables sector plays also an important role in the domestic agriculture with the share of 12% for fruit and 8% for vegetables in the value of plant production [GUS 2019]. The picture of the sector in Poland reflects changes in the agro-food system. Foreign direct investments and international competition, new consumption patterns, advances in information and transportation technology, have redesigned both the macroeconomic environment and incentive structure for market players. It is assumed that major shifts in the fruit and vegetable sector globally are driven by the emergence of modern retail channels and growing concentration of companies processing fruits and vegetables [Bijman and Hendrikse 2003].

These changes required farmers to look for ways to improve their bargaining position in the face of the growing processing and retail sectors. Individual producers with small production volumes, often lacking the necessary logistics infrastructure, encountered difficulties in entering redesigned distribution channels [Beamer 1999]. In response to the new challenges, the state provided aid to horticultural growers by providing them with financial support to set up producer organizations (PO's). According to data from the Polish Ministry of Agriculture and Rural Development, fruit and vegetable producer organizations received approximately EUR 1 billion of public aid in the years 2004–2013 [Chlebicka 2017]. As a result of this support, the scope of horizontal integration among fruit and vegetable producers in Poland has been constantly growing. While in 2004, i. e. in the year of Poland's accession to the EU, there were almost no officially recognised producer organizations, at the beginning of 2019 there were 271 such organizations [Rejestr…]. Comparing to other European Union Countries the number of PO's is relatively big but at the same time, they associate relatively small number of farmers. The question is though weather these entities are big enough to supply modern retail distribution chains.

So far, the literature has been dominated by research on the process of establishing producers' organizations, the effects of cooperation in PO's from the perspective of associated farmers, the conditions for effective cooperation in PO's [Krzyżanowska and Trajer 2014, Bouamra-Mechemache and Zago 2015, Francesconi and Wouterse 2015]. Only scattered studies address the issue of POs activities on the market, including key marketing decisions such as the product offer or distribution channels [Camanzi et al. 2011].

Firstly, the aim of the study is to indicate the distribution channels used by PO's. Secondly, an attempt to answer the question whether producer organizations supplying products to retail chains differ from other entities is made. In particular, the scale of pro-

duction of producer organizations is verified as a key factor in adjusting to the needs of concentrated buyers related to the volume, quality and logistics. The study is conducted using a unique database of the entire population of PO's active in the fruit and vegetable sector in Poland in 2017.

Data and methods

The empirical study analysis is based on unpublished data on producer organizations from the fruit and vegetables sector in Poland collected by the Agency for Restructuring and Modernization of Agriculture (ARMA). The agency implements measures dedicated to producer organizations in Poland under the 1st pillar of the EU Common Agricultural Policy. Data covered production and marketing activities of all fruit and vegetable PO's in 2017, however due to the fact that for some PO's data were incomplete, the sample used is 260 PO's instead of 271. Descriptive analysis was used to indicate and discuss distribution channels used by PO's. In the second part of the analysis, the logistic regression model was used to distinguish the characteristics of PO's affecting their participation in the large retailers' supply chain.

Distribution channels for fruit and vegetables in Poland

Distribution is the process of moving products or services from the producer to the consumer through distribution channels. In turn, distribution channels are defined as the group of successive links (persons or institutions) through which one or more marketing streams flow [Norwood and Lusk 2018]. Given the two main uses of fruit and vegetables (direct consumption and processing), the distribution system for these products should be considered in two cases: the distribution system for fruit and vegetables intended for further processing and the distribution system for fresh fruit and vegetables intended for direct consumption [Karasiewicz 2001]. The purchase of fruit and vegetables for further processing is carried out primarily by direct purchases of processing companies from producers, intermediaries and wholesale markets used mainly by small processing companies. On the other hand, wholesale trade in fresh fruit and vegetables in Poland is mainly conducted through [Gołębiewski and Sobczak 2017]:

- wholesale markets and commodity exchanges (including online), where retail stores, intermediaries (including exporters), HoReCa sector representatives usually source their supplies;
- retail chains which purchase from producers (directly and/or via distribution centres or intermediaries);
- intermediaries.

Retail trade in fruit and vegetables involves retail chains (super and hypermarkets, discount stores), individual grocery stores, markets, catering outlets and producers selling on their farms.

As far as fruit and vegetables processing is concerned, there were about 2300 enterprises in Poland in 2015, of which 420 produced juices [unpublished data of Central Statistical Office]. The vast majority of them were small companies employing up to

nine persons. There were 350 enterprise with more than nine employees, including 216 small enterprises (with 10–49 workers), 110 medium-sized enterprises (50–249 workers) and 22 large enterprises (more than 250 persons employed). The value of sold production of fruit and vegetable processing enterprises and juice producers (employing more than nine people) in 2015 amounted to approximately EUR 3,206 million [unpublished data of Central Statistical Office]. The market share of large enterprises accounted for 40%, which was driven by the 60% market share of large juice producing companies. The market share of the 14 largest enterprises producing processed fruit and vegetable products was smaller and amounted to 30%. The share of medium-sized companies in the market of processed fruit and vegetable products was 50%, and in the case of juices 34%. It should be noted here that in the case of Poland, processing is very important for the allocation of domestic production. It is estimated that about 50% of fruit harvests and 30% of vegetable harvests go to processing [unpublished estimates of Institute of Agricultural and Food Economics for 2017].

The distribution of fresh fruit and vegetables has changed dramatically due to the emergence of super and hyper markets in Poland 30 years ago. Currently, modern distribution channels account for 56% of the value of food retail sales, with discount chains having the largest share (over one third of the modern food market). In terms of retail sales of fresh fruit and vegetables, discount stores had the largest share in retail sales of these products in 2016 – 38%. Jeronimo Martins Polska (Biedronka stores) remained the leader with over 25% share in retail sales of fresh fruit and vegetables. Other formats of modern retail trade had a smaller share in retail sales of fresh fruit and vegetables, equal to 17% for supermarkets and 14% for hypermarkets. Discount chains and supermarkets are the channels where fruit and vegetable sales are constantly growing. The development of these channels takes place at the expense of individual grocery stores and hypermarkets. However, when compared to Western European countries, grocery retail market in Poland is still highly fragmented, with c.a. 135,000 outlets in 2016 (about 3500 grocery retailers per million residents) [GfK Polonia 2017].

In the distribution of fruit and vegetables in highly developed countries there is a clear trend to move away from a transactional approach to cooperation and integrated forms of marketing across the distribution channel [Stokke 2009]. Distribution channels are shortened due to the willingness of large retailers to establish direct contacts with manufacturers, excluding the wholesale level. This phenomenon is in line with the general trend of decreasing importance of the institutional wholesale trade, accompanied by capital and organizational and technical concentration at the retail level. Wholesale markets work well in a situation where both the sellers and the final buyers are confronted with a high degree of fragmentation of entities. The subject of individual transactions are then relatively small quantities of products, which are additionally characterized by seasonality and short duration (there is a need for frequent deliveries and quality control). With the increasing share of retail chains in fruit and vegetables retail, the share of direct sales from producers (suppliers) to supermarkets is increasing. Direct cooperation of large retail chains with producers guarantees certain benefits – their supplier is not anonymous (as on the stock exchange or auction), a number of requirements are imposed on producers, it is possible to interfere in the production processes in order to ensure the desired quality [Hendrikse and Bijman 2001]. Large customers seeking to reduce their own transaction

costs focus on working with a small number of suppliers who are able to provide large supplies of homogeneous quality products, delivery of a wide range of fruit and vegetables, all year round deliveries and high quality of products [Reardon et al. 2009].

Products and marketing channels used by fruit and vegetable PO's in Poland

Fruit and vegetable producer organizations are economic operators set up by individual growers to strengthen their bargaining power of the market. Cooperation in producer organizations enables, among others, concentration of supply, joint planning of production, concentration of demand for production means, negotiation of sales/purchase conditions, gaining new markets, activities aimed at improving the quality of manufactured products, creation and promotion of own product brands. Membership of producer groups may bring a number of benefits to producer members. The most frequently mentioned in the literature include improvement of the income situation of producers, improvement of the quality of manufactured products and access to new markets [Chlebicka et al. 2009].

According to the data of the Agency for Restructuring and Modernization of Agriculture, currently there are 271 fruit and vegetable producer organizations in Poland. At the beginning of 2019, they associated 6.3 thousand producers. The average number of members per one entity was 23 producers, however, half of them associated nine members and less. The largest number of members per one PO was 203 producers, the lowest accounted for five growers.

Producer organizations on the fruit and vegetable market are dominated by those that sell both fruit and vegetables (42%), only vegetables (26. 2%), only fruit (24. 3%), nineteen entities produced mushrooms and one herbs. In 2017, the area devoted to fruit production in growers-members farms amounted to 32. 2 thousand hectares, and 21.1 thousand hectares for vegetables. This represented respectively 10% and 11.5% of the total area of fruit and vegetable production in Poland [GUS 2019].

Producer organizations are created primarily for the purpose of marketing products produced by associated producer members. Under the law, a producer may be a member of only one producer organization for a particular product category. Growers are also obliged to market practically entire production via PO. At the same time, a producer organization may source products from other producers who are not members, up to the limit of 50% of the PO sales revenue.

In 2017, fruit and vegetable producer organizations generated sales worth PLN 2720 million; fruit sales amounted to PLN 1223 million, while vegetable sales amounted to PLN 1497 million. The average value of sales per one PO was PLN 12 million, while the median was PLN 5 million. The highest recorded value of annual sales by PO amounted to PLN 141 million. In 2017, around 36% of PO sales were generated by products purchased from producers who were not members of PO's.

As far as the product offer is concerned, it should be noted that the level of product specialization is high – the most important product category constituted almost 80% of the sales value. The offer of PO's was dominated by apples, which accounted for 56% of sales in the case of fruit organizations. Apples were included in the offer of 94 companies,

and what is more, in the case of as many as 82 entities they constituted the most important product category sold. As far as vegetables are concerned, the most important product category were greenhouse tomatoes (20% of vegetable sales).

Depending on the adopted marketing strategy, PO's used different distribution channels to sell their products. As depicted in Table 1, the most important marketing channel for Polish PO's in 2017 was wholesale markets which accounted for 45% of the POs' total sales. Retail chains (super and hypermarkets, discount chains) ranked the second and accounted for approximately 22% (18% for fruit and 25% for vegetables). The share of processing companies in turn was considerably lower and amounted to 17%.

Other channels were less important – mall retail shops accounted for 2% of the total value, 3% was self-processed whereas the remaining 11% was accounted for by other outlets. Interestingly, the share of particular types of distribution channels in the case of fruit and vegetables was in general very similar. A slight difference was found in the case of processing that turned out to be more important for marketing vegetables.

The majority of the PO's used more than one distribution channel (80% of all POs). Around 30% of companies used a single distribution channel, which usually related to those specialized in supplying vegetables for processing, followed by PO's involved in the production of greenhouse tomatoes and mushrooms. Producer organizations specialized in fruit production used more diversified distribution strategies when compared to those selling vegetables.

Selling to large retail chains was used by approximately one third of PO's under study. This share was comparable to the share of PO's transacting with small retail shops and other outlets. However, it was considerably lower than the share of PO's supplying either the wholesale channel or the processing industry channel. The two latter channels were both used by approximately 70% of PO's.

Table 1. Fruit and vegetables sales of Polish POs by marketing channels in 2017 (sales in m. PLN)
Tabela 1. Sprzedaż owoców i warzyw przez polskie organizacje producenckie w 2017 r. (sprzedaż w mln PLN)

Marketing channel	All OP's		Fruit OP's		Vegetables OP's	
	Sales	Share in total OP(%)	Sales	Share in total fruit (%)	Sales	Share in total vegetable (%)
Retail chains (directly)	491.34	22	207.07	18	284.27	25
Wholesale markets	1013.77	45	495.76	44	518.01	45
Small retailers	35.51	2	27.07	2	8.44	1
Others	243.84	11	171.10	15	72.74	6
Processing companies	396.45	17	162.19	14	234.26	20
Own processing	67.38	3	38.04	3	29.34	3
Products withdrawn from the market	26.04	1	24.90	2	1.14	0
Total	2274.33	100	1126.13	100	1 148.20	100

Source: own calculations based on unpublished data collected by ARMA.

The characteristics of producer organizations supplying retail chains

Given the changes in the distribution of fresh fruit and vegetables related to the increasing role of retail chains (discussed in section 2), it is worth taking a closer look at whether PO's selling to the retail chains stood out from the others. As shown in Table 2, it appears that PO's supplying retail chains were performing better than others. The average value of sales was more than half as high as in the case of other entities. At the same time, on average, PO's selling to retail chains noted a much higher share of sales generated by production sourced from growers non-members. Moreover, these PO's used relatively more distribution channels – four compared to two. At the same time the share of the main marketing channel in sales of PO's selling to retail chains was relatively smaller – 63% compared to 82%.

Table 2. Average sales of POs* in 2017 (PLN m.)
Tabela 2. Przeciętna przedaż realizowana przez OP* w 2017 r. (mln PLN)

Scale of production of POs	POs selling to retail chains (1)	POs not selling to retail chains (2)	Difference between (1) and (2)
Total	18.4	8	56%
Production of growers-members	13	6.4	51%
Production of growers-members per one member	0.46	0.24	48%
Production procured from non--members	5.4	1.6	70.3%

* without OP's specializing in the production of products for processing

Source: own calculations based on unpublished data collected by ARMA.

Based on specific requirements of modern retail chains discussed in the section 2, it can be expected that POs delivering to this marketing channel are relatively larger and more productive. To assess the determinants of the participation of PO's in the modern retailers supply chain a number of variables were considered. Variables were grouped into three sets: productivity, organizational and product specific factors. Factors related to productivity included land size of farmers-members (*Mem_land*), sales generated by production from growers-members (*Mem_s*) and sales generated by production from growers non-members (*Nmem_s*). Organizational factors embraced the number of years of operation on the market (*Years*), legal form of the PO (*Legal*). The last set comprised the category of products delivered (fruit – *Fruit*, vegetables – *Veg*) and the level of specialization (80% of sales and more generated by one product category meant high specialization; *Spec*).

In the logit regression analysis, the dependent variable corresponded to the decision to deliver to retail chains, and assumed a categorical value of 1 and 0 otherwise. The model equation was formulated as follows:

$$Y_i = \log\left(P_i / 1 - P_i\right) = \alpha + \beta X_i + e_i$$

where:
Yi – dummy variable that takes the values of 1 for farmers selling vegetables to supermarkets and 0 otherwise;
$\log(P_i/1 - P_i)$ – logit for market channel choice;

P_i – probability of participation in supermarket supply chain;
$(1 - P_i)$ – probability that farmers have not organized to supply vegetables to supermarkets;
X_i – vector of independent variables (three groups);
β_i – parameters to be estimated;
e – error term absorbing all omitted factors.

Table 3 presents the results of the logit estimates of the factors influencing POs participation in the modern retail chains.

Table 3. Factors affecting PO's participation in the modern retail chains
Tabela 3. Czynniki wpływające na udział OP w nowoczesnych sieciach handlowych

Variable	Marginal effects	Std. Err.	*z*-Statistic	*p*-Values	Odds ratio
Mem_land	0.1072*	0.0574	1.85	0.024	3.4658
Mem_s	0.3530***	0.0566	4.13	0.000	24.1011
Nmem_s	0.4138***	0.1107	2.83	0.005	76.7976
Years	0.0661	0.0739	0.89	0.371	1.4703
Legal	0.0112	0.0568	0.20	0.843	0.1660
Veg	–0.0451	0.2079	–0.22	0.828	0.5395
Fruit	–0.0712	0.0567	–1.25	0.210	0.3778
Spec	0.0085 0.0750 –0.11 0.910 0.8902	–0.0085 0.0750 –0.11 0.910 0.8902	–0.0085 0.0750 –0.11 0.910 0.8902	–0.0085 0.0750 –0.11 0.910 0.8902	–0.0085 0.0750 –0.11 0.910 0.8902

N =257 (260-POs delivering only to processing companies), log Likelihood = –29.56685, LR χ^2 = 108.44, Prob > χ^2 = 0.0000, Pseudo R^2 = 0.5567.

*, ** and *** denote statistical significance at 10, 5 and 1% confidence levels respectively.

Source: own calculation based on ARMA data.

The results showed that the model is highly significant (the log likelihood statistic was –29.56685; Pseudo R^2 value 0.5567; χ^2 of 108.44 is significant at 0.1% level with a *p*-value of 0.000). Among the individual explanatory variables, all the factors connected with the PO productivity were statistically significant. However, factors related to the period of market operation, legal form and type of the product and product specialization turned out to be statistically insignificant.

Land area of growers members had a positive sign for large retail supply chain participation, which is consistent with the a priori expectations. The marginal probability value (0.1072) has significance *p*-value of 0.054. These findings imply that an increase in the area under production of PO's members results in supermarket participation. The odds ratio value of 3.4658 associated with members' land area indicates that the probability of participating in large retailers supply chain increases with increased area that a PO has at its disposal.

The marginal probability of sales generated by growers-members production (0.3530) is significant at 0.1% level (*p*-value=0.000). The positive sign on its coefficient indicates that an increase of production by growers-members results in increased large retailers supply chain participation choice by PO's. The value of odds ratio (24.1011) shows that POs are most likely to increase participation in this marketing channel with increased production delivered by growers-members.

The value of sales generated by the production procured from growers non-members has a marginal probability of 0.4138 which is significant (*p*-value = 0.005) at 1% level. The positive sign explains that an openness of a PO to buy produce from non-members results in shifting from traditional markets to modern retail chains participation. The relatively large odds ratio (76.7976) indicates that PO's are most likely to choose large retail chains with increased levels of outside procurement practices.

Summary and conclusions

The process of concentration of the processing industry and food retail trade, which has been observed for many years in the world and recently in Poland, has had serious consequences for the strategy and organization of suppliers. An interesting and rarely discussed topic in Polish studies are the effects of the growing role of retail chains in the organization of the food supply chain. Fruit and vegetables are one of the few categories of agricultural products that are placed on shop shelves in an unprocessed form. It is therefore to be expected that adaptations to the supply model implemented by large retailers will be the most visible in the fruit and vegetable sector. These changes will mainly affect the organization of production and logistics, with particular emphasis on the quality aspect (at the stage of production, storage and transport) and changes in distribution channels used by fruit and vegetable growers.

Producer organizations are playing an increasingly important role in the marketing fruit and vegetables products in Poland. They concentrate supply through cooperation between individual producer who members of PO's, as well as through the purchase of products from outside the PO, acting as an intermediary in this case. The study showed that PO's used a vast variety of distribution channels. The most important channels, representing 84% of POs sales, were the following: wholesale markets, retail chains (super and hypermarkets, discount chains) and processing companies. In line with expectations formulated based on the literature review, it turned out that PO's selling to retail chains were relatively larger in terms of the value of produce delivered by producers-members.

Moreover, these entities were also more likely to source fruit and vegetables from farmers who are not their members. This observation may indicate that the bargaining power of significant number of PO's in Poland is still insufficient and that it needs to be strengthened. However, the fact that large PO`s need to buy additional quantities of produce from non-members may indicate the unwillingness of non-associated producers to join active POs. On the other hand, it may result from the PO's willingness to reduce risk resulting from unstable environmental conditions, lack of long-term sales contracts or, generally speaking, reluctance for commitments related to the accession of new members to the PO.

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Correspondence address:

Aleksandra Chlebicka, PhD
(https://orcid.org/0000-0002-3896-154X)
Warsaw University of Life Sciences – SGGW
Institute of Economics and Finance
Department of Economics and Economic Policy
Nowoursynowska St.166, 02-787 Warsaw, Poland
e-mail: aleksandra_chlebicka@sggw.pl

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Bogdan Klepacki, Aleksandra Perkowska
Warsaw University of Life Sciences – SGGW

Specificity of the supply chain on the cereals market

Specyfika logistycznego łańcucha dostaw na przykładzie rynku zbóż

Abstract. The study presents the production of major agricultural products in Poland and in the world. The specificity of logistics in the field of plant production has been described in detail. The supply chain scheme in agribusiness was presented. The article presents trends on the global cereal production market and describes the market in Poland in detail. A graphic presentation of the flows of cereal products from primary producers to the consumer was prepared. The authors presented the trends of changes in the cereals sector and their products. Studies have shown that the logistics chain of cereals and their products is extensive. It covers many grain producers, agri-food processing units, agricultural trade, wholesale and retail food trade. The condition for the success of the cereal logistics chain is its efficient management, as well as the mutual trust of its participants and flexibility in adapting to new challenges.

Key words: logistics, agriculture, food industry, agricultural trade, supply chain, cereals

Synopsis. W opracowaniu przedstawiono produkcję ważniejszych artykułów rolnych w Polsce i na świecie. Szczegółowo opisana została specyfika logistyki w zakresie produkcji roślinnej. Zaprezentowano schemat łańcucha dostaw w agrobiznesie. Przedstawiono tendencje na światowym rynku produkcji zbóż, a także opisano szczegółowo rynek w Polsce. Opracowano graficzną prezentację przepływu przetworów zbożowych od wytwórców początkowych do konsumenta. Przedstawiono tendencje zmian w sektorze zbóż, a także ich przetworów. W badaniach stwierdzono, iż łańcuch logistyczny zbóż i jego przetworów jest rozbudowany. Obejmuje on wielu wytwórców zbóż, jednostek przetwórstwa rolno-spożywczego, handlu rolnego, hurtowego i detalicznego handlu żywnością. Warunkiem sukcesu łańcucha logistycznego zbóż jest sprawne zarządzanie nim, a także wzajemne zaufanie jego uczestników i elastyczność w dostosowaniu się do nowych wyzwań.

Słowa kluczowe: logistyka, rolnictwo, przemysł spożywczy, handel rolny, łańcuch dostaw, zboża

Introduction

Poland is a country with significant agricultural production potential, resulting from a relatively large, in relation to many other EU countries, areas of arable land and considerable resources of the labor force. The specific features of Poland's natural conditions and the entire complex of organizational and economic conditions [Krasowicz and Kuś 2010] determine the degree of utilization of this potential and its regional diversity. Production of cereal products in the world is important compared to other plant products however, it is produced in conditions of the dispersed economy, which causes the need to create effective supply chains. Recently, the concentration of cereal production has been noticed, but hundreds of thousands of farmers still deal with this activity. In the research of A. Madej [2018], an analysis of the spatial concentration of cereal cultivation for most crops, in 2016 compared to 2010, showed an increase in concentration index with varying levels of severity. This means that in the modern economy, the importance of organizing and managing cereal flows will continue to be very important.

The aim and methods

The main aim of the article was to analyze the market of plant products with particular emphasis on cereal products. The article also presents the author's pattern of the cereal sector supply chain. The research material was secondary data from publications of the Polish Central Statistical Office and the Institute of Agricultural and Food Economics – National Research Institute. Data analysis covers plant production with particular emphasis on cereal products, both in Poland and worldwide.

The study uses the method of literature review. The results of the data analysis were presented using a descriptive, tabular and graphic method.

Position of Poland in the global crop production

Plant production in the world is very diverse. The level of production of individual plants on a global scale is presented in Table 1.

On a global scale, the most important group of plants deciding about the possibility of feeding humanity are cereals (including corn and rice). Their total harvest in the world in the year 2017 is estimated at 2,892 billion tons. The basic cereal crop is corn, supplying 39.2% of the grain, the rice followed by wheat (by 26.7%). These three plants provide a total of 92.6% of the total grain of this group. Much smaller is the importance of barley and marginal millet, oats and rye.

Poland is one of the major producers of plant products both in the European Union and in the world. Important information in this area is presented in Table 2.

In the European Union, Poland is a leading producer of rye, potatoes and sugar beet. It is similar in the case of world rankings, although apart from rye they are usually further places. For comparison, the second part of the table gives Poland's place in mining activities and selected industrial production. The data indicate that the places obtained by Polish agriculture are similar to the position of other branches of the national economy.

Table 1. World production of more important agricultural products
Tabela. 1. Światowa produkcja ważniejszych artykułów rolnych

Agricultural products	The level of production in (M t)		Change (%) 2017/2010
	2010	2017	
Grain	2381	2892	21
Maize	852	1135	33
Wheat	640	772	21
Rice	701	770	10
Barley	123	147	20
Millet	33	28	–15
Oats	20	26	30
Rye	12	14	17
Potatoes	333	388	17
Sweet potatoes	106	113	7
Sugar cane	1683	1842	9
Soybeans	265	353	33
Rape	59.8	76.2	27
Olives	20.4	20.9	2
Groundnuts in shell	43.5	47.1	8
Vegetables (excluding melons)	824	1094	33
Fruits (including melons)	756	866	15
Citrus fruits	129	147	14
Coffe	8.5	9.2	8
Tea	4.6	6.1	33
Cocoa beans	4.3	5.2	21
Cotton (lint)	23.8	26.2	10
Flax fibre and tow	0.6	0.8	33
Sisal	0.4	0.2	–50
Natural rubber	10.8	14.3	32

Source: [GUS 2019].

Table 2. Poland's share in selected production areas in Europe and the world
Tabela 2. Udział Polski w wybranych obszarach produkcji w Europie i na świecie

Specification	Share in % of the EU		Place in the EU		Share in % of the world		Place in the world	
	2010	2017	2010	2017	2010	2017	2010	2017
Total area	1.4	1.4	9	9	0.2	0.2	68	69
Population	5.2	5.1	8	8	0.6	0.5	68	69
Production of:								
wheat	4.7	4.3	6	6	1.5	1.5	15	16
rye	27.8	23.9	2	2	23.9	19.5	2	2
barley	4.6	4.3	7	8	2.8	2.6	11	11
maize	2.3	3.6	13	8	0.2	0.4	38	27
potatoes	7.9	7.5	4	4	2.5	2.4	7	8
sugar beets	6.6	7.6	5	4	4.4	5.2	7	6
raw sugar	7.4	7.8	4	5	1.0	1.0	20	16
Production of primary energy	2.7	2.7	8	6	0.5	0.5	36	34
Production of coal:								
hard	18.4	15.6	2	2	1.2	1.0	9	10
lignite	10.5	11.6	4	3	6.7	7.4	7	5
cement	5.9	6.1	6	4	0.5	0.4	26	26
crude steel	2.8	3.8	8	7	0.6	0.6	19	19
refined copper	15.3	15.6	3	3	2.9	2.5	9	10
electricity	3.2	3.4	8	7	0.7	0.7	23	24
gross domestic product	2.4	2.6	11	10	0.7	0.7	24	23

Source: [GUS 2019].

Trends in cereal production in the world and Poland

In world statistics, cereals are most often analyzed in two groups: wheat and feed grains. Wheat is grown on the largest scale in the Commonwealth of Independent States, the Americas, the European Union and East Asia. In the last two decades, the area's tendency has increased (in the harvest years from 2000/2001 to 2014/2015 by 3.9%), with the highest dynamics in South Asia (by 14.9%) and Oceania (11.2%). A decrease (20.5%) was recorded in South America and North America (by 5.3%). The area of fodder cereal

cultivation increased by 8.4% over the period considered, the fastest in East Asia (by 40.9%) and South America (by 27,%). The decrease was mainly recorded in South Asia (by 11.3%) and the European Union (7.7%).

Area crops are not the best measure of the importance of individual cereals, more accurate is the level of collections, which are presented in Table 3.

Table 3. Wheat and feed cereal harvest by region of the world
Tabela 3. Zbiory pszenicy i zbóż paszowych według rejonów świata

Region	Harvest in years (million t)			
	2000/01–2002/03	2003/04–2007/08	2008/9–2011/12	2012/13–2014/15
Wheat				
EU	125.5	131.8	141.6	147.5
East Asia	93.7	103.0	116.3	126.1
South Asia	95.7	98.4	110.9	125.9
CIS	77.8	88.3	106.4	103.0
North America	80.0	82.3	90.3	91.1
Near East	37.0	42.3	36.8	38.6
Africa	17.4	21.7	23.3	25.8
Oceania	21.0	18.2	25.5	25.1
South America	21.4	23.8	24.2	20.7
others	3.7	4.0	3.8	4.1
Feed cereals				
North America	313.6	366.0	383.7	404.7
East Asia	125.1	153.3	183.3	225.2
EU	145.1	149.3	153.8	156.2
South America	70.8	85.1	103.2	133.1
Africa	81.3	94.0	108.2	115.4
CIS	56.9	58.1	68.2	83.3
South Asia	36.9	42.1	47.2	50.5
Southeast Asia	18.6	23.9	27.0	31.0
Near East	17.0	19.4	18.8	20.3
Oceania	11.6	11.6	12.4	12.7
others	11.4	14.3	13.4	13.4

Source: [Szajner 2015].

The European Union is the largest producer of cereals, especially wheat, in the world scale, however, the volume of harvest increased much faster in Africa (by 48.4%), East Asia (by 34.6%) and South (by 31.6%) and Commonwealth of Independent States (32.4%). These regions increased the global harvest by 23.6%. Wheat production decreased only in South America (–3.3%). On the other hand, feed grain production grew the fastest in South America (88.1%), East Asia (80%) and Southeast Asia (66.6%). The European Union's advantage over other producers is decreasing. With an increase in EU production by 17.6%, China recorded a 34.8% index, and India 31.1%. The CIS and the USA are also important wheat producers, but the largest increase among the ten largest wheat producers was recorded in Ukraine (by 61.2%).

The largest producers of feed cereals are the United States, China and the European Union. However, the most harvests increased in Ukraine (by 128.8%), Brazil (96.6%), Argentina (82.1%) and in China (81.3%), with a global increase of 40.2%.

In Poland, the area of cereal sowing has been steadily decreasing since 1990, from over 14 to 11 million ha, and has stabilized in recent years. The scale of storage and marketing of cereals measured by their inventory, harvest, import and export are presented in Figure 2. During the research period in Poland, cereal harvests increased by 7.1%, although the directions and pace of change varied. Corn harvest increased the most – which is becoming an increasingly important product of Polish agriculture (over 2.5 times).

Cereals are mainly used for feed (over 60.9%) and then for human consumption (below 20%). In the analyzed years, the use of cereals for industrial processing increased (2.3 times), especially for the production of bioethanol (5.4 times).

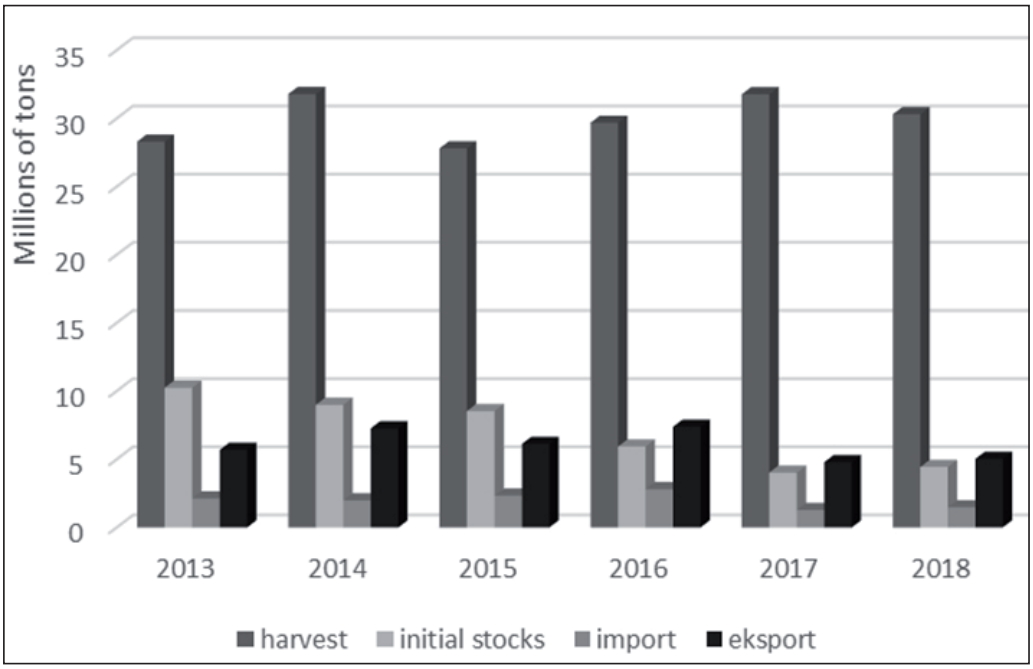

Figure 1. The level of grain mass in Poland in 2013–2018 (M t)

Rysunek 1. Poziom masy towarowej zbóż w Polsce w latach 2013–2018 (mln t)

Source: own study based on [IERiGŻ-PIB 2018].

The specificity of logistics in the field of plant production

The role of logistics in agribusiness is particularly important due to the specificity of the sector, which manifests itself in many aspects [Klepacki 2016]. There is an imbalance of supply and demand for agricultural products at different times of the year, especially in the cereals, oil and fruit and vegetable sectors. Most plant products are obtained once a year and in a certain season, while the demand for agricultural raw materials and food products is quite even. there is therefore a need to store these raw materials, while storage involves costs. In agriculture and agri-food processing, specific warehouses are needed, because products stored incorrectly lose their value (deteriorate). Often, such warehouses are specialized and their construction is expensive, but they must provide stored products with the right conditions in terms of temperature, humidity and even air movement. Many plant materials have low transport and storage susceptibility, some contain a lot of water (e.g. green fodder, silage, roots, tubers, fruit and vegetables – even 80–90%), they are not concentrated and require food processing, e.g. for drought, jams or bread. Agricultural products without processing are often economically and physically sensitive to transport. Economic sensitivity is due to the high water content, and physical sensitivity due to the delicacy of products, especially fruits such as raspberries and strawberries. Incorrectly transported, they change their characteristics and lose value for the individual customer. They can also undergo adverse processes such as fermentation, decay or drying. Some agricultural products require specialized means of transport, e.g. For the transport of flour, cereal, rice – bulk transport. The farm is of a spatial nature. Plant production takes place in fields located at a considerable distance from the economic center and other fields. This means that a large mass must be transported to and from the fields of the production means (fertilizer, seed, pesticides, water), and agricultural products (grain and straw cereals, potato tubers, roots beet, vegetables, fruit etc.). In agriculture, not very large, dispersed farms still dominate, which means they need to consolidate small batches of goods into larger units for trade, processing or export. This means the need for many intermediate links in the supply of raw materials and food products from the farmer to the final consumer. Both the level of technical sophistication and the level of producers' knowledge vary. Not all manufacturers appreciate and implement modern technological requirements. They are often very attached to traditional production methods, while the contemporary audience put specific demands on product quality, as well as their uniformity.

Typical supply chain in agribusiness

Logistics supply chain is the next stages of the entire process flow of goods and services from producer to consumer [Bechtel and Jayanth 1997]. Such a chain can be of different lengths and depths. It starts with producers of primary raw materials for the entire production (e.g. oil, coal, etc.), or a specific link in the chain. Regardless of their length, all operations and processes must be organizationally and financially coordinated. International institution – The Council of Supply Chain Management Professionals (CSCMP) provide the concept of logistics management as "that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the

point of consumption in order to meet customers' requirements" [CSCMP 2019]. Mentzer et al. define the supply chain as "a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer" [Mentzer et al. 2001].

In a typical logistics chain, there are many processes related to production, inventory, demand management, order processing and purchasing. In the course of implementing the logistics chain, it is important to obtaining raw materials (e.g. extraction), a supply of raw materials and semi-finished products, production as well as distribution of finished products to the customer. The logistics chain is a network extending between the supply and sales market, producers, suppliers, commercial units, logistic units and final recipients. It covers the flow of goods, information and financial resources [Szymańska et. al. 2018].

The basic organizational principles that exist in logistics chains generally also apply to food flows. Organizational scheme common to almost all logistic chains in agribusiness is shown in Figure 2.

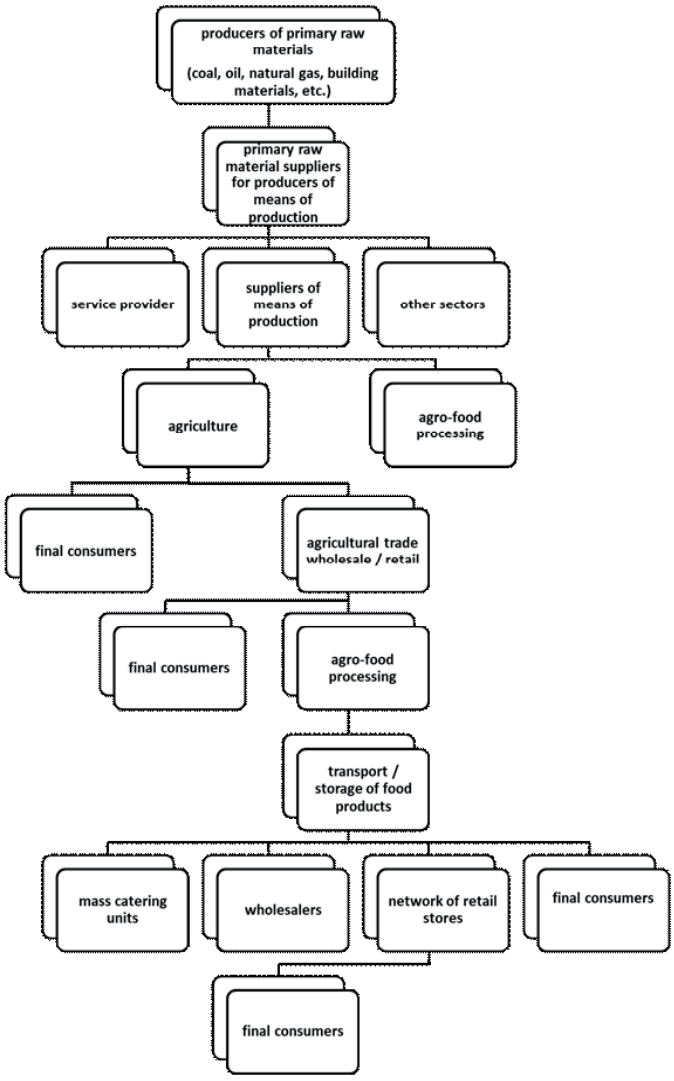

Figure 2. Generalized scheme of food supply chains
Rysunek 2. Ogólny schemat łańcuchów dostaw żywności
Source: [Klepacki and Perkowska 2018].

Logistics supply chain of the cereal sector

Food products can be obtained directly from cereals as a raw material, or indirectly. Direct use takes place with only a slight grain processing, e.g. in the form of milling, resulting in middling serving as an animal feed. This situation is common in meat and milk producers, who use their own feed grain cereals. The situation is similar in the production of e.g. cereal or oat flakes. Increasingly, cereal grain is "processed" several times in various production and commercial units. This means that the movement and processing must take place inefficient links of many networks of connections [Klepacki 2000]. The main cereal supply chain processes and their links are presented in Figure 3.

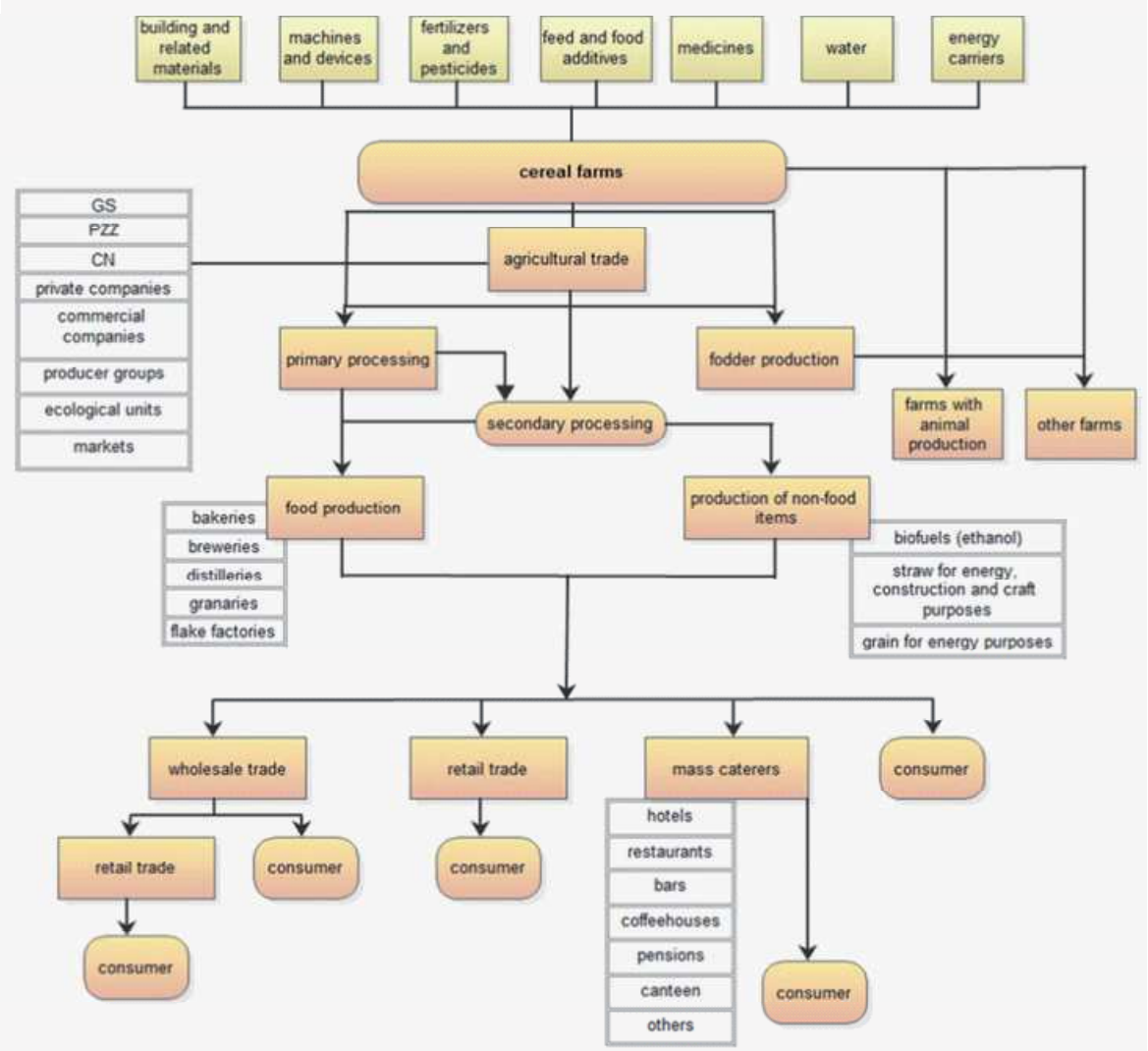

Figure 3. Supply chain pattern cereals sector
Rysunek 3. Schemat łańcucha dostaw sektora zbożowego
Source: [Klepacki and Perkowska 2018].

The cereal supply chain begins with producers and suppliers of inputs[1], such as: agricultural machinery and tools, building materials, energy carriers, fertilizers, plant protection products, feed, medicines, seed and germs, etc. The "roots" of the supply chain can therefore be sought in mines, machinery and chemical factories, but also on other farms. This indirectly indicates how large the recipient/buyer of industrial and own production is the agricultural sector.

Agricultural production takes place in a large number of relatively small farms, so it is very dispersed and requires a good system of connections between producers and recipients of grain as well as good organization of transport and storage. In agriculture, the number of cereal producers has decreased. This is due to the decreasing number of farms in total from 2.86 million in 2000 [GUS 2008] to 1.41 million in 2017 [GUS 2018] – over 50%.

Cereal grain flows for processing take place in many channels. The simplest relationship is: producer – processor. In the case of cereals, they are a farm – cereal industry plants, e.g. mills, feed processing plants, etc. However, this type of supply mainly concerns producers of large grain batches or producer groups. Many farmers produce smaller quantities of cereals and use the services of intermediaries, such as commercial companies and private entities.

Conclusions

1. The cereal sector is one of the most important in global and Polish agribusiness. The functioning of the sector is an important factor in the economic situation of many entities in agriculture and beyond.
2. The logistics chain of cereals and their products is very extensive. It includes over one million cereal producers, tens of thousands of agri-food processing units, agricultural trade, wholesale and retail food trade. It must be flexible and adapt to new challenges related to technological and organizational progress as well as changes taking place in the agribusiness environment and among clients.
3. The condition of supply chain success in distributed raw material production is the efficiency of managing individual entities. Equally important are solidarity and mutual trust of producers, traders, processors and consumers. It is important to recognize that every actor in the supply chain benefits in a similar way.

[1] In the presentation of logistic chains of agricultural raw materials and their products, the authors usually omit the link of producers and suppliers of raw materials and means of production for agriculture. However, we consider this to be the wrong approach. Modern agriculture depends on the quantity, quality and timeliness of their deliveries as well as industrial or commercial enterprises.

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Correspondence addresses:

prof. Bogdan Klepacki PhD, Eng, h.c. multi
(https://orcid.org/0000-0003-3483-7530)
Warsaw University of Life Sciences in Warsaw – SGGW
Institute of Economics and Finance
Department of Logistics
Nowoursynowska St. 166, 02-787 Warsaw, Poland
e-mail: bogdan_klepacki @sggw.pl

Aleksandra Perkowska, MSc
(https://orcid.org/0000-0002-7059-0689)
Warsaw University of Life Sciences in Warsaw – SGGW
Institute of Economics and Finance
Department of Logistics
Nowoursynowska St. 166, 02-787 Warsaw, Poland
e-mail: aleksandra_perkowska @sggw.pl

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Marek Ziemian[1]***, Jarosław Kobryń***[2]
[1]Ekspert transportu drogowego
[2]WSB University in Poznan

Selected problems in the transport of food from Poland to the Middle East

Wybrane problemy w transporcie żywności z Polski na Bliski Wschód

Abstract. The article discusses the main factors that affect the management of shipping covered by the ATP Convention to the Middle East, including the way of planning the route taking into account the specificity of cargo with low natural, technical and economic transport susceptibility, illustrated on a case study of food transport. Problems and their consequences in such transportation, which the carrier faces, can in particular cases, lead to bankruptcy. This market may soon become an alternative to the changing European transport market.

Key words: road transport, supply chain, logistics, ATP, management

Synopsis. W artykule omówiono główne czynniki jakie mają wpływ na zarządzanie przewozem ładunków objętych konwencją ATP do krajów Bliskiego Wschodu, w tym sposób planowania trasy przejazdu z uwzględnieniem specyfiki ładunków o niskiej podatności transportowej naturalnej, technicznej i ekonomicznej, na przykładzie studium przypadku transportu żywności. Problemy i ich skutki w takim transporcie, które napotyka przewoźnik mogą w szczególnych przypadkach prowadzić nawet do upadłości. Rynek ten może niedługo stać się alternatywą dla zmieniającego się rynku przewozów europejskich.

Słowa kluczowe: transport drogowy, łańcuch dostaw, logistyka, ATP, zarządzanie

Introduction

Road transport is one of the most dynamically developing branches of the economy in the world. Polish entrepreneurs from the TSL industry have used Poland's accession to the structures of the European Union and the opportunities associated with it like no other. Transportation of low-susceptibility cargo, requiring proper planning of the transport route, selection of crews, minimizing loading and transporting time, maintaining constant temperature of the cargo [Jadczak 2019], are quite modestly analyzed in the literature

[Wronka 2010, Rudzińska et al. 2011, Rybińska and Galińska 2014]. A similar situation occurs with the analysis of the risk of transport services in the new markets where Polish carriers appear.

The consequence of transport management in the absence of proper information is planning far from the actual conditions in which the transport takes place. Defects that occur during transport may qualify the load for disposal [Ustawa z dnia 15 listopada 1984…]. The costs of cargo loss and utilization are often borne by the carrier, which often exceeds its financial capabilities and leads to bankruptcy [Cyganik 2014]. From the data published by the insurance company Euler Hermes, the insolvency of Polish road carriers in 2017 increased by 43% compared to the previous year. The 2018 bankruptcy reports show an increase in such insolvent enterprises in the TSL sector. The debt of 27,800 Polish carriers is over PLN 925 million, in 2017 the debt amounted to PLN 664 million.

This article attempts to examine the impact of the specificity of transport management in the EU on the implementation of road transport to the Middle East, and thus on the possibilities of functioning of Polish transport companies on that market.

The situation of the road transport industry in terms of Polish carriers

Poland has a strategic position in the European transport network between the east and the west of Europe, which results in growing demand for transport services. According to data published by the Chief Inspector of Road Transport[1] in 2018, 35,997 business entities that owned 234,639 vehicles dealt with international road transport in Poland. Most of them are small enterprises that on average had 3–5 vehicles.

Table 1 Business entities involved in international road transport in Poland
Tabela 1 Podmioty gospodarcze zajmujące się drogowym transportem międzynarodowym w Polsce

a – 2017 b – 2018	transport of goods		transport of people		Increase / decrease	
					transport of goods	transport of people
Licenses	a	34 633	a	3 245	increase 3.9%	increase 2.4%
	b	35 997	b	3 326		
Increase	a	217 984	a	12 598	increase 7.6%	increase 3.6%
	b	234 637	b	13 057		

Source: own development of data based on GITD data.

The year 2018 was another year in which road transport developed. An increase in road carriers was recorded both in goods and passengers. The number of entrepreneurs performing road transport of goods increased by 3.9% compared to 2017, the number of owned vehicles over 3.5 t permissible total weight increased by 7.6%. Despite the large fragmentation of Polish transport companies, they have a modern fleet of vehicles, ap-

[1] Transport carried out on the basis of a national permit or the EU license with vehicles over 3.5 t GVW.

prox. 77% have vehicles with Euro 5 and Euro 6 emission standards. These data confirm that Poland has one of the most modern truck fleets in Europe. The average cost of buying a road tractor with a semitrailer is around 600,000. PLN depending on the equipment. Polish carriers have mastered the road transport market from year to year, increasing their share since the time Poland joined the European Union. According to data published by Eurostat, transport performance in 2017 in tonne-kilometers accounted for 20.5% of total transport throughout the European Union. In international transport in 2018, the share of Polish carriers accounted for 35.4%. We are the leader on the road transport market, followed by countries such as the Netherlands, Germany and Spain. In 2018, Polish carriers generated PLN 120 billion in so-called Gross value added (the value of all products and services produced by all domestic entities less costs associated with their production), which accounted for 6% GDP. It is 0.5% more than in 2014.

The average employment under the employment contract in the entire transport sector in 2018 was 622,900 people and was by 4.1% higher compared to 2017.

The biggest threats in the further development of road transport include:

- lack of new qualified professional drivers,
- increase in minimum wage rates, i.e. an increase in employee maintenance costs,
- tightening of regulations and sanctions for not complying with them,
- new EU regulations, issues related to posted workers,
- no agreement between the EU and the United Kingdom,
- increase in fuel prices and road tolls,
- meeting emission standards,
- new smart tachographs.

At the end of 2018, Polish carriers missed about 100,000. drivers. The downward trend in driver education began as early as the 1990s – liquidation of vocational schools, changes regarding Driver Education entities admission to the market that took place in 2000, resignation from practical training in categories C, C + E in trade schools, discrepancies between the curriculum and market needs, large costs of training, lack of teaching staff. Contemporary vocational education is mainly based on retrained teachers in postgraduate studies. During two or three semesters, a humanist receives the right to teach vocational subjects. System solutions in Polish education effectively block the inflow of new staff. The Polish vocational education system in the field of the TSL industry has stopped in the previous era and there is no indication that anything will change in the near future. The main barrier on the path to acquire new staff is the pay system, no credit for years of teaching experience in the profession. An employee after 20–30 years of work in the TSL industry going to work in a state educational institution can count on a net salary of PLN 1750–2200 per month depending on seniority pay**.** On-line trainings try to save the difficult market situation [Madej et al. 2015].

Polish entrepreneurs are being increasingly forced to reach for foreigners. Employing an employee from a country not belonging to the European Union to the EFTA countries in road transport as a driver carries risks and costs. No knowledge of the Polish language, the need for additional training in the field of transport law, ensuring adequate social conditions. Despite these difficulties, carriers are increasingly deciding to employ foreigners. According to the data published by GITD, the number of foreigners employed as drivers is increasing every year. Table 2 shows the number of valid driver cards on December 31.

2017 and December 31. 2018. The table does not include cards issued during the analyzed years. This number significantly exceeds the number of cards in circulation at the end of the analyzed periods.

Table 2 Number of valid driver cards
Tabela 2 Liczba ważnych kart kierowcy

2017	Quantity	2018	Quantity	Incease (%)
Russia	317	Russia	505	159.3
Belarus	9 436	Belrus	16 521	155.8
Kazakhstan	26	Kazakhstan	92	353.8
Moldova	808	Moldova	1 186	146.8
Ukraine	35 115	Ukraine	48 624	138.5
Other	436	Other	932	213.8
Total	46 138	Total	**67 891**	**147.1**

Source: own development of data based on GITD data.

The number of driver cards issued in 2018 was 72,390, but at the end of the year only 67,7891 drivers remained in Polish enterprises. The Polish driver card authorizes to practice in the EU. Earnings of drivers in the countries of the old Union are much higher than in Poland, which is why over the past year 4499 drivers left our country and started working behind our western border.

In recent years, the transport strategy has been oriented towards risk management. Hazard identification and change management are important here [Kobryń 2016]

Road transport of food to the Middle East

There are two areas of international transport of goods. No permits are required within the European Union [Neider 2015] – a Community license is sufficient. In the case of transporting goods outside the European Union , the so-called foreign permit, issued by the minister of transport of the country to whose territory the goods are to be imported or exported or transported through. The number of these permits is negotiated annually between the Polish Government and the governments of individual countries. Road transport is the foundation of the modern global economy. Its proper course and security conditions guarantee not only the efficient functioning of companies and institutions but also affect each of us. Despite the development of other modes of transport, road transport is the only one that can perform the full door-to-door service. The expansion directions of our road transport significantly exceed the borders of the European Union. Balkan and Middle Eastern countries such as Turkey, Iraq, Iran, Armenia, Georgia have become a new destination for Polish carriers. Attractive freight rates and ease of obtaining return loads are an incentive. Polish carriers [Ustawa z dnia 6 września 2001…, RPE i Rozporządzenie Parlamentu... nr 1071/2009] with modern equipment, trained and experienced drivers can compete on this market with carriers from the Balkan countries, Turkey and Ukraine. The Polish economy also has a lot to offer to contractors from these countries.

CEMT/ECMT

Texte rédigé dans les deux langues officielles de la CEMT (1)
Text in the two official languages of the ECMT (1)

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Secretariat

CODE DU PAYS QUI DÉLIVRE L'AUTORISATION :
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Name or business name and full address of the haulier.
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Figure. 1. EKMT/CEMT permit model
Rysunek 1. Model zezwolenia EMKT/CEMT
Source: [Madej et al. 2019].

According to GITD data, 952 EKMT[2] permits have been distributed for road transport outside the European Community, which means that 26.45% of Polish carriers have the ability to transport goods outside the EU.

A case study of road transport from Katowice (Poland) to Zakho (Iraq)

The implementation of long-distance transport requires from the carrier not only additional permits, reliable vehicles, but also adequate financial resources [Banaszyk and Gołembska 2017]. Planning transports on such long routes requires from the entrepreneur to carefully select drivers, have knowledge of local regulations and local customs [Bukowski and Sobczak 2017].

The object of research in this work was road transport on the route Katowice (Poland)–Zakho (Iraq), which actually took place in 2019, however, due to the protection of personal data, the details could not be provided in this article.

Transport time. When determining the time of such transport, the European Community Regulation no. 561 applicable in the EU and EFTA countries should be taken into consideration. Transport time is crucial for unprocessed loads with a short shelf life. Driving time means only the duration of driving activity recorded by a digital or analogue tachograph in accordance with Regulation (EEC) No 3821/85, or manually registered in accordance with Article 16 clause 2 of Regulation (EEC) No 3821/85 [RPE i RWE nr 165/2014], which states that "While the equipment is unserviceable or operaing defectively, drivers shall mark on the record sheet or sheets, or on a temporary sheet to be attached to the record sheet, all information for the various periods of time which is not recorded correctly by the equipment". To interpret individual requirements regarding the driver's working time standards correctly, the regulations of RWE 561 must be respected. The regulation allows the driving time to be extended to 10 hours twice a week. According to the regulation, a week means the period from 00:00 on Monday to 24:00 on Sunday. The weekly maximum driving time is 56 hours (4 days × 9 hours + 2 days × 10 hours = 56 hours), a two-week driving time is 90 hours. This means that within two consecutive weeks, the sum of driving hours may not exceed 90. The condition of using the maximum weekly driving time is driving in the previous week for 34 hours and the following week for 34 hours. It often happens that the misunderstanding of the week definition used by drivers is treated in this case as the "driver's work week" calculated from the end of one weekly rest period to the start of the next weekly rest period, which does not necessarily have to start on Monday. Another limitation is the legal regulations regarding night work. If the driver drives a vehicle or performs other work between 00:00 and 4:00 a.m., he can work a maximum of 10 hours on this day.

[2] International carriage of goods between certain countries is carried out on the basis of the authorization of the European Conference of Ministers of Transport (EKMT). The permit is a document that allows you to take an unlimited number of courses between EKMT member countries, whose course is documented in a properly completed subscription.

The transport time also depends on the route chosen [Jadczak 2019]. The goal is to find the optimal solution with the restrictions adopted [Kobryń 2013].

The question to be answered is whether to delegate a single or double crew to carry out the transport? Tables 3 and 4 present an example travel time schedule under the following assumptions:

- distance 3551 kilometers,
- one-man crew (Table 3),
- two-man crew (Table 4),
- average speed of the team 58 km/h,
- daily driving time 9 hours,
- weekly rest reduced to 24 hours,
- no extended driving time of 10 hours,
- average continuous driving time of 4 hours, 18 minutes,
- maximum weekly and bi-weekly driving time – average time of breaks during one day of driving a vehicle and one hour for a double crew, included.

According to data analysis in Tables 3 and 4, a shorter crew time will be provided by a crew of two. One-man crew is a subject to restrictions resulting from legal regulations.

Technical travel time assuming 58 km/h on this route is 61 hours 13 minutes, assuming an increase or decrease in average speed within +/– 5 km/h, travel time can be reduced or increased by 4 hours 52 minutes, which practically has no effect on time of the entire transport process. When planning transport, the return to the country should be considered, the total time is 122 hours 26 minutes. The one-man crew will return after 17 days [Rozporządzenie Parlamentu... nr 561/2006], assuming that unloading and loading will take place on the same day, in the case of a two-man crew return will take place after 9 days, assuming a weekly rest period shortened by 24 hours.

Transport conditions. The ATP Convention clearly defines the conditions that must be met in transport of food. For this type of transport, the cold chain should be kept in line with the recommended temperatures [Trafiałek and Bilska 2016].

The main principle in monitoring the food cold chain is to constantly monitor the product "from loading to consumption". Considering the complexity of the global food logistics chain, this is not always easy. Both refrigerated containers and vehicle bodies "refrigerated" are equipped with a temperature monitoring system. The temperature is registered continuously, it is also possible to print the temperature course from any duration of the transport process. You can then immediately respond to irregularities and temperature changes, which significantly reduces losses. You can also verify the conditions in which the transport took place.

Polish sanitary regulations regarding the production processes of animal and vegetable products intended for human consumption are strict. [Rybińska and Galńska 2014] The importer's country requirements are in most cases known and published by the Chief Veterinary Inspectorate.

Considering the variability of the law also in the importer's country, it is recommended to monitor the required documents on an ongoing basis, the length of the shelf life, transport conditions, and phytosanitary clearance conditions. In the absence of agreements between the Polish side and the importer's country, such data should be obtained from our

Table 3. Single crew
Tabela 3 Załoga jednoosobowa

Start Day / hour	Finish Day / hour	Activity	Time	Kilometers traveled
Mon. 7:00	Mon. 8:00	loading	1 h	–
Mon. 8:00	Mon. 12:18	driving	4 h18 min.	249 km
Mon. 12:18	Mon. 13:03	break	45 min	–
Mon. 13:03	Mon. 17:21	driving	4 h 18 min	249 km
Mon. 17:21	Tue. 04:21	daily rest	11 h	–
Tue. 4:21	Tue. 8:39	driving	4 h 18 min	249 km
Tue. 8:39	Tue. 9:24	break	45 min	–
Tue. 9:24	Tue. 13:42	driving	4 h min	249 km
Tue. 13:42	Wed. 00:42	daily rest	11 h	–
Wed. 00:42	Wed. 5:00	driving	4 h 18 min	249 km
Wed. 5:00	Wed. 5:45	break	45 min	–
Wed. 5:45	Wed. 10:03	driving	4 h 18 min	249 km
Wed. 10:03	Wed. 21:03	daily rest	11 h	–
Wed. 21:03	Wed. 23:58	driving	2 h 55 min	140 km
Wed. 23:58	Thu. 3:21	other work (customs clearance)	3 h 23 min	–
Thu. 3:21	Thu. 5:24	Driving	2h 03 min	113 km
Thu. 5:24	Thu. 6:09	Break	45 min	–
Thu. 6:09	Thu. 7:03	Driving	54 min	52 km
Thu. 7:03	Thu. 18:03	daily rest	11 h	–
Thu. 18:03	Thu. 22:21	Driving	4 h 18 min	249 km
Thu. 22:21	Thu. 23:06	Break	45 min	–
Thu. 23:06	Fri. 3:41	Driving	4 h 18 min	249 km
Fri. 3:41	Fri. 14:41	daily rest	11 h	–
Fri. 14:41	Fri. 19:29	Driving	4 h 18 min	249 km
Fri. 19:26	Fri. 20:11	break	45 min.	–
Fri. 20:11	Sat. 00:28	driving	4 h 18 min	249 km
Sat. 00:28	Sat. 11:28	daily rest	11 h	–
Sat. 11:28	Sat. 15:46	driving	4 h 18 min	249 km
Sat. 15:46	Sat. 16:31	break	45 min	–
Sat. 16:31	Sat. 20:49	driving	4 h 18 min	249 km
Sat. 20:49	Sun. 20:49	weekly rest	24 h	–
Sun. 20:49	Mon. 1:07	driving	4 h 18 min	249 km
Mon. 1:07	Mon. 1:52	break	45 min	–
Mon. 1:52	Mon. 6:10	driving	4 h 18 min	249 km
Mon. 6:10	Mon. 17:10	daily rest	11 h	–
Mon. 17:10	Mon. 21:10	other work, (customs clearance)	4 h	–
Mon. 21:10	Mon. 22:03	driving	1 h 04 min	62 km

*The difference in travel time results from rounding to full minutes.

Source: own development of data based on [Rozporządzenie Parlamentu... nr 561/2006, Rozporządzenie Ministra... 2010]..

Table 4. Two-man crew
Tabela 4 Załoga dwuosobowa

Start Day / hour	Finish Day / hour	Activity	Time	Kilometers traveled
Mon. 7:00	Mon. 8:00	loading	h	–
Mon. I D 8:00	Mon.12:18	driving	4 h 18 min	249 km
Mon. II D 8:00	Mon. 12:18	disposition	4 h 18 min	–
Mon. I D 12:18	Mon. 16:36	disposition	4 h 18 min	–
Mon. II D 12:18	Mon. 16:36	driving	4 h 18 min	249 km
Mon. I+II D 16:36	Mon. 17:36	break	1 h	–
Mon. I D 17:36	Mon. 21:54	driving	4 h 18 min	249 km
Mon. II D 17:36	Mon. 21:54	disposition	4 h 18 min	–
Mon. I D 21:54	Mon. 01:54	disposition	4 h 18 min	–
Mon. II D 21:54	Tue. 1:54	driving	4 h 18 min	249 km
Tue. I + II D 1:54	Tue. 10:54	daily rest	9 h	–
Tue. I D 10:54	Tue. 15:12	driving	4 h 18 min	249 km
Tue. II D 10:54	Tue. 15:12	disposition	4 h 18 min	–
Tue. I D 15:12	Tue. 19:30	disposition	4 h 18 min	–
Tue. II D 15:12	Tue. 19:30	driving	4 h 18 min	249 km
Tue. I+II D 19:30	Tue. 20:30	break	1 h	–
Tue. I D 20:30	Tue. 22:55	driving	2 h 25 min	140 km
Tue. I D 22:55	Wed. 3:18	other work (customs clearance)	3 h 23 min	–
Wed. II D 20:30	Wed. 3:18	disposition	5 h 58 min	–
Wed. II D 3:18	Wed. 7:36	driving	4 h 18 min	249 km
Wed. I D 3:18	Wed. 7:36	disposition	4 h 18 min	–
Wed. I D 7:36	Wed. 8:54	driving	1 h 18 min	75 km
Wed. I + II D 8:54	Wed. 17:54	daily rest	9 h	–
Wed. I D 17:54	Wed. 22:12	driving	4 h 18 min	249 km
Wed. II D 17:54	Wed. 22:12	disposition	4 h 18 min	–
Wed. II D 22:12	Thu. 2:30	driving	4 h 18 min	249 km
Thu. I D 22:12	Thu. 2:30	disposition	4 h 18 min	–
Thu. I+II D 2:30	Thu. 3:30	break	1 h	–
Thu. II D 3:30	Thu. 7:48	disposition	4 h 18 min	–
Thu. I D 3:30	Thu. 7:48	driving	4 h 18 min	249 km
Thu. II D 7:48	Thu. 12:06	driving	4 h 18 min	249 km
Thu. I+II D 12:06	Thu. 21:06	daily rest	9 h	–
Thu. I D 21:06	Thu. 1:24	driving	4 h 18 min	249 km
Thu. II D 21:06	Fri. 1:24	disposition	4 h 18 min	–
Fri. II D 1:24	Fri. 5:42	driving	4 h 18 min	249 km
Fri. I D 1:24	Fri. 5:42	disposition	4 h 18 min	–
Fri. I D 5:42	Fri. 6:20	driving	38 min	37 km
Fri. I D 6:20	Fri. 10:20	other work, (customs clearance)	4 h	–
Fri. II D 5:42	Fri. 10:20	disposition	4 h 38 min	–
Fri. II D 10:20	Fri. 11:24	driving	1 h 04 min	62 km

*The difference in travel time results from rounding to full minutes.

Source: own development of data based on [Rozporządzenie Parlamentu... nr 561/2006, Rozporządzenie Ministra... 2010]..

contractor. The Chief Veterinary Officer[3], if the required documents are not specified, and the document template is missing, recommends taking the following steps:

1. Obtaining (by the entity concerned) the model of a sanitary certificate applicable to the importation of a given product onto the market of a third country (e.g. from a contractor).
2. Obtaining its certified translation into Polish (having the value of an official translation).
3. Preparing a statement that the model certificate is accepted by the competent authority of the country of destination or that it was obtained through the trade partner of the importing country as an official requirement.
4. Preparing a statement regarding legal and financial liability for possible consequences of rejection of a shipment by the authorities of the importing country.

The above documents should be presented to the district veterinarian, who on their basis, can verify compliance with the requirements contained in the certificate and, in the case of positive verification, issue a sanitary certificate officially certifying the compliance of the batch of goods sent to the given third country with the requirements [Rozporządzenie Komisji... nr 589/2008].

One of the basic mistakes that importers and exporters of food make is the lack of information about the shelf life of a given product. Basic data [Rozporządzenie Komisji... nr 589/2008], – the date of production and expiry date is provided in the veterinary certificate issued by the district veterinarian [Trafiałek and Bilska 2016]. There is no specific date in this certificate when the product may cross the borders of the importing country at the latest.

Each food product has two expiry dates:

– The first date is specified by the district veterinarian when issuing a product certificate of origin, it is the best before date.
– The second date, when the product can cross the border of the importing country at the latest, how many days of shelf life must it have. This deadline is set by the importing country and confirmed by the agreement between the countries.

These are the most important factors, however, the problem is so complex that this article does not exhaust the full spectrum of managing such transport.

Summary

The analyzed selected factors affecting the management of the transport of loads covered by the ATP Convention to Middle East countries are based on international agreements, but the specificity of a destination country or a transit one can cause significant difficulties. The time and transport conditions should be basic – in this case the specificity of transport management in the EU is the heart of the road transport of food to the Middle East. However, other specific elements, such as refueling and stopping points during transport, armed conflicts, the specificity of the Balkan countries or border check standards, which differ from European standards, must also be taken into account. It is also

[3] https://www.wetgiw.gov.pl/ [access: 06.12.2019].

worth remembering that the problems and their consequences in such transport, which the carrier encounters, may in particular cases lead to bankruptcy. The topic is important because this market may soon become an alternative to Polish transport companies due to the changing European transport market.

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Correspondence addresses:

Marek Ziemian, MSc Eng
e-mail: marekziemian@interia.pl

Jarosław Kobryń, PhD, ScD Eng
(https://orcid.org/0000-0001-8645-860X
WSB University in Poznań
Faculty in Chorzów
Departments of Engineering Management and Logistics
Sportowa St. 29, 41-506 Chorzów, Poland
e-mail: jaroslaw.kobryn@chorzow.wsb.pl

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Sylwia Konecka
Poznań University of Business and Economics

Intelligent supply chains from the perspective of benefits and costs for transport-forwarding-logistics industry

Inteligentne łańcuchy dostaw z perspektywy korzyści i kosztów przedsiębiorstw branży transportowo-spedycyjno-logistycznych

Abstract. The article presents the results of the literature review analysis regarding the solutions used that are characteristic of the concept of intelligent supply chain. Then, based on the available industry reports and pilot survey studies, the potential benefits and costs of the possibility of using these solutions in transport and forwarding enterprises were indicated.

Key words: transport-forwarding-logistics industry, intelligent supply chains, road transport

Synopsis. W artykule zaprezentowano wyniki analizy przeglądu literatury w zakresie wykorzystywanych rozwiązań charakterystycznych dla pojęcia inteligentnego łańcucha dostaw. Następnie na podstawie dostępnych raportów branżowych i pilotażowych badań ankietowych, wskazano potencjalne korzyści i koszty z możliwości zastosowania tych rozwiązań w przedsiębiorstwach transportowo-spedycyjnych.

Słowa kluczowe: branża transportowo-spedycyjno-logistyczna, inteligentne łańcuchy dostaw, transport drogowy

Introduction

Evidence for intelligence solutions in supply chains can be found in any logistics-related process or service from the basic to the complex. It is seen as new and advantageous to a particular focal audience [Flint et al. 2005] and it may also be fundamental for some companies, e.g., in the transportation industry [Wagner 2008].

Transport processes somehow bind all links in the supply chain. Undoubtedly, transport is one of the areas affecting the functioning of the supply chain, including through optimal utilization of capacity, route planning, logistics customer service standards and used communication tools connecting the supplier and customer of the load [Konecka et al. 2019].

The latest full CSO data on GDP – for 2017 – shows that the transport and storage sector has generated 5.8% GDP. In 2017, it was PLN 115.3 billion. It is worth noting that this result was the second largest in the concentrated service sector (the higher share in GDP – 15,.7% was obtained in the "trade; repair of motor vehicles" segment) [GUS 2019].

Polish carriers are also impressive compared to other European Union countries. A glance at the latest Eurostat data for 2018 shows that Poles accounted for over a fifth of international road transport in the European Union. In this respect, we have no equal in the entire Community. We are not only the leader of the ranking in terms of international transport volume, but if we compare the next two countries in the ranking – the Netherlands and Germany, then their combined result is smaller than the share of Polish transporters.

The entire volume of transported loads on the EU market was in 2018 1175 billion tons (data from 28 EU countries). Poles had the largest share in working out this result – 22.6%. international transport (266.7 million tons). The second place was taken by the Netherlands, which obtained a half result – 132.5 million tons [Kulikowska-Wielgus et al. 2019].

Therefore, an important research area is the potential of using intelligent solutions used in supply chain management, with particular emphasis on transport, forwarding and logistics processes.

Purpose and methodology

The main purpose of this article is to determine what solutions in the field of intelligent supply chains can be used in transport, forwarding and logistics activities. And also demonstrating the legitimacy of implementing such solutions for the activities of entrepreneurs in this industry from the point of view of potential costs and benefits.

The main research questions are:

1. What solutions in the field of intelligent supply chains can be used in transport, forwarding and logistics activities?
2. Do Polish transport, forwarding and logistics entrepreneurs treat intelligent technological solutions as a source of benefits for their enterprise? If so, which ones?
3. Are solutions in the field of intelligent supply chains in transport-forwarding-logistics activities treated by Polish transport-forwarding-logistics companies as an additional cost of operations? If so, what are the costs?

To answer these questions, a literature review was used, analyzing the Scopus database for the keywords "intelligent supply chains" including "transport". An analysis was also made of industry reports on the activities of Polish transport-forwarding-logistics companies and statistical data of the Central Statistical Office. Preliminary pilot surveys were also used.

Intelligent supply chains

Practitioner research argues that, in the future, supply chains will be autonomous and will have predictive capabilities [IBM 2015, WEF 2018, DHL]. Using IoT sensors, quintillion bytes of data will be generated across supply chain operations. AI will be deployed

to analyse information in real time, monitor operations across the globe, predict the future with minimum error rate, and take actions to adjust to rapidly changing environments [Wu et al. 2016]. Smart supply chains collectively possess not only intelligent and innovative characteristics but also information in the next generation supply chain is overwhelmingly being machine-generated, for example, by sensors, RFID tags, meters, and many others [Wu et al. 2016].

Literature review shows that intelligent solutions that apply to supply chains in the literature of subject are discussed above all at the level of various types of algorithms – genetic algorithms or fuzzy-logic systems [Ngai et al. 2014], intelligent systems in intermodal transport [Mondragon et al. 2012], in urban and extra-urban transport [Ehlers et al. 2017], regarding the use of intelligent algorithms for flow management in the field of reverse logistics [Yan, et al. 2015], evolution of the ITS system [Wang, 2017] and safety of their use [Erdogan 2017], intelligent warehouse management system [Mao et al. 2018], Cloud of Things [Yan et al. 2014], RFID [Zhao 2017], Kiva robots [Bogue 2016], Voice picking and Pick-by-Light technologies [Fager et al. 2019], autonomous vehicles [Graham et al. 2019].

In spite of the promising benefits of the self-thinking supply chain found in practitioner literature, academic research on this and related topics is scarce. Calatayud, Mangan and Christopher [2019] in their systematic literature review found no articles exploring the self-thinking supply chain and only 28 articles referring to related concepts such as "autonomous", "predictive", "smart" or "intelligent" supply chain. These articles were spread across different fields, including SCM, computer science, engineering and economics. The analysis of the selected articles gave insights into in particular two new digital technologies that are associated with autonomous, predictive, smart or intelligent supply chains, namely, IoT and AI.

Among all critical resources, information systems continue to play a critical role in SCM as supply chain performance is often characterized and facilitated by the real-time collaboration and sophisticated integration. SCM would not even be possible without the advances in information systems and technology [Konecka and Maryniak 2019].

Intelligent supply chains versus transport

Thus, preliminary research and review of the literature on the subject of solutions used in intelligent supply chains shows that a significant proportion of the issues considered concern transport activities.

Analyzing the abstracts from Scopus database for two keywords "intelligent supply chains" in the "transport" 356 articles have been received. The oldest are from 2001. Considering the numerical distribution over the last 10 years, a significant increase in publications in this respect should be noted from 2014 – 34 articles, then in 2015 – 19 articles, in 2016 – 37, 2017 – 20, in 2018 –26 articles and the largest number in 2019, as many as 54 articles.

By analyzing in detail the abstracts of selected articles, the most frequently described tools were identified. Previously identified as part of intelligent supply chain management tools. The most frequently described technology – in 41 articles was RFID technology. Most often RFID is described as a technology enabling electronical and automatic

identification of vehicle, freight container, returnable transport unit and packing, track and tracing system using RFID technology, using RFID technologies in aircraft, in UK High Way Agency, using RFID in the fresh fruit transport and RFID in IT architecture of inteligent freight transportation.

Then often described technology are intelligent transport systems (ITS) – 14 articles. Internet of Things is almost as often discussed topics, among 356 articles identified, as many as 13 articles concerned this technology. In the next 9 articles ICT was discussed, in 8 articles artificial intelligence was described. Block chain and autonomous vehicles are presented in 3 articles. Automation as a technology for intelligent supply chains is discussed in 2 articles. Interestingly, the database of selected articles did not include anything about TMS (Transport Management Systems). The number of articles about subsequent tools is presented in Table 1.

Table 1. The number of articles about subsequent tools of intelligent supply chain
Tabela 1. Liczba artykułów o poszczególnych narzędziach inteligentnego łańcucha dostaw

The selected tool of intelligent supply chain	Number of articles
RFID (Radio-frequency identification)	41
ITS (Intelligent Transport Systems)	14
IoT (Internet of Things)	13
ICT (Information and Communication Technologies)	9
AI (Artificial Intelligence)	8
Automation	2
TMS (Transport Management Systems)	0

Source: own work

Potential benefits and costs of using intelligent technologies

According to the results of the PwC "21st CEO Survey", as many as 68% of the CEO's and directors of global companies in the transport and logistics industry expect changes in key service technologies to have a breakthrough in their business. In this report, practitioners point out the basic benefits of using auto-autonomous vehicles. According to practitioners [PwC 2019] autonomy in the form of fully autonomous vehicles is key to filling the labor supply gap in the market will enable a reduction of transport costs by 28% after 2025 by replacing the costs of labor (drivers) with the costs of software, telematics, and remote control. Most economic, social or political and legal factors will most likely lead to an increase in costs in the industry, and autonomy can, therefore, be one of the few ways to reduce them. As many as 78% of representatives of global transport and logistics companies plan to take action to automate tasks and positions to ensure effective implementation of the company's goals. In turn, 31% of them plan to invest in automation by 2020 [PwC 2017].

The authors of the report [Wolak 2019] claim that, on the other hand, the global economy 4.0 is more and more clearly marked in the global economy, which assumes

the use of data to make better decisions and allocate resources faster. He assumes that algorithms, armed with a large amount of data, can perform these tasks more efficiently than humans. The transport industry seems to be still at the tail of these innovations. It is quite strange because it could be great benefit for transport. First, because it is a fragmented industry like no other. Transport resources, senders, recipients, intermediaries form a network that is difficult to efficiently handle using manual processes. Hence, paradoxically, one can hear that despite the lack of transport space, many carriers drive undercharged or empty. At the same time, transport generates huge amounts of data that can be used to optimize its performance. Modern telematics in vehicles send information on their location and condition on an ongoing basis, ERP, TMS and WMS systems have data on the content and purpose of the load. There are also all kinds of beacons installed more often in the loads themselves, toll collection devices, drivers' mobile phones, electronic documents, including waybills and many more. A huge amount of data that seems underestimated, which is properly stored and processed by algorithms, can contribute to a better matching of loads to the means of transport, to a better use of each cubic meter of the semi-trailer and each kilometer of the route. To make better use of existing resources when they cannot be enlarged enough and in anticipation of greater autonomy in supply chains.

At EU-28 level, fundamental changes are planned to the regulations concerning road transport, including the provisions of the Mobility Package, and changes to the provisions concerning the coordination of social security systems and other social regulations [Klaus 2019]. These changes will cause inter alia increasing the costs of transport networks – (due to reducing their efficiency) and labor costs, increasing risk and barriers – for conducting business, especially for small carriers due to the increase in regulatory complexity, increasing in the level of concentration – as a result of the collapse of small enterprises that do not have the appropriate share of transport in the country and on foreign markets in their activities.

The Mobility Packed can also cause potential problems not directly related to the use of intelligent tools. For example: decrease in revenues related to the restriction of market access – in the scope of crosstrade and cabotage services, and as a consequence also the handling of import and export of goods; moving services of Polish carriers – from EU markets to the Polish market; forced internationalization of carriers, who operate today in many foreign markets from Poland. Reducing transport performance in international transport services, e.g. by 20%, would mean a reduction in the total transport performance of Polish carriers by nearly 13%. The transport work carried out by Polish entrepreneurs in international transport constitutes as much as 64% of their total transport work, so the majority of Polish carriers' activity is threatened by changes in law.

The growing requirements in the scope of environmental protection (regarding lower CO_2 emissions and other pollutants, the use of more ecological drives and local restrictions on the movement of combustion vehicles) will also contribute to the increase in costs. Insufficient level of development of domestic law in the field of new technologies may hinder their implementation by Polish carriers, giving foreign advantage. Obtaining technological advantage by carriers from Western countries [PwC 2019]. The expected impact of technological changes is unprecedented, given that in recent years, apart from

increasing the efficiency of engines and increasing the volume of transport, no significant technological changes have been observed. The diesel engine, which has been used for decades, is a standard in the road transport industry in the EU-28. According to ACEA data, in 2016, among vehicles with GVW > 3.5 tonnes in the EU-28, over 96.1% were diesel vehicles, which means that the diesel engine continues to be the main solution in European markets. Currently, work is underway on the development of several alternative drives, but their popularization requires not only appropriate technology, but also the availability of charging or refueling infrastructure. Its absence, combined with the high cost of purchase, is a significant limitation for such vehicles. Reducing fuel consumption translates directly into savings in transport. Alternative drives also remain relatively expensive in relation to the investment capacity of small carriers. Concerns are also related to the government's policy on taxing various fuels.

The "Transport of the Future" report also indicates the potential benefits and costs of transport and forwarding activities from the use of intelligent technologies. According to its authors only the current increase in costs and shrinking margins in the industry become the reason why companies are looking for technological solutions, starting from digitization.

The transport and logistics sector is characterized by a huge space for development through digitization, because the technologies that serve it are already mature. Digitization is not just about administration, accounting processes and internal processes. It also enters the sphere of creating new business processes (e.g. related to the control of physical conditions in the transport process, electronic clearance of goods in terminals), and even affects the change in the manner of cooperation with customers and conclusion of contracts (visible in the "platformisation" of service transactions).

Transport companies indicate that a significant barrier to the development of digital solutions by entrepreneurs is the shortage of people with competences in the field of digital technologies. According to 58% of representatives of transport and logistics companies surveyed, it is difficult to recruit people with the skills necessary to develop digital technologies. It is also important to change the behavior of consumers and enterprises, in particular as regards shifting the ordering of services and trade in goods to the internet, and the increasing availability of (already considered simple) internet technologies, applications, databases and ERP class systems.

Platforming is also an opportunity and a threat for small carriers. On the one hand, new platforms will be potential sources of revenue. On the other hand, they can start to exert a strong influence, e.g. on price levels on the market, which is visible in the case of platforms for transporting people, which are currently lowering prices to attract customers. Small carriers will not create platforms themselves due to low investment resources, therefore they will have to rely on external solutions in this respect.

Intelligent Transport Systems (ITS) are systems built with the use of telematics/internet of things solutions supporting the management of urban traffic, public transport, passenger and goods flow, fleet and cargoes as well as collecting and reporting vehicle traffic information. From the perspective of transport entrepreneurs, they enable better remote vehicle management. According to forecasts, by 2022 the turnover of companies

offering solutions for intelligent transport systems (ITS) in road transport will be globally more than USD 72.3 billion, growing at a rate of 7.9% in 2016–2022.

Access to collections of various data from sensors of production or transport machines gives the possibility of continuous analysis of the condition of devices. Also allows use the data to avoid failures or deficiencies. In transport, predictive repairs can play a key role in minimizing breakdowns that have a huge impact on vehicle safety.

Blockchain (DLT) technology solutions allow the transport and logistics industry to achieve many benefits, such as e.g. increased: security – product identification and the possibility of auditing while maintaining privacy using shortcut keys, efficiency – reduced demand for document processing (due to automation), transparency – easier and more reliable tracking and checking of sources, reliability – after entering information into the network it cannot be easily changed.

Transport and logistics and the automotive industry are two of the four industries that, according to PwC [Report "What's the real value of AI for your business?"] research, show the highest benefits from the implementation of artificial intelligence solutions. Full autonomy of heavy goods vehicles will undoubtedly change the transport market thoroughly, but it will only take place on a massive scale within 10 years. In the period of 5 to 10 years, however, the first implementations of partial autonomy in combination with platooning can be expected. Autonomous transport will also enable a reduction of transport costs by 28% after 2025 by replacing labor costs (drivers) with software, telematics and remote control costs. This is particularly important because most economic, social or political and legal factors will most likely lead to an increase in industry costs, and autonomy may therefore be one of the few ways to solve this problem.

As a result, the transport industry is beginning to recognize the importance of autonomy. As many as 78% of representatives of global transport and logistics companies plan to take actions to automate tasks and positions to ensure effective implementation of the company's goals. In turn, 31% of them plan to invest in automation within three years from the date of the survey [PwC Digital IQ Survey 2017]. From the perspective of a road carrier, autonomy will mean the possibility of reducing costs, but also the need to learn how to use new technologies and develop new business processes that will be necessary for this.

In Poland, most road transport companies are small and medium-sized enterprises. That is why it is worth looking at inteligent solutions, a specially autonomous transport from their perspective. The results of pilot research carried out among road transport operators in Greater Poland in 2019 indicate that [Różniewicz 2019]. According to 58% of respondents, by 2030 autonomous cars will normally functioning on Polish roads, only 16% were skeptical about such implementation prospects. 76% of respondents declared their willingness to participate in courses enabling better understanding of the topic of autonomous vehicles. 82% of respondents are willing to replace trucks and vans in their own fleet with self-steering ones. Among the benefits that the respondents saw in the introduction of autonomous cars, cost optimization was 58% first. It was to consist of getting rid of the costs of drivers' salaries, faster covering the route – without mandatory breaks in accordance with the „Act on the driver's working time", timely delivery. 32%

of respondents noticed the benefit of being able to constantly monitor a vehicle, its location and, technical parameters. Only 14% of respondents saw the benefit of eliminating a significant number of accidents caused by drunk drivers.

Questions about the potential benefits of using autonomous vehicles as well as threats were multiple-choice questions. Respondents perceived threats more often. They considered the biggest threat to the lack of trust in the 36% system, they are also afraid of software errors and the inability to respond to such obstacles from vehicles. 64% of respondents indicated that autonomous vehicles were not adapted to the psychological aspects of other road users – for example, the behavior of drunk pedestrians. Another threat is what has also been indicated as an advantage, i.e. reduced employment of drivers – 44%, also in the context of retraining or acquiring new skills, piloting an autonomous vehicle.

The number of technological solutions used in enterprises employing respondents may also affect the perception of automation. The vast majority of respondents declared that their enterprises use the most popular solutions, i.e. GPS (Global Positioning System) – satellite navigation system, working time controller and driving speed controller. Twenty three people indicated that they worked with the help of cargo tracking, and three people less – with a fuel consumption meter. The least respondents got acquainted with the functioning of the tire pressure sensor and temperature sensor. Awareness and ability to use individual tools also results in answering previous questions. People who worked with the fuel consumption meter, work time controller, GPS indicated that they are in favor of the introduction of autonomous cars because it will facilitate their work because the above devices will cease to need them.

Most, because 96% of respondents would like to use the latest technologies at work. 60% of respondents believe that inteligent solutions in transport are an expensive solution. In this issue, the most important were the responses of employees who use the latest technologies at work. They are the ones who have the greatest awareness and have broader knowledge than others. After careful analysis, it was this group of people who fully opted for autonomous transport. And 40% of those surveyed believe that an investment in autonomous rolling stock will pay off and begin to bring benefits in a few years.

Modern autonomous transport models are the result of many compromises, not least because of the need to provide value in environmental, social and economic terms – as indicated above. This is one of the main reasons why their implementation has been so slow. Another reason is the lack of mechanisms for the integration of sectoral policies implemented in self-government administration bodies, as well as systematic identification of cooperation, especially between sectors.

Summary and conclusions

In summary, the questions posed in the introduction to this article should be answered. It should be noted that the most often described in the literature tool for intelligent supply chains that can be used by transport and forwarding companies are: evolutionary versions of ITS, RFID, cloud of things and IoT, blockchain and IoT. Their use can take place in both intermodal transport and urban transport.

Industry reports show that the future technologies for this industry are: digitalization, platformization, intelligent transport systems, blockchain, autonomous transport. The implementation of intelligent solutions brings both potential benefits and costs. They were discussed in the article, however, they require a different perspective – social, environmental and economic costs and benefits, as well as from the perspective of the entity to which they relate. For example, increasing road safety by introducing intelligent tachographs is an undoubted benefit. However, by small entrepreneurs it will be treated as a cost, additionally forced by law. Thus, in addition to the three perspectives mentioned above, benefits and costs should be examined and compared in the group of small and medium-sized enterprises, large logistics operators and from the perspective of legislative entities.

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Correspondence address:

Sylwia Konecka, PhD
(https://orcid.org/0000-0001-9283-7059)
Poznań University of Business and Economics
Department of Logistics
Niepodległości Ave. 10, 6 01-685 Poznań, Poland
e-mail: sylwia.konecka@ue.poznan.pl

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Piotr Jałowiecki
Warsaw University of Life Science – SGGW

Assesment of advancement level of logistic systems in Polish agri-food industry

Oszacowanie poziomu zaawansowania systemów logistycznych w polskim przemyśle spożywczym

Abstract. The paper presents the results of research on the relationship between the level of advancement of technology, solutions and logistics systems used in the Polish food sector, and the size of employment, scale of investment, financial situation and position on the market of food enterprises. Several different dependency assessment methods were used and compared in the study. The research falls within the broader thematic area of Solow's productivity paradox in its extended understanding of logistics systems [Jałowiecki 2018]. The results obtained seem to correspond to one of the most frequently raised reasons for the occurrence of this paradox related to statistical methods. The main purpose of the research, the results of which were presented in the work, was to construct a synthetic indicator to assess the level of sophistication of logistic solutions used and to use it in the research of the food sector.

Key words: logistic systems advancement, Solow's productivity paradox, synthetic indicator, food industry

Synopsis. W pracy przedstawiono wyniki badań dotyczących związku między poziomem zaawansowania technologii, rozwiązań i systemów logistycznych stosowanych w polskim sektorze spożywczym a wielkością zatrudnienia, skalą inwestycji, sytuacją finansową i pozycją na rynku przedsiębiorstw spożywczych. W badaniu wykorzystano i porównano kilka różnych metod oceny zależności. Badania mieszczą się w szerszym obszarze tematycznym paradoksu produktywności Solowa w jego rozszerzonym zrozumieniu systemów logistycznych [Jałowiecki 2018]. Uzyskane wyniki wydają się odpowiadać jednej z najczęściej podnoszonych przyczyn występowania tego paradoksu związanej z metodami statystycznymi.

Słowa kluczowe: zaawansowanie systemów logistycznych, paradoks produktywności Solowa, wskaźnik syntetyczny, przemysł spożywczy

Introduction

Agriculture and food production has always played a significant role in the Polish economy. As a consequence, Poland has been and still is perceived as a largely agricultural country as well as an important food producer [Borkowski 2003]. Therefore, the

agri-food processing sector plays a very important role in the Polish economy. Over the past 25 years, he has undergone significant changes that have completely changed his face. First, in the 90s of the last century, they were associated with the social and political transformation, as a result of which the Polish economy transformed from centrally managed to free market. At that time, changes in the agri-food processing sector concerned mainly the ownership and organizational structure of enterprises as a result of privatization processes and foreign investments. Then, as a consequence of Poland's efforts to join the EU, both before and after accession, changes in the agri-food processing sector covered the organization and technology of food production. They were, in turn, a consequence of the need to adapt Polish food producers to EU legal regulations and quality standards [Krajewski and Borkowski 2002].

The agri-food processing sector includes producers of foodstuffs for humans and animals, non-alcoholic and alcoholic beverages as well as tobacco products. According to the Polish Classification of Activities, the 2007 version (PKD 2007) includes sections C (manufacturing), divisions 10 (production of food products), 11 (production of beverages) and 12 (production of tobacco products). This term, however, does not apply to entities involved in the production of agricultural produce, animal husbandry (section A, division 1), acquisition of wild-growing forest products (section A, division 2), fisheries, fisheries (section A, division 3) and food distribution (section G, chapter 46).

The agri-food processing sector defined in this way covers a very wide and diverse area of production activity. His enterprises can be divided into four types of processing, and then a more detailed division into 11 industries. Enterprises processing animal products include the following industries: meat processing and preserving and production of meat products (group 10.1 according to PKD 2007), processing and preserving of fish, crustaceans, and molluscs (group 10.2) and production of dairy products (group 10.5). Enterprises processing plant products include the following industries: processing and preserving fruit and vegetables (group 10.3), production of grain mill products, starch and starch products (group 10.6). Enterprises dealing with secondary processing include the following sectors: production of bakery and flour products (group 10.7), production of other food products (group 10.8), production of ready feed and animal feed (group 10.9). Only the production of stimulants is involved in the tobacco industry only (group 11.0). There are also industries grouping enterprises dealing with various types of processing: production of oils and fats of vegetable and animal origin (group 10.4) and production of beverages (group 12.0), among which alcoholic beverages are classified as stimulants.

As can be seen, the food processing sector in Poland is very diverse both in terms of industry and due to the very large number of enterprises belonging to the SME segment (small and medium enterprises). The second source of high diversity of the food sector is the large variety of food products resulting from their degree of processing and the complexity of technological processes used in their production. The large dispersion and complex structure of recipients of finished food products also have a significant impact on the increase in the complexity of food products, but above all the complexity of multidimensional logistic networks of food enterprises (see Table 1). Transactions of agri-food products carried out with a retail store will be significantly different from transactions

Table 1. Average numbers of suppliers of agricultural raw materials, recipients of food products and offered assortment items in Polish food enterprises, taking into account the division by industry and according to the size of employment

Tabela 1. Średnia liczba dostawców surowców rolnych, odbiorców produktów spożywczych i oferowanych pozycji asortymentowych w polskich przedsiębiorstwach spożywczych, z uwzględnieniem podziału według branż i grup wielkości zatrudnienia

Group of enterprises	Average number of suppliers	Average number of recipients	Average number of items in the assortment
Meat	255.8	78.8	134.6
Fruits and vegetables	114.5	86.6	99.7
Oil and fats	22.0	10.6	4.6
Dairy	440.9	1375.1	48.4
Cereal and starch	80.6	110.6	54.8
Bakery	8.0	71.4	82.4
Grocery	17.7	145.5	212.8
Feed	51.0	82.4	122.9
Beverages	12.5	183.1	32.9
Micro	23.6	43.9	40.3
Small	40.0	64.4	84.0
Middle	317.3	154.1	155.7
Large	277.6	1396.2	222.1
All	97.8	137.4	**102.0**

Source: [Jałowiecki 2016].

with a commercial network or wholesaler. These differences will concern not only the place and time of loading, or the current quality of the product, but also the range, volume and financial conditions of delivery, and above all the logistics necessary for their implementation. The standardization of transactions in food products is quite difficult in practice, even at the level of prices, which for the same product, but differing in the date of production by a few days can be very different. All this is a significant impediment, e.g. to the digital description of food transactions, or to carry them out via the Internet [Klepacki 2016].

Random factors, such as weather changes, refrigeration equipment failures, and transport delays are other factors that have a strong impact on increasing the complexity of food logistics chains. They all also reduce the level of predictability of logistics processes and lower predictability of prices of agri-food processing products. Geographic and seasonal factors associated with the seasons also have a significant impact on food prices. Their abrupt changes, often have a strong impact on all participants of the food logistics chains.

These conditions make it crucial for food companies to have an effective logistics system. It can be said without exaggeration that proper organization and management of logistics is not only a means to achieve higher competitiveness or greater efficiency of business operations, but above all becomes a condition for functioning on the food market in general [Szymanowski 2008].

The first goal of the research was to develop a synthetic indicator for assessing the level of technology advancement, logistics solutions, and systems in enterprises, and to use it in relation to the food sector. The second objective of the study was to assess the diversity of logistics advancement levels in the surveyed food enterprises, taking into account their breakdown by industry and employment size group, investment level, financial situation, and market position. An additional third methodical goal of the research was to compare two methods of categorizing the value of the synthetic indicator used to assess the level of sophistication of the logistic solutions used: even distribution and division in relation to the average value and fold standard deviation.

It should be also emphasized that in the known literature on the subject, synthetic indicators have not been used so far to assess the level of sophistication of the logistic solutions used. However, the way of constructing analogous indicators for measurements in other thematic areas is quite similar. In connection with the above, experience from the creation of synthetic indicators used in other areas of research related to management and economics was used [Vilaseca et al. 2006, Domínguez-Domínguez and Núñez-Velázquez 2007, Dominiak et al. 2016, Edquist et al. 2018].

Data source and methods

In this research, the REGON database prepared by the Central Statistical Office was used. It was used to obtain the address data of Polish agri-food processing enterprises to which the survey was addressed in the paper version. Also, the survey was made available in electronic form on a website.

The research sample consisted of 512 enterprises in the Polish food sector. In the first stage of research, the results of surveys carried out in these enterprises were used. The surveys, in addition to general information about the surveyed enterprises, provided data on the solutions they use in five areas of logistics: inventory management, warehouse management, transport management, packaging management and reverse logistics as well as organization and management of logistics. They also contained data on information management solutions. In addition to information on solutions, the results of surveys also included assessments of the financial situation, market position, scale of investment processes, costs of logistics activities, knowledge about logistics and the quality of logistics support by ICT.

From among 11 food industry sectors, 9 were selected for further analysis, for which the questionnaires received a sufficient number of responses. For this reason, the research on the industry of processing and preserving fish and other fisheries products (code 10.2 according to the PKD 2007 register) and tobacco production (code 12.0) was abandoned. The surveyed enterprises were divided into 4 groups of employment size according to the methodology used by the Central Statistical Office (GUS). In this way, micro-enterprises (employing up to 9 people), small enterprises (10–49 people), medium-sized enterprises (50–249 people) and large enterprises (250 and more people) were distinguished.

A dedicated synthetic indicator developed based on data from surveys was used to assess the level of advancement of logistics systems used in the surveyed enterprises. The Logistics Advancement Level (LAI) indicator was built in three stages, and then its value was determined for all surveyed enterprises. In the first stage, a set of variables

that could potentially affect the enterprise characteristics described by the indicator was selected. The division of variables according to 5 areas of logistics activities: logistics organization, inventory management, warehouse management, packaging, and returnable logistics and transport management. During the selection of potential variables, extensive literature studies and an expert method were used, but it was not possible to refer to existing, similar logistic indicators due to their lack in the literature on the subject. In the second stage, variables strongly correlated with each other within each identified area of logistics activities were eliminated. Then, using the backward stepwise regression method, those variables were eliminated whose impact on the studied enterprise logistics advancement was statistically insignificant. During the aggregation of the values of the left variables into partial indicators for each of the five logistics areas listed, we decided not to assign weights to all components as a weight equal to 1. The reason was the inability to use the expert method and large differences in the ranges of values of individual variables, which in turn did not allow apply statistical weight selection methods, e.g. based on the values of the classic coefficient of variation. The obtained values of partial indices were normalized, and then they were aggregated into the LAI indicator. Finally, the LAI indicator was formed by aggregation of 24 components (Table 2).

Table 2. Components of the synthetic level indicator of logistics solutions (LAI)
Tabela 2. Składniki syntetycznego wskaźnika poziomu rozwiązań logistycznych (WZL)

Area of logistics activities	Components of the LAI indicator
Logistics organization and management	(1) owning a separate logistics department; (2) the number of active areas of logistics; (3) the number of separate cost accounts for various logistics activities; (4) the number of ways to measure service quality and customer satisfaction.
Inventory management	(1) classifying storage; (2) inventory accounting method; (3) method of determining the safety stock of production materials; (4) method of determining the safety stock of finished products; (5) production method taking into account demand and supply.
Warehouse management	(1) the number of collateral in warehouses; (2) sufficiency of storage space; (3) sufficiency of warehouse equipment; (4) method of identifying materials and goods in warehouses.
The management of packaging and reverse logistics	(1) share of packaging and returnable resources; (2) packaging standardization level.
Transport management	(1) transport planning method; (2) use of special vehicles; (3) number of categories of internal transport; (4) the number of categories of external transport and transport services.

Source: [Jałowiecki and Jałowiecka 2014].

In the study, the categorized values of the LAI indicator were used, because the other variables used also had a categorized form. Two categorization methods were used in the study. The first categorization method (method A on the figures) was based on the mean value and standard deviation of the LAI indicator according to the formulas (1). The second method of categorization (method B on the figures) was based on an even division of the entire range of LAI values according to formulas (2).

$$\begin{aligned}
&\text{very low} = 1 && \text{for } \min(x) \le x \le \overline{x} - s_x \\
&\text{low} = 2 && \text{for } \overline{x} - s_x < x \le \overline{x} - \frac{1}{2} \cdot s_x \\
&\text{middle} = 3 && \text{for } \overline{x} + \frac{1}{2} \cdot s_x < x \le \overline{x} + \frac{1}{2} \cdot s_x \\
&\text{high} = 4 && \text{for } \overline{x} + \frac{1}{2} \cdot s_x < x \le \overline{x} + s_x \\
&\text{very high} = 5 && \text{for } \overline{x} + s_x < x \le \max(x)
\end{aligned} \tag{1}$$

where:
$\overline{x}$ – average value of LAI indicator;
s_x – standard deviation of LAI indicator.

$$\begin{aligned}
&\text{very low} = 1 && \text{for } \min(x) \le x \le \min(x) + \frac{1}{5} \cdot \left(\max(x) - \min(x)\right) \\
&\text{low} = 2 && \text{for } \frac{1}{5} \cdot \left(\max(x) - \min(x)\right) < x \le \frac{2}{5} \cdot \left(\max(x) - \min(x)\right) \\
&\text{middle} = 3 && \text{for } \frac{2}{5} \cdot \left(\max(x) - \min(x)\right) < x \le \frac{3}{5} \cdot \left(\max(x) - \min(x)\right) \\
&\text{high} = 4 && \text{for } \frac{3}{5} \cdot \left(\max(x) - \min(x)\right) < x \le \frac{4}{5} \cdot \left(\max(x) - \min(x)\right) \\
&\text{very high} = 5 && \text{for } \frac{4}{5} \cdot \left(\max(x) - \min(x)\right) < x \le \max(x)
\end{aligned} \tag{2}$$

In examining the relationship between LAI values and selected characteristics of the surveyed enterprises, a linear regression model was used.

For comparative purposes, another method of identification and assessment of the strength of the relationship between the studied characteristics of food enterprises was also used. It was an independence test based on χ^2 test statistics according to formula (3).

$$\chi^2 = \sum_{i=1}^{k} \sum_{j=1}^{l} \frac{(ni_j - \hat{n}_{ij})^2}{\hat{n}_{ij}} \tag{3}$$

where:
i – number of categories of the first characteristic examined, e.g. employment size;
j – number of categories of the second characteristic examined, e.g. employment size;
n_{ij} – subgroup size in the multi-division table for row i and column j;
$\hat{n}_{ij}$ – theoretical size of the subgroup in the multi-division table in row i and column j.

This method was used only for comparative purposes, because even in connection with the determination of one of the convergence coefficients, e.g. V-Cramer (V_{xy}), T-Czuprow (T_{xy}), it only allows to determine the existence or not dependence, assess its strength, but does not allow to determine its direction (positive, negative).

All calculations were performed at a significance level of $\alpha = 0.05$. In the case of the chi-square test of independence, the number of degrees of freedom necessary to determine the theoretical value of test statistics was $df = (5 - 1)\cdot(4 - 1) = 12$.

Results

The average LAI value obtained when categorizing enterprises according to method A was 3.00, while when categorizing according to method B it was 2.80. Figure 1 shows the average LAI values determined following method A (dark color) and method B (light color) for the food industry sectors under study. The average difference between the LAI values for all food industries was determined as the weighted arithmetic average, in which the number of surveyed enterprises in individual industries played the role of weights. It amounted to 0.206 for the industry and it was the largest for enterprises from the grocery sector (0.733, i.e. 356.7% of the average). The average difference between the average LAI values obtained using the A and B categorization methods (0.206) is slightly larger than the difference between the LAI values obtained for the entire food sector (0.200) using the same categorization methods.

The obtained results, despite quite large differences in the average LAI value in some food industries (other food, dairy and bakery products), indicate some regularity. As for industries, there is no logical order according to which they can be ordered to examine the correlation relationship, and in turn, the use of the chi-square independence test is impossible due to the inability to re-categorize LAI average values, it was decided to use the following scheme tests to determine whether or not this regularity. The average LAI

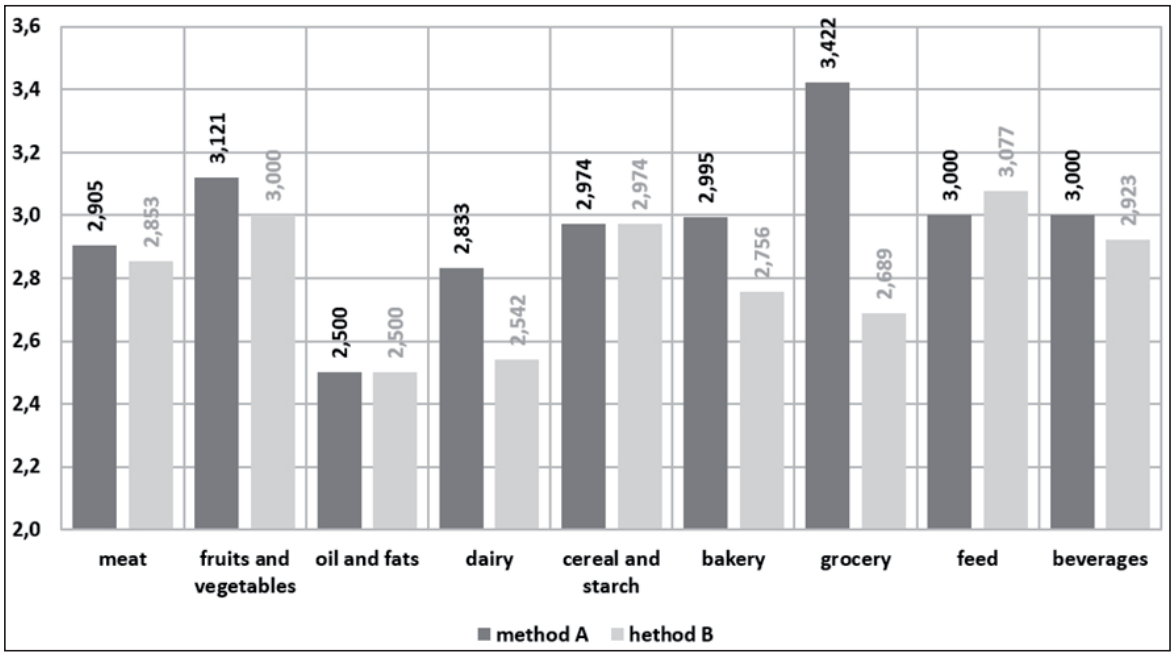

Figure 1. Average LAI values in the analysed food industry sectors in Poland
Rysunek 1. Średnie wartości WZL w badanych sektorach przemysłu spożywczego w Polsce
Source: own study.

values for individual food industries were sorted in descending order, determining their artificial order, and then the values of Pearson's linear (r_P) and Spearman rank correlation coefficients (r_S) with the average numbers of agricultural raw material suppliers, recipients of ready food products and assortment items in the studied sectors were determined. Correlation indicators were determined in this way for both methods of categorization (A and B) and determining the average value of LAI indicators for individual industries.

In the case of the relationship between the average value of the LAI indicator and the number of suppliers of agricultural raw materials, a weak negative relationship, rather non-linear or no such correlation relationship was found (r_P = –0.217, r_S = –0.360 for categorization of LAI indicator method A, and r_P = –0.289, r_S = 0.083 for method B). In the case of the relationship between the average LAI value and the number of recipients of finished food products, the indications regarding the correlation relationship were ambiguous (r_P = –0.136, r_S = 0.301 for method A, and r_P = –0.454, r_S = 0.067 for method B). However, in relation to the relationship between the average LAI value and the average number of product items offered in individual industries, a very strong positive linear relationship was identified (r_P = 0.806, r_S = 0.577 for method A, and r_P = 0.229, r_S = 0.333 for method B).

Figure 2 presents the average LAI values in employment size groups determined following the A and B categorization methods, and the trend lines determined for these methods together with the equations and coefficients of determination R^2.

The results obtained using both methods of LAI categorization indicate two different types of relationships. In both cases, the linear nature of the relationship with similar average strength was found. In the case of method A, this is a negative relationship, which

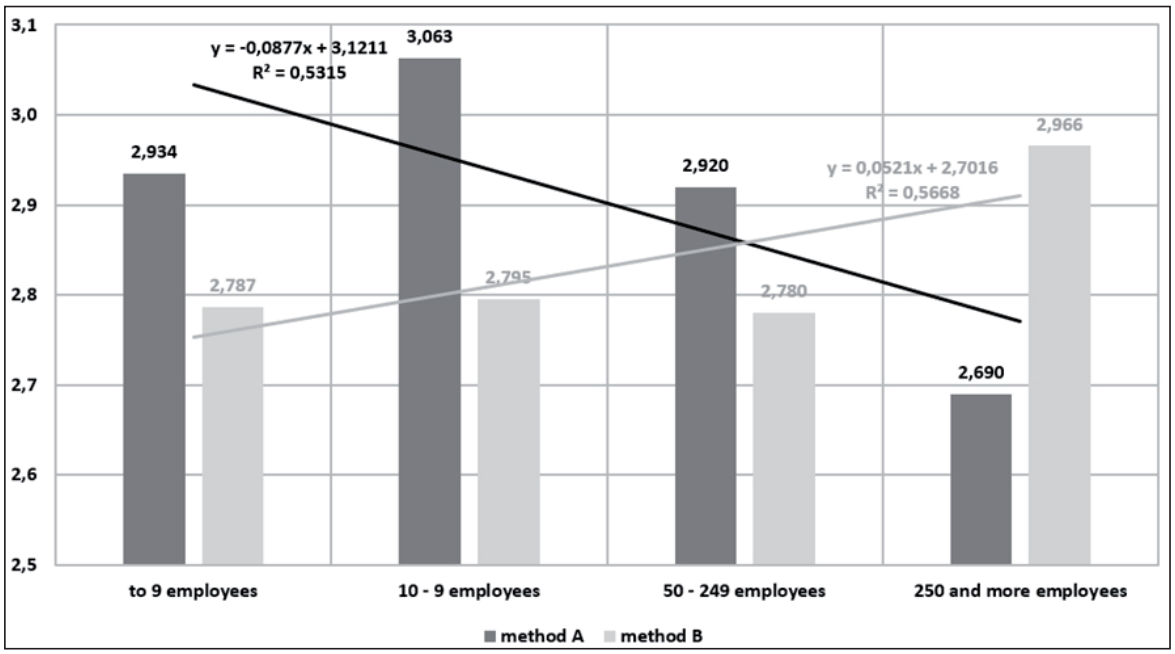

Figure 2. Average LAI values in employment groups in polish agri-food companies

Rysunek 2. Średnie wartości WZL w grupach wielkości zatrudnienia w polskich przedsiębiorstwach rolno-spożywczych

Source: own study.

means that as employment increases, the LAI value describing the advanced level of logistics solutions and systems decreases. In the case of method B, the situation is exactly the opposite, which means that the increase in employment is correlated with the increase in the level of sophistication of logistics solutions and systems. The latter relationship is slightly stronger.

Figure 3 presents the average values of the LAI indicator in individual groups of investment volume of food enterprises determined using the A and B methods of categorizing the value of this indicator and the identified linear trends along with equations and values of the coefficient of determination R^2.

As with employment, the relationships identified using methods A and B are completely different. The positive relationship identified using method B categorization of LAI values is twice as strong as the negative relationship identified using method A.

Figure 4 presents the average LAI values in groups of food enterprises divided according to the assessment of the financial situation using both methods A and B categorization LAI values. As before, linear tendencies with equations and R^2 determination coefficient values were also determined for both methods. This time, the negative relationship identified using Method A categorization of LAI values was about four times stronger than the positive relationship determined using Method B.

Figure 5 presents the average LAI values determined for groups of food enterprises divided according to the market position assessment determined using the A and B categorization methods. Similarly to the assessment of the financial situation, a very strong negative trend meaning that a better market position is not associated with a higher level of advancement of logistics solutions and systems.

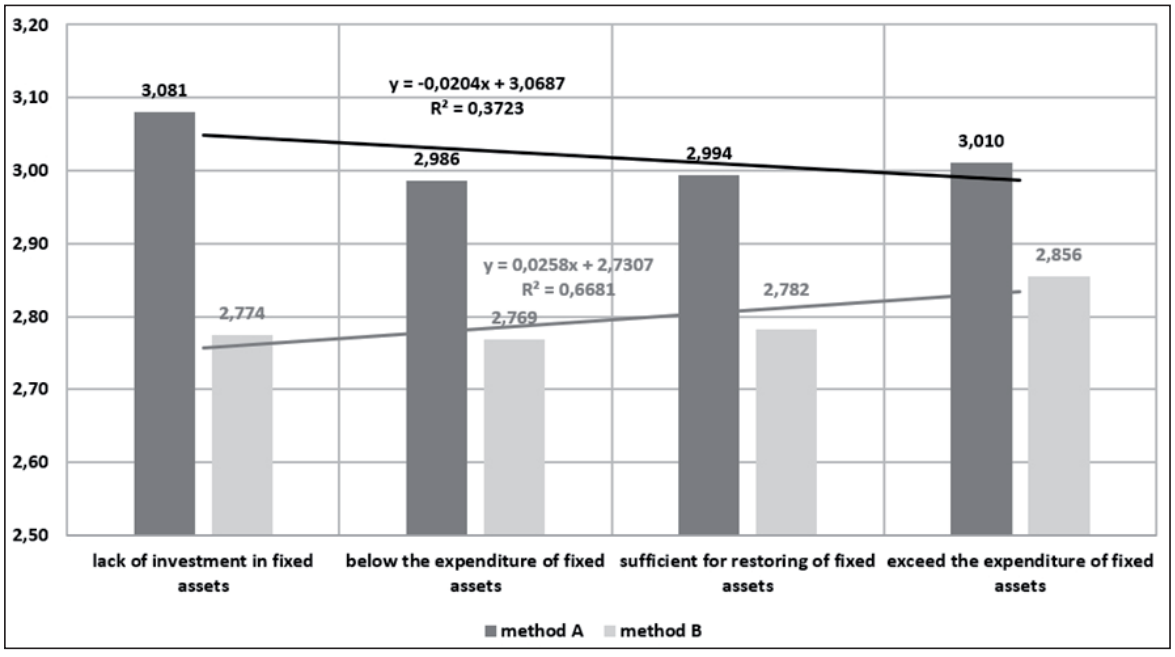

Figure 3. Average LAI values in groups of investment level in polish agri-food companies
Rysunek 3. Średnie wartości WZL w grupach poziomu inwestycji w polskich przedsiębiorstwach rolno-spożywczych

Source: own study.

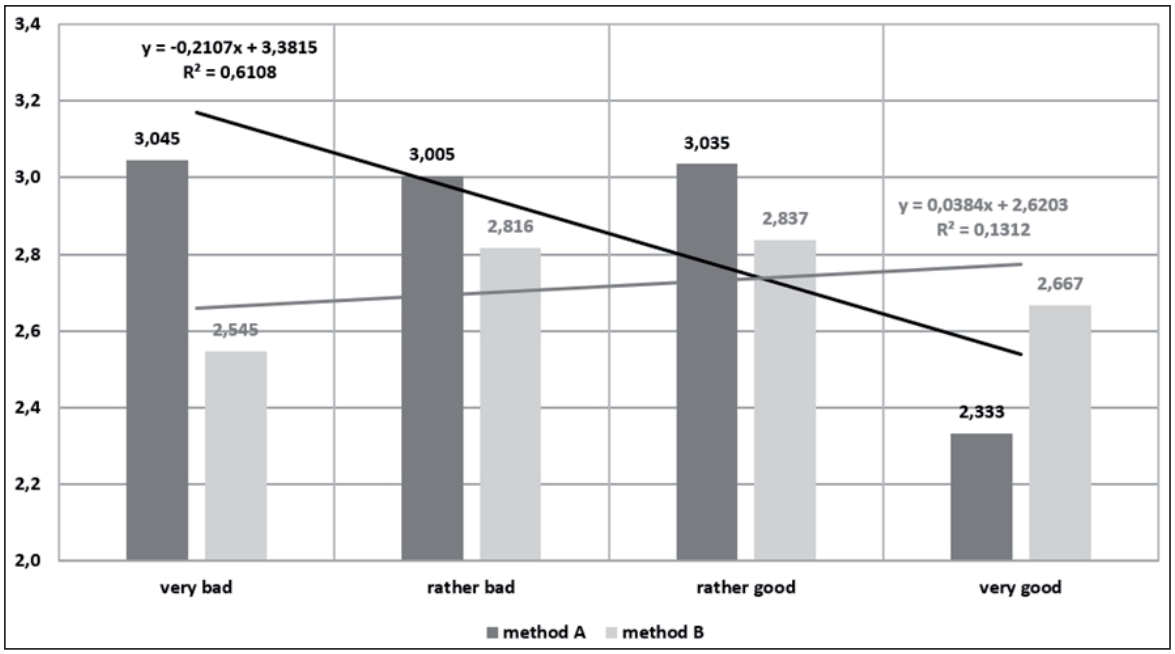

Figure 4. Average LAI values in groups of financial situation level in polish agri-food companies
Rysunek 4. Średnie wartości WZL w grupach poziomu sytuacji finansowej w polskich przedsiębiorstwach rolno-spożywczych

Source: own study.

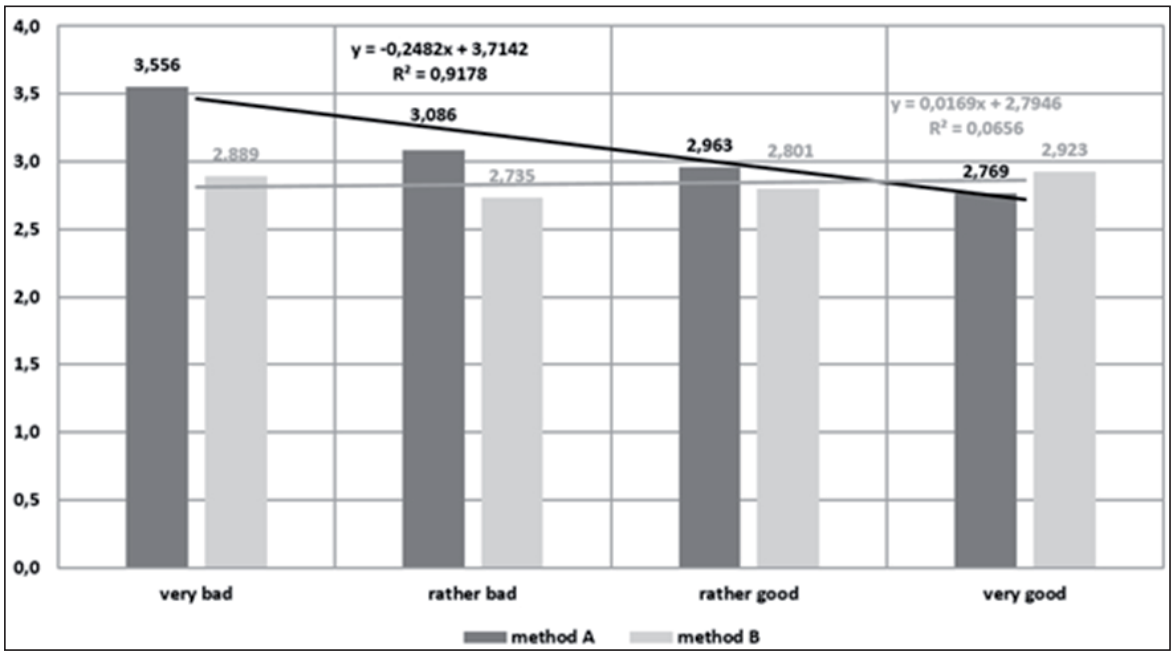

Figure 5. Average LAI values in groups of market position level in polish agri-food companies
Rysunek 5. Średnie wartości LAI w grupach poziomu pozycji rynkowej w polskich przedsiębiorstwach rolno-spożywczych

Source: own study.

In light of the results obtained so far, quite surprising results were obtained by using the chi-square test to identify the relationship between the average LAI value and the studied characteristics of food enterprises. The results for the results of categorization obtained using method A are shown in Table 3, and with using method B in Table 4.

Table 3. Chi-square independence test results for method A
Tabela 3. Wyniki testu niezależności chi-kwadrat dla metody A

Characteristics of enterprises	χ^2	$\chi^2_{\alpha,df}$	*p*-value	T_{xy}	V_{xy}
Employment size	9.36	21.03	0.67	0.073	0.078
Investments scale	11.76	21.03	0.46	0.086	0.092
Financial situation	10.20	21.03	0.59	0.077	0.083
Postion on market	10.68	21.03	0.56	0.079	0.085

Source: own study.

Table 4. Chi-square independence test results for method B
Tabela 4. Wyniki testu niezależności chi-kwadrat dla metody B

Characteristics of enterprises	χ^2	$\chi^2_{\alpha,df}$	*p*-value	T_{xy}	V_{xy}
Employment size	11.07	21.03	0.52	0.079	0.085
Investments scale	3.37	21.03	0.89	0.046	0.049
Financial situation	0.43	21.03	0.98	0.016	0.017
Postion on market	8.03	21.03	0.78	0.068	0.074

Source: own study.

According to the results obtained, presented in Tables 3 and 4, no correlation was found between the level of advancement of logistics solutions and systems and employment, the scale of investment, financial situation and market position of the surveyed food enterprises. Additional confirmation of this fact was the extremely low values of the V-Cramer and T-Czuprow convergence indicators, whose values for any dependence and for both methods A and B did not exceed 0.1 (on a scale from 0 to 1).

Summary

The results obtained during the tests are very divergent. Trend analysis using method A of the categorization of LAI index values clearly indicates the occurrence of the Solow productivity paradox. According to the author's previous research in this subject area, the understanding of the Solow paradox should be extended from the traditional area of ICT technologies also to technologies, solutions and logistics systems. This is primarily the result of high synergies between ICT technologies and modern logistics systems known today as e-logistics [Jałowiecki 2018]. In turn, trend analysis using categorization using method B indicates the absence of this paradox in relation to all the characteristics studied, and in the case of employment and investment scale it even indicates a clear positive correlation of these characteristics with the level of advancement of logistics solutions

and systems. Finally, as a result of using the χ^2 test of independence, no relationship was found between studied characteristics of agri-food enterprises.

The resulting large discrepancy in results appears to correspond at least in part to one of the most frequently raised reasons for the Solow productivity paradox, using traditional measurement methods that do not take into account many of the intangible aspects of acquiring and implementing ICT, and logistics. First of all, making accurate measurements of the value of investments in information and communication technologies and logistics closely related to them, as well as capital associated with these technologies is very difficult because ICT price indicators take into account only their quantitative changes, but virtually completely omit qualitative changes resulting from the introduction of increasingly modern technology generations.

In general, it should be emphasized that investments in modern ICT technologies primarily create intangible assets that are not in any way taken into account when measuring productivity increases by traditional methods. Such values should undoubtedly include brand value, image, reputation, company reputation, which significantly affect its market position, or intellectual capital (know-how, patents, inventions, future technologies, research and development results), of which measurable the benefits appear in the long term. The implementation of ICT solutions is usually accompanied by complementary investments, especially in the field of organizational and often structural changes in enterprises. This creates a kind of organizational capital, often treated as one of the components of intellectual capital. Although it should undoubtedly be included in assets, it is usually extremely difficult or impossible to estimate its value using commonly used accounting techniques. Finally, all types of statistics do not take into account the so-called "Consumer surplus", i.e. greater utility for consumers who can more effectively use the producers' offer. This usefulness is obtained as a result of supporting the possibility of getting acquainted with the range of products and handling transactions by implemented ICT technologies. This type of intangible benefit on the part of the consumer is not only difficult to estimate, in traditional methods of measuring economic growth, the "consumer surplus" is not taken into account at all [Brynjolfsson 1993, Brynjolfsson and Saunders 2010].

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Correspondence address:

Piotr Jałowiecki, PhD, Eng
(https://orcid.org/0000-0002-3610-2151)
Warsaw University of Life Sciences in Warsaw – SGGW
Management Institute
Nowoursynowska St. 166, 02-787 Warsaw, Poland
e-mail: piotr_jalowiecki@sggw.pl

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Agnieszka Tłuczak
Opole University

Application of the fuzzy TOPSIS method in management of food supply chain

Zastosowanie rozmytej metody TOPSIS w zarządzaniu łańcuchem dostaw żywności

Abstract. This paper presents a multi-criteria decision-making method: the fuzzy TOPSIS method. This approach is an alternative for AHP, TOPSIS, ELECTRE or PROMETHEE methods. The paper presents the possibility of using the fuzzy TOPSIS method in food supply chain management (SCM). For this purpose, a brief review of the literature is shown. Then the fuzzy TOPSIS method is presented. At the end of the article, a simple problem is shown.

Key words: food supply chain, fuzzy TOPSIS method, management

Synopsis. W pracy przedstawiono wielokryterialną metodę podejmowania decyzji: rozmytą metodę TOPSIS. Jest to alternatywa dla metod AHP, TOPSIS, ELECTRE lub PROMETHEE. W pracy przedstawiono możliwość zastosowania rozmytej metody TOPSIS w zarządzaniu łańcuchem dostaw żywności (FSCM). W tym celu przedstawiono krótki przegląd literatury. Następnie przedstawiono rozmytą metodę TOPSIS, na końcu artykułu pokazano możliwość zastosowania metody do rozwiązania problemu.

Słowa kluczowe: łańcuch dostaw żywności, rozmyta metoda TOPSIS, zarządzanie

Introduction

The agri-food supply chain (ASC) concept was first proposed by scholars in the agricultural economics and management discipline [Salin 1998, Mardsen et al. 2000]. The commonly used terms to describe this idea include agricultural supply chain, agricultural value chain, food supply chain, and food value chain. The food supply chain is composed of a wide diversity of products and companies which operate in different markets and sell a variety of food products. It combines activities whose primary purpose is to ensure buyer satisfaction and profit to enterprises participating in the flow of products and services from the sphere of primary agricultural production (farmer) to the consumer (Fig. 1). All sectors, which belongs and create the food supply chain, are important from the economically point of view. There is many interactions between this sectors, purchasers and suppliers appear in every link in the food supply chain [Bukeviciute et al. 2009].

The diversity of the modern food supply chain and its ever-changing dynamics creates many challenges for the food industry. Agri-food supply chain management (ASCM) was first defined by a group of Dutch scholars, mainly from Wageningen University, The Netherlands, whose studies were published as monographs and in journals. ASCM refers to the management of the relationship(s) among the raw material supply for agricultural production, production processing, and product logistics and distribution [Hobbs and Young 2000, Van der Vorst 2000, Apaiah and Hendrix 2005, Taylor and Fearne 2006, Van der Vorst et al. 2007, Ahumada and Villalobos 2009].

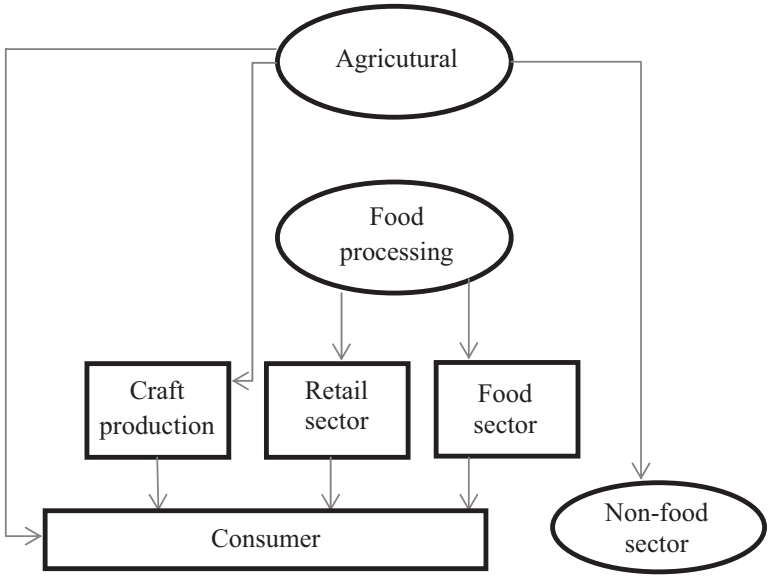

Figure 1. Schematic representation of the food supply chain
Rysunek 1. Schemat łańcucha dostaw żywności
Source: [Bukeviciute et al. 2009].

There is many methods supporting decision making in the field of efficiently management of food supply chain. To the group of decision support methods can be included multi-criteria decision making methods. These methods are used to support the decision-making process in situations where the choice is made between many variants. It is important, however, to properly select assessment criteria and to correctly assign weights. This means that depending on the issue, the criteria should reflect various aspects such as costs, time, requirements of the close and distant environment, implementation possibilities and others [Kukułka and Wirkus 2017]. In literature, the most frequently raised problems are those regarding location selection [Chu 2002, Martin et al. 2003, Farahani and Asgari 2007, Ertgrul et al. 2008; Tabari et al. 2008, Tzukaya et al. 2008, Avashti et al. 2011], choice of supplier [Chan and Kumar 2007; Onut et al. 2009], choice of strategy [Poh and Ang 1999, Wey and Wu 2007] or performance assessment (utility) [Chamodrakas et al. 2009, Bojkovic et al. 2010, Kannan et al. 2013]. The most commonly used methods to solve these problems are primarily: Analytic Hierarchy Process (AHP) [Poh and Ang 1999, Ertgrul et al. 2008], fuzzy AHP (fAHP) [Chan and Kumar 2007, Tabari et al. 2008], Analytic Network Process (ANP) [Wey

and Wu 2007, Tzukaya et al. 2008], fuzzy ANP (fANP) [Onut et al. 2009], Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) [Farahani and Asgari 2007], fuzzy TOPSIS (fTOPSIS) [Ertgrul et al. 2008, Chamodrakas et al. 2009, Onut et al. 2009 Kannan et al. 2013], ELimination and Choice Expressing REality (ELECTRE) [Bojkovic et al. 2010] and fuzzy Preference Ranking Organization Method for Enrichment Evaluations (fPROMETHEE) [Martin et al. 2003]. In the Polish literature on the subject, a description of multi-criteria methods and their application can be found in the work Sałabun [2015], Żak [2005], Żak and Sawicki [2000], Roszkowska [2009], Rudnik and Kacprzeak [2017].

Methodology

The TOPSIS method (Technique for Order Preference using Similarity to Ideal Solution) is a useful tool that is used to rank variants (alternatives, criteria) during the decision making process. The factor that distinguishes this method is the use of a measure of relative distance to the best solution, which is a model (ideal) and the worst solution, which is anti-ideal [Ertuđrul and Karakaṭođlu, 2008]. This method was extended by Chen in 2000 to fuzzy environments, which used a fuzzy linguistic value as a substitute for the directly given crisp value in the grade assessment. This method is used, among others, for the choice of supplier [Furnell 2001, Boran et al. 2008, Gupta and Gupta 2012], selection of projects and risk assessment [Boran et al. 2008], evaluation of websites [Kabir and Hasin 2013], selection of the object [Ertuđrul and Karakaṭođlu 2008], etc. It is also possible to find hybrid approaches. In 2012 Tansel proposed an integration of the Fuzzy TOPSIS method of linear programming for credit risk assessment [Tansel 2012]. Sun [2010] and others [Wang et al. 2009, Łuczak and Wysocki 2013] propose creating decision models and rankings based on integration of Fuzzy AHP and Fuzzy TOPSIS methods [Kauf and Tłuczak 2018].

In fuzzy TOPSIS method the decision matrix is defined by triangular fuzzy numbers. Decision matrix is made by fuzzy assessment of decision variants due to further criteria's. This assessments are given by formula [Boran et al. 2008, Kauf and Tłuczak 2018]:

$$\widetilde{f}_k(a^j) = (l_{jk}; m_{jk}; u_{jk})$$

and this are triangular positive fuzzy numbers where:
l_{jk} – pessimistic assessment of j-th variant based on the k-th criterion;
m_{jk} – most expected assessment of j-th variant based on the k-th criterion;
u_{jk} – optimistic assessment of j-th variant based on the k-th criterion;
$l_{jk} \geq 0$;
$m_{jk} \geq 0$;
$u_{jk} \geq 0$.

In the process of management of food supply chain, the following stages of calculation can be distinguished on the Fuzzy TOPSIS method [Boran et al. 2008, Ertuđrul and Karakaṭođlu 2008, Wang et al. 2009, Sun 2010, Łuczak et al. 2012, Wysocki 2013]:
1. Normalization of the fuzzy decision matrix $\widetilde{N} = \left[\tilde{z}_{jk}\right]$ where:

$$\tilde{z}_{jk} = \left(\frac{l_{jk}}{\max\limits_{j} u_{jk}}; \frac{m_{jk}}{\max\limits_{j} u_{jk}}; \frac{u_{jk}}{\max\limits_{j} u_{jk}} \right)$$

– benefit criteria;

$$\tilde{z}_{jk} = \left(\frac{\min\limits_{j} u_{jk}}{l_{jk}}; \frac{\min\limits_{j} u_{jk}}{m_{jk}}; \frac{\min\limits_{j} u_{jk}}{u_{jk}} \right)$$

– cost criteria.

2. Calculate the weighted normalized fuzzy decision matrix:

$$\widetilde{V} = \left[\tilde{r}_{jk} \right]$$

where:

$$\tilde{r}_{jk} = w_j \tilde{z}_{jk}$$

for $j = 1, \ldots, m$ and $k = 1, \ldots, n$, and $\sum_{k=1}^{n} w_k = 1$.

3. Identify the fuzzy positive ideal solution (FPIS)

$$\left(f_k(\tilde{a}^+) = \tilde{v}_k^+ = \max \tilde{r}_{jk} \right)$$

and fuzzy negative ideal solution (FNIS)

$$\left(f_k(\tilde{a}^-) = \tilde{v}_k^- = \min \tilde{r}_{jk} \right)$$

$j = 1, \ldots, m$ and $k = 1, \ldots, n$.

4. Calculate the distance of each alternative from ideal and negative ideal:

$$d_j^+ = \sum_{k=1}^{n} d\left(\tilde{r}_{jk}, \tilde{v}_k^+ \right)$$

and

$$d_j^- = \sum_{k=1}^{n} d\left(\tilde{r}_{jk}, \tilde{v}_k^- \right)$$

$j = 1, \ldots, m$ and $k = 1, \ldots, n$.

5. The closeness coefficient S_j represents the distances to fuzzy positive ideal solution and the fuzzy negative ideal solution:

$$s_j = \frac{d_j^-}{d_j^+ + d_j^-}$$

for $j = 1, \ldots, m$.

6. The alternative with highest closeness coefficient represents the best alternative and is closest to the Fuzzy Positive Ideal Solution and farthest from Fuzzy Negative Ideal Solution.

Example of use the fuzzy TOPSIS method

A discrete problem of multi-criteria decision making is considered. The decision problem is: how to choose a contractor/supplier which will deliver agricultural products to the processing plant. The three criteria which represents the possibility of risk: f_1 – cost / / price, f_2 – quality, f_3 – flexibility. And six of contractor will be assessed due to these criteria.

The profitable criteria will be considered, and each of them will be defined by a triangular fuzzy number. Assessment of decision variants against the criteria forming the decision making matrix is provided by the Table 1.

The next stage involves steps as outlined in section 2. Construct a normalized fuzzy decision matrix as shown in Table 2. The step of data normalization is necessary to overcome differences between the units. Normalization also enables valuation measure in the same range of values which is usually between zero and one. In the range system, 1 represents the highest value in upward movement where 0 represents the lowest value.

The next step is constructing a weighted normalized fuzzy decision matrix. For this purpose, the weight vector was as follow (0.45, 0.2, 0.35). To get multi criteria index, data from each of the criteria need to be aggregated. A lot of various methods can be implemented to do this. It this paper weighted mean was used, which can be calculated in two ways: by using arithmetic and geometric mean. Index based on arithmetic mean is generally more popular because of easily understood and implemented.

The next step is to get the fuzzy positive ideal solutions (FPIS) and fuzzy negative ideal solutions (FNIS). After getting the ideal solutions, the next step is to calculate the distance of the alternatives from (FPIS) and (FNIS) using equation (8) and (9), respectively (tab. 4). The last step was to find the closeness coefficient of each alternative, which is calculated according to formula (10): $a_1 = 0.46$, $a_2 = 0.45$, $a_3 = 0.71$, $a_4 = 0.48$, $a_5 = 0.40$, $a_6 = 0.53$.

Table 1. Fuzzy decision matrix

Tabela 1. Macierz wariantów decyzyjnych

			Offer of a logistics operator					
			a_1	a_2	a_3	a_4	a_5	a_6
criteria	f_1	l	2	3	5	1	1	5
		m	4	5	9	2	2	9
		u	6	7	11	7	5	10
	f_2	l	3	2	1	4	1	3
		m	5	3	3	6	5	5
		u	7	5	4	9	5	6
	f_3	*l*	5	4	4	3	5	2
		m	7	7	5	7	9	3
		u	9	9	12	10	12	4

Source: own study.

Table 2. Fuzzy normalized decision matrix for the selection

Tabela 2. Znormalizowana macierz rozmyta

			Offer of a logistics operator					
			a_1	a_2	a_3	a_4	a_5	a_6
criteria	f_1	l	0.18	0.27	0.45	0.09	0.09	0.45
		m	0.36	0.45	0.82	0.18	0.18	0.82
		u	0.55	0.64	1	0.64	0.45	0.91
	f_2	l	0.33	0.22	0.11	0.44	0.11	0.33
		m	0.56	0.33	0.33	0.67	0.56	0.56
		u	0.78	0.56	0.44	1	0.56	0.67
	f_3	l	0.42	0.33	0.33	0.25	0.42	0.17
		m	0.58	0.58	0.42	0.58	0.75	0.25
		u	0.75	0.75	1	0.83	1	0.33

Source: own study.

Based on table 6, it can be seen that the coefficients of the third alternative is the highest value followed by first and the fifth. Based on the coefficients, an alternative to selecting the firms listed on third should be the first choice, followed by selecting the firms listed first and the last one is to select a firm on the sixth.

Table 3. Weighted normalized fuzzy decision matrix
Tabela 3. Ważona znormalizowana rozmyta macierz decyzyjna

			Offer of a logistics operator					
			a_1	a_2	a_3	a_4	a_5	a_6
criteria	f_1	l	0.08	0.12	0.2	0.04	0.04	0.2
		m	0.16	0.2	0.37	0.08	0.08	0.37
		u	0.25	0.29	0.45	0.29	0.2	0.41
	f_2	l	0.07	0.04	0.02	0.09	0.02	0.07
		m	0.11	0.07	0.07	0.13	0.11	0.11
		u	0.16	0.11	0.09	0.2	0.11	0.13
	f_3	l	0.15	0.12	0.12	0.09	0.15	0.06
		m	0.2	0.2	0.15	0.2	0.26	0.09
		u	0.26	0.26	0.35	0.29	0.35	0.12

Source: own study.

In essence, the greater the value of the coefficient indicates the priorities of the decision to be made. This method not only allows the decision maker to provide the rank of each alternative, but also shows the degree of likelihood of alternative selection.

Table 4. Fuzzy positive ideal solutions (FPIS) and fuzzy negative ideal solutions (FNIS)
Tabela 4. Rozmyte pozytywne idealne rozwiązania (FPIS) i rozmyte negatywne idealne rozwiązania (FNIS)

	Criteria								
	f_1			f_2			f_3		
	l	*m*	*u*	*l*	*m*	*u*	*l*	*m*	*u*
FPS	0.20	0.37	0.45	0.09	0.13	0.20	0.15	0.26	0.35
FNS	0.04	0.08	0.20	0.02	0.07	0.09	0.06	0.09	0.12

Source: own study.

Summary

Supplier assessment is an extremely important issue for the effectiveness and efficiency of every enterprise. In the area of enterprise supply logistics it takes place twice: in the supplier selection phase (before cooperation with him) and in the phase (during) the cooperation itself. A very important element of functioning of food supply chain is its efficient management of entities operating in it. The right choice of agricultural product supplier can minimize the risk of incurring losses due to the short shelf life of these

products. Multi-criteria decision-making methods can be helpful in choosing a supplier. Their scope of application in logistics and supply chain management is very wide.

The presented fuzzy TOPSIS method has a number of advantages and disadvantages that allow it to be used in logistics and supply chain management issues. The identified problem is unfortunately not immune to the rank reversal phenomenon. In this method expert decides about the weighting for individual criteria. The subject of the analysis was potential offers of suppliers evaluated in terms of the occurrence of risk in the implementation of projects.

The choice of supplier is often a strategic decision for the company, and especially applies to suppliers of the most important supply goods with whom long-term contracts are signed. This choice should take into account all the benefits and losses that the company incurs in connection with this choice, and not just one element (e.g. price).

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Correspondence address:

Agnieszka Tłuczak, PhD, Eng
(https://orcid.org/0000-0001-6217-8822)
Opole University
Faculty of Economics
Ozimska St. 46a, 45-058 Opole, Poland
e-mail: atluczak@uni.opole.pl

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Katarzyna Łukasiewicz
Warsaw University of Life Sciences – SGGW

Digital competences in supply chain management

Kompetencje cyfrowe w zarządzaniu łańcuchem dostaw

Abstract. The article discusses digital competences in general and their importance in supply chain management in the context of a changing, modern world. Attention was drawn to the fact that digital competences can be the key to success for an organization if used properly or they can only be an element of adaptation to changing conditions. Skills dedicated years ago to a narrow group of specialists are now available to millions of people around the world. Nowadays, we can deal with more and more issues using only the electronic way, whether we are willing to use this solution. In logistics, we can specify many technologies that can help to increase company efficiency and to build a competitive advantage. This situation confirms the importance of the described issue.

Key words: digital competences, supply chain, management, organization

Synopsis. W artykule omówiono kompetencje cyfrowe w ujęciu ogólnym oraz ich znaczenie w zarządzaniu łańcuchem dostaw w kontekście zmieniającego się nowoczesnego świata. Zwrócono uwagę na fakt, iż kompetencje cyfrowe mogą być dla organizacji kluczem do sukcesu, jeśli są odpowiednio wykorzystywane, albo też mogą stanowić jedynie element dostosowania się do zmieniających się warunków. Umiejętności przed laty dedykowane wąskiej grupie specjalistów dziś są dostępne dla milionów ludzi na świecie. W obecnych czasach coraz więcej spraw możemy załatwić, wykorzystując drogę jedynie elektroniczną. W logistyce możemy określić wiele technologii, które mogą przyczynić się do podniesienia efektywności firmy i mogą pomóc budować przewagę konkurencyjną. Taka sytuacja potwierdza ważność opisywanego zagadnienia.

Słowa kluczowe: kompetencje cyfrowe, łańcuch dostaw, zarządzanie, organizacja

Introduction

The development of digital competences is important not only because of the requirement of the times we live in. It is even a necessity resulting from the functioning of the individual in society. We will use digital competences because it will make our lives easier, which can be seen through the possibilities of shopping online, organizing meetings and making contacts, acquiring knowledge or even doing work.

The aim of the article is to present the issues of digital competences used in organizations, with particular emphasis on small and medium-sized enterprises. Particular attention was paid to assessing the level of digitization of the Polish economy and society compared to EU countries using the Digital Economy and Society Index (DESI), which presents a set of specific factors: connectivity, infrastructure level, human capital and its skills, the degree of Internet use, possibilities and scope of implementing digital technologies as well as popular and well-known digital public services. The study also indicates the importance of this issue of using digital competences in supply chain management in logistics. Data were presented using tables and drawings. The research method used in the study is a critical presentation of the literature on the subject, analysis of the data contained in the available reports. A review of the literature and analyzed data indicate that digital technologies play a very important role in the development of companies. „Digital technologies revolutionizing the way of doing business. Their implementation allows companies to expand their operating coverage, enables better management of relationships inside and outside the company, facilitates access to information and data processing and helps to use resources more efficiently (...)". The ability to use the potential of digital technologies – the competences of enterprises and people – becomes thereby a source of competitive advantage for companies and economies [Śledziewska and Włoch 2015].

The essence of digital competences

Before we explain the concept of digital competences, we must explain what competences are. According to Król [2006], these are predispositions in the field of knowledge, skills and attitudes ensuring the implementation of professional tasks at an effective and / or distinguishing level, in accordance with the standards set by the organization for a given position. According to Rostkowski [2004a], these are all employee qualities that, when challenged and developed in the work process, lead to results consistent with the company's strategic goals.

Digital competences are defined in the literature in various ways. For the purposes of the study it is assumed that they mean a harmonious set of knowledge, skills and attitudes that allow for the effective use of digital technologies in various areas of life [Analysis… 2014]. Digital competences are included in broadly understood competences in the area of ICT (Information and Communications Technology), including IT (Information Technology) and IS (Information Systems).

We treat competence as the ability to use a medium to support an area that the entity considers important or that takes a long time (i.e. is indicated by the individual as an important area of his life) [Filiciak et al. 2013].

Digital competences can be considered at two levels: individual and organizational. Individual competences, understood in general, are most often defined as a combination of three elements: knowledge, skills and attitudes [European… 2008, Jasiewicz et al. 2019]. Having specific knowledge means acquiring information through learning facts, theory and practice (I know), skills are the ability to use knowledge to perform a specific task (I can), and attitudes give incentives to act (I want and I am ready). According to the Digital Information Society in Figures report [Ministry of… 2014], we define digital competences as a set of information competences covering information retrieval skills,

understanding it, as well as assessing its credibility and usefulness, as well as IT competences, which include the ability to use a computer and other electronic devices, use of Internet and the use of various types of applications and software, as well as creating digital content. Referring to the findings of the European Parliament and the Council [European Parliament… 2006] in relation to the determination of key competences in the process of lifelong learning, IT competences are one of the many key competences listed above that can guarantee the greater flexibility of the workforce, enabling it to adapt faster to changes. These are also important factors affecting innovation, competitiveness, motivation and job satisfaction, and thus the quality of work. Digital competences include the proper and critical use of information society technologies, and thus basic skills of ICT information and communication technologies [Śledziewska 2015].

Employee competences are the most valuable capital that an enterprise has. The task of personnel processes today is not only to acquire, assess and plan employee development, but above all to adapt their competences to the needs of the company and to use them in accordance with these needs [Rostkowski 2004b]. In literature, a lot of space is devoted to the study of digital (computer, media) competences among young people [ICILS 2013]. One can also find publications on gaps in the digital society [Żak 2013].

When defining competencies at the organizational level (including digital competences), we can refer to the resource theory of the enterprise, according to which organizations compete and create value using resources [Conner 1991]. Defining competences also includes the concept of so-called key competences [Hamel and Prahalad 1990], i.e. those that allow a company to gain and develop a competitive advantage. What does digital competence mean? This issue can be considered in two approaches: catalogue and relational [Analysis… 2014].

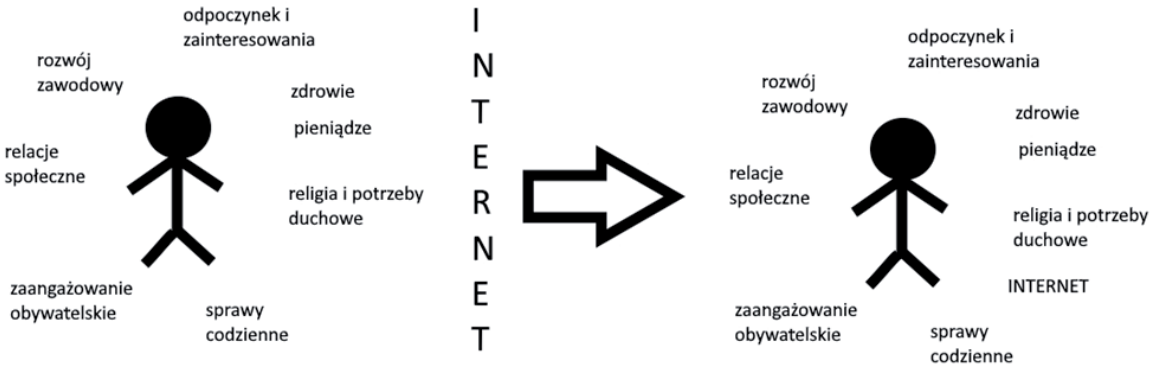

Figure 1. Nonrelational and relational digital competence model
Rysunek 1 Nierelacyjny i relacyjny model kompetencji cyfrowych
Source: [Analysis… 2014].

In terms of catalogue approach, we can interpret digital competences as certain defined elements that are acquired through education and used in life as needed. On the other hand, competence in the relational system assumes that information technologies are not so much an area as a dimension of human functioning. These two approaches are presented on Figure 2 [Analysis… 2014].

The essence of supply chain management

The supply chain is a network of organizations involved through relationships with suppliers and customers in various processes and activities that create value in the form of products and services delivered to final consumers [Christopher 1998].

Supply chain management is the management of relations with suppliers and customers and buyers in order to provide the highest value to the customer at lower costs for the entire supply chain [Christopher 1998].

In order to indicate the importance of supply chain management, in which the final recipient is at the end and who is interested in the efficient functioning of logistics processes, it is worth clearly stating that such action should be thought out and focused on effective building of competitive advantage.

The functioning of logistics and the supply chain is not possible without technology. Among the most important technological factors in logistics and the supply chain, the following should be certainly mentioned [Marzantowicz 2019]: computerization, digitization, automation, robotization, virtualization. The first element belongs to those of fundamental importance, from which technological changes begin, and the remaining ones are those that may cause management to be ineffective or less effective.

In the process of supply chain management, it is important to skilfully adapt to technological changes or even the ability to create, apply and develop them. This requires appropriate managerial competence. In view of the requirement of advanced technological changes, i.e. automation or robotization, it becomes a basic competence need to combine technical skills with the so-called soft competences, such as the ability to adapt processes to the requirements of market changes and own changes [Marzantowicz 2019].

Digitization will be the dominant trend on the TSL market (transport, forwarding, logistics) in the future. As the logistics chain is changing as a result of the increasing use of internet commerce and intermediary platforms, the individual customer and his needs are in the focus of logistics companies. This change increases the possibility of new entities entering the market with competences expected by clients and also requires increasing the level of transparency of the entire supply chain and reacting to real-time deviations. Digitization is mentioned by most companies as both an opportunity and a threat. First of all, it means larger investments in data collection, analysis and management systems (Big Data), process automation (robotization) or transferring most of the activities to the cloud for easy access from anywhere [Fechner and Szyszka 2018].

Digital competence in Poland according to the Digital Economy and Society Index (DESI) ranking

Modern digital technologies can significantly affect the business. Thanks to their use, they can expand business sizes, better acquire and manage information and take care of relationships within the company and with the environment. Therefore, the ability to use digital competences of companies and people can become a source of competitive advantage for companies.

According to the DESI index developed by the European Commission, Poland does not occupy a good position. This index makes it possible to study, each year, the level of digitization of the economies and societies of European Union member states. When it comes to the ranking, we can include the following:

– connectivity,
– human capital,
– use of internet services,
– integration of digital technology,
– digital public services.

Over the past three years, Poland is on the 25th place among EU countries. Despite the fact that the numbers are getting better and better, our position does not change. From year to year we achieve an increasing percentage of the share, but it is still not enough to change the position (Figure 2).

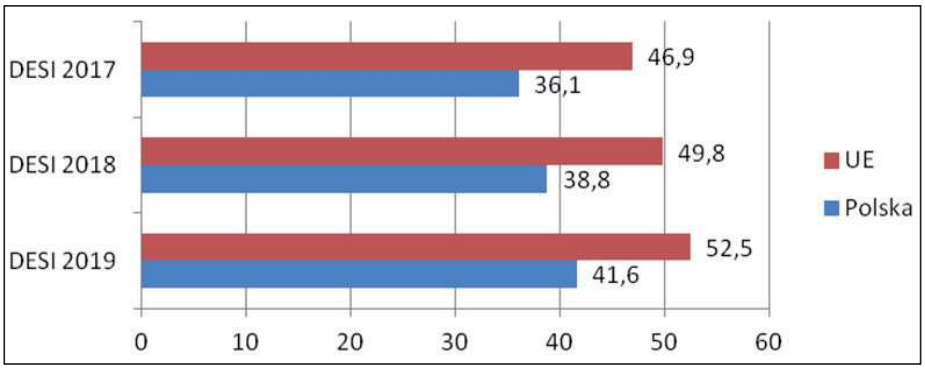

Figure 2. Ranking of the Digital Economy and Society Index
Rysunek 2. Ranking Indeksu Gospodarki Cyfrowej i Społeczeństwa
Source: [The Digital Economy… 2019].

In the further part of the study, all components of the previously mentioned ranking were thoroughly analyzed. As far as the first parameter is concerned - namely connectivity - we see diversity (Figure 3). Our position changes every year: from 43.5% in 2017 to 51.9% in 2019. However, we are still far from the parameters obtained by EU countries (by about 7% in 2019).

Table 1 presents the list of elements constituting the category of connectivity. From the components presented, it can be seen that we achieved the highest scores in the category of using mobile broadband services: from 115 in 2017 to 163 in 2019 (which gives an increase of 41.7%). As part of this element, we surpass EU countries. Also, when it comes to 4G coverage (93%) we are very close to EU results (94%). Poland's disadvantage is the coverage of fixed broadband (79% compared to 97% for the EU). According to the National Broadband Plan [2020] by the end of 2020 it is planned to:

– ensuring universal access to the Internet with a speed of at least 30 Mb/s;
– lead to the use of access services with a speed of at least 100 Mb/s by 50% of households.

It can therefore be concluded that the situation in this area will improve over time.

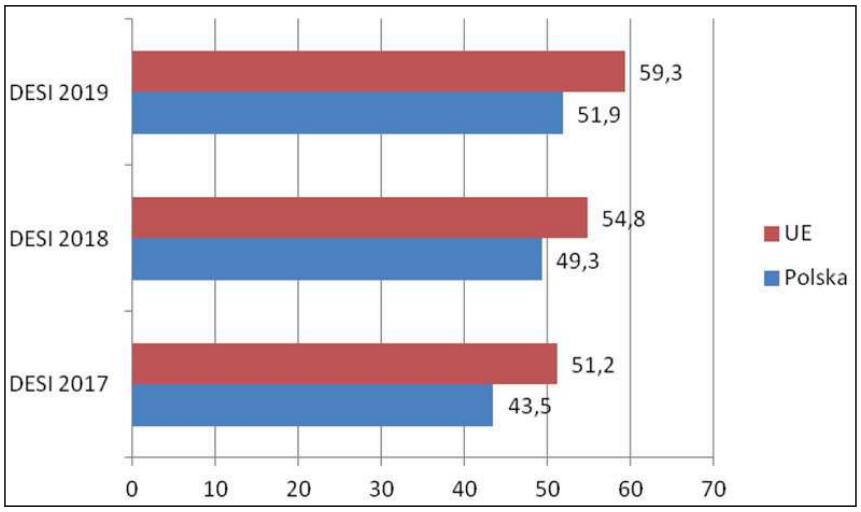

Figure 3. Connectivity in the DESI ranking
Rysunek 3. Komunikacja w rankingu DESI
Source: [The Digital Economy… 2019].

Table 1. Detailed characteristics of the connectivity category in the DESI ranking
Tabela 1. Szczegółowa charakterystyka kategorii komunikacji w rankingu DESI

Specification	Poland (%)			UE (%) 2019
	2017	2018	2019	
Fixed broadband coverage (% households)	81	81	79	97
Fixed broadband take-up (% households)	59	61	60	77
4G coverage (% households)	91	91	93	94
Mobile broadband take-up (Subscriptions per 100 people)	115	144	163	96
Fast broadband (NGA) coverage (% households)	61	65	66	83
Fast broadband take-up (% households)	26	32	36	41
Ultrafast broadband coverage (% households)	ND	49	54	60
Ultrafast broadband take-up (% households)	8	13	23	20
Broadband price index Score (0 to 100)	88	88	86	87

Source: [The Digital Economy… 2019].

The next analysed component of the ranking is human capital. The data are presented in Figure 4. We deviate significantly from the data characterizing the EU. Poland ranks 22nd.

According to the data from the ranking, the number of people using the Internet is growing, however, basic and advanced digital skills are below the EU average (Table 2). It turns out that in Poland at least basic digital skills have 46% of people, it is 4.5% more compared to 2017, and 23.9% less than in the EU. In contrast, 21% of the population has secondary digital skills, with a difference of 10.5% compared to 2017 and 47.6% compared to the EU. If companies do not hire employees with an appropriate level of digital competence, they will not implement new digital technologies. In such companies, a suf-

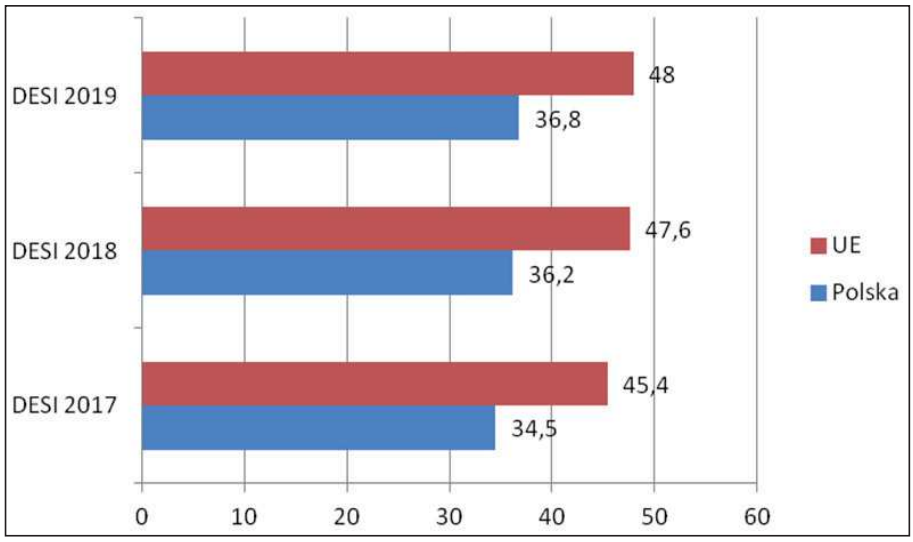

Figure 4. Human capital
Rysunek 4. Kapitał Ludzki
Source: [The Digital Economy… 2019].

ficiently high level of digital competence will not be the main required factor during the recruitment process. It may also turn out that improving qualifications in this area will not always be treated properly, i.e. that they should be constantly increased.

Table 2. Characteristics of the human capital category as part of the DESI ranking
Tabela 2. Charakterystyka kategorii kapitału ludzkiego w ramach rankingu DESI

Specification	Poland (%)			UE (%) 2019
	2017	2018	2019	
At least basic digital skills (% individuals)	44	46	46	57
Above basic digital skills (% individuals)	19	21	21	31
At least basic software skills (% individuals)	47	49	49	60
ICT specialists (% total employment)	2.6	2.7	2.8	3.7
Female ICT specialists (female employment)	0.8	0.9	0.9	1.4
ICT graduates (% graduates)	2.9	3.0	3.1	3.5

Source: [The Digital Economy… 2019].

Digital skills are part of priority axis 3 of Operational Programme Digital Poland (OP DP) for 2014–2020: "Digital competences of the society". The focus is mainly on the digital inclusion of older people, people with disabilities and people with special training needs [Index… 2019].

The next element of the ranking is presented in Figure 5, this is the use of Internet services. Poland is below the EU average, taking 24th place.

Details are presented in Table 3.

As it can be seen from the data in Table 3, Poles are active on the Internet. The most popular forms of Poles' activity are: reading news, listening to music, watching movies,

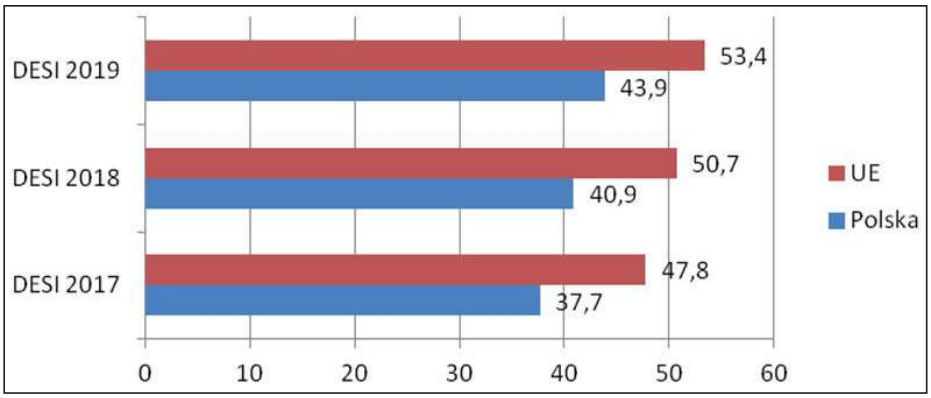

Figure 5. Position of Poland in the DESI ranking – the use of Internet services (%)
Rysunek 5. Pozycja Polski w rankingu DESI – wykorzystanie usług internetowych (%)
Source: [The Digital Economy… 2019].

Table 3. Use of Internet services
Tabela 3. Wykorzystanie usług internetowych

Specification	Poland (%)			UE (%) 2019
	2017	2018	2019	
People who never used the internet (% individuals)	22	20	18	11
Internet users (% individuals)	70	73	75	83
News (% individuals)	79	79	79	72
Music, videos and games (% internet users)	68	68	75	81
Social networks (% individuals)	60	63	64	65
Banking (% internet users)	53	52	57	64
Shopping (% internet users)	56	58	60	69
Selling online (% internet users)	21	20	18	23

Source: [The Digital Economy… 2019].

computer games and using social media. We have 18% of people who have never used the Internet (Table 3) in Poland, 18.1% less compared to 2017 and 61.1% less than EU countries. We outperform EU countries when it comes to news acquisition. Here we have 79% of people, it is more by 8.9% than in EU countries. On the Internet, we gladly use banking (57 – EU 64%) or do shopping (60% – EU 69%). The next analyzed element of the ranking is the integration of digital technology. Figure 6 shows the figures for the last 3 years. Unlike previous features, the discrepancies here are definitely bigger. In 2019, we reached the value of 24.8, which gives us 26th position, and EU countries reached the value of 41.1, which is almost twice as high.

Table 4 contains data on the detailed characteristics of digital technology integration. When it comes to details, the use of electronic information exchange is preferred by 26% of companies and it is more by 23.8% than in 2017. Its scope includes: electronic information exchange, social media, large data sets and the cloud.

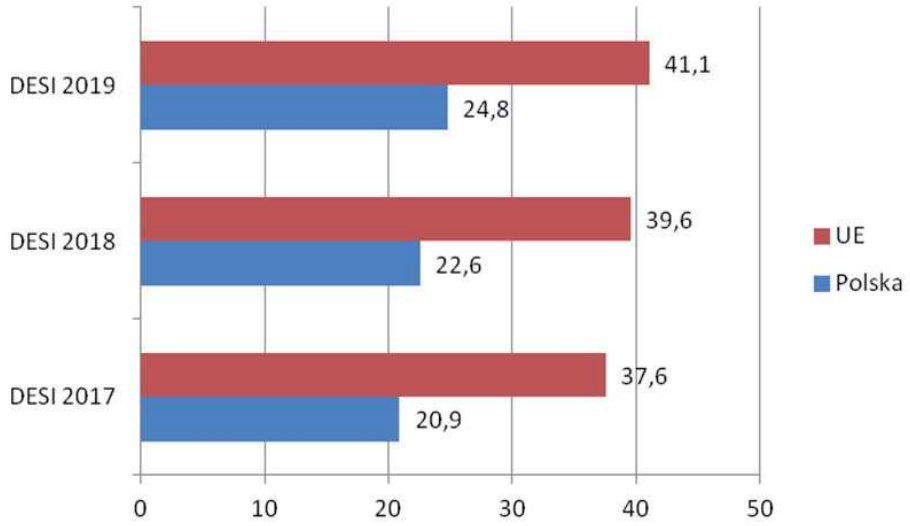

Figure 6. Integration of digital technology
Rysunek 6. Integracja technologii cyfrowych
Source: [The Digital Economy… 2019].

Table 4 Integration of digital technology
Tabela 4. Integracja technologii cyfrowych

Specification	Poland (%)			UE (%) 2019
	2017	2018	2019	
Electronic information sharing (% enterprises)	21	26	26	34
Social media (% enterprises)	9	10	10	21
Big data (% enterprises)	6	6	8	12
Cloud (% enterprises)	5	6	7	18

Source: [The Digital Economy… 2019].

There is a visible difference in relation to EU countries (a difference of 30.8%). When it comes to the use of social media by companies, here we have only 10% of companies, while in the EU the result indicates 21%, so over 100% more. Noteworthy is the use of large data sets (8% of companies) and the cloud (7% of companies). Values in EU countries are 12% and 18% respectively.

In Poland, a lot of emphasis is placed on the development of digital technologies, even as part of programs coordinated at EU level. Poland is a member of the European High-Performance Computing Joint Undertaking and as many as four of the Polish centers have been included in the list of the global top 500 HPC (ranking of 500 non-dispersed computer systems with the highest power in the world), with the highest place – 131 [Index 2019]. Cyber security is a very important issue that needs to be addressed here.

The last of the presented characteristics is digital public services. The data presented in Figure 7 indicate that in terms of this parameter we are also in a lower position than EU countries.

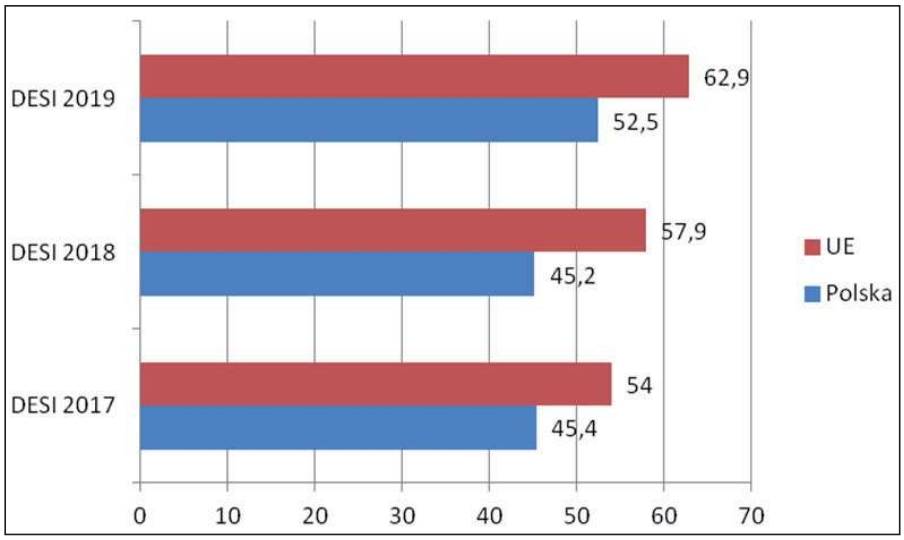

Figure 7. Digital public services
Rysunek 7. Cyfrowe usługi publiczne
Source: [The Digital Economy… 2019].

Table 5 presents the characteristics of digital public services. When it comes to public administration users, we have 49% of them, 30.6% less than in EU countries, and more by 8.8% than in 2017. The number of users increases every year what shows that these services are gaining popularity. Perhaps this proves that society is convinced to facilitate dealing with official matters.

Table 5. Characteristics of digital public services
Tabela 5. Charakterystyka cyfrowych usług publicznych

Specification	Poland (%)			UE (%) 2019
	2017	2018	2019	
e-Government users (% internet users needing to submit forms)	45	45	49	64
Online service completion Score (0 to 100)	79	81	84	87

Source: [The Digital Economy… 2019].

Easier access and more user-friendly new electronic services for citizens and businesses could lead to even greater improvements in digital public administration. It would also be worth to disseminate information about the facilities, dates or simplicity of using this type of services.

Summary

Nowadays, the best way to increase enterprise productivity and gain competitive advantage in international markets is the widespread implementation of increasingly advanced digital technologies. The use of various management methods and tools as well as techniques and technologies in connection with soft competences gives the opportunity to build flat, hierarchical management strategies which will allow at the same time to shift

the burden of responsibility for the efficiency of logistics processes from the final recipient to the entire supply chain management [Marzantowicz 2019].

Taking into consideration the analysis carried out, it is worth specifying the so-called key actions:

– conduct training in obtaining or raising digital competences pointing to the benefits of their assimilation visible in the increase in the efficiency of work performed or the growth of development potential,
– maintain progress in the digitization of public services,
– increase the availability and quality of broadband connections, while reducing the price of using the internet,
– motivate to acquire new skills, both in an organized way (training) and independently (self-study),
– ensure digital security, which means that more and more people will want to take advantage of the various amenities resulting from having digital competences.

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Correspondence addresses:

Katarzyna Łukasiewicz, PhD
(https://orcid.org/0000-0001-9715-3756)
Warsaw University of Life Sciences in Warsaw – SGGW
Management Institute
Nowoursynowska St. 166, 02-787 Warsaw, Poland
e-mail: katarzyna_lukasiewicz@sggw.pl

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***Anzhela Cherchata*[1], *Konrad Michalski*[2], *Tetiana Tarasova*[3]**
[1] SHEE "Prydniprovska State Academy of the Civil Engineering and Architecture", Ukraine
[2] Warsaw University of Life Sciences – SGGW
[3] Kharkiv State University of Food Technology and Trade, Ukraine

Integrated logistics solutions in the enterprise's development strategy

Zintegrowane rozwiązania logistyczne w strategii rozwoju przedsiębiorstwa

Abstract. The article discusses the concept of integrated logistics, which is an interconnected set of operations of the enterprise management system, providing for the balanced movement of material, information and financial flows of the company. Guided by the basic principles of integrated logistics is proposed the basic platform of the hierarchical structure of the enterprise logistics system in the form of logistics network configuration. This will allow real enterprises to build their own integrated logistics system, define their logistics mission and strategy, and identify business processes for managing resource flows. For the acceptance of the integrated logistic decisions within the limits of concrete strategic problems the simulation model of formation of economic streams of the building enterprise taking into account functioning of a set of the interconnected and interconnected streams corresponding to certain business processes is offered. The stages of logistic flows are defined, creating the basis for the formation of an integrated logistic system. A mechanism has been developed for the functioning of a construction company within the logistics system at the strategic and tactical levels of management, which makes it possible to coordinate the activities of units related to logistics activities.

Key words: business process, logistics system, logistic process, building industry

Synopsis. W artykule omówiono koncepcję zintegrowanej logistyki, która jest połączonym zestawem operacji systemu zarządzania przedsiębiorstwem, zapewniającym zrównoważony przepływ materiałów, informacji i przepływów finansowych firmy. Kierując się podstawowymi zasadami zintegrowanej logistyki, zaproponowano podstawową platformę hierarchicznej struktury systemu logistycznego przedsiębiorstwa w postaci konfiguracji sieci logistycznej. Pozwoli to prawdziwym przedsiębiorstwom zbudować własny zintegrowany system logistyczny, zdefiniować misję i strategię logistyczną oraz zidentyfikować procesy biznesowe do zarządzania przepływami zasobów. Do akceptacji zintegrowanych decyzji logistycznych w granicach konkretnych

problemów strategicznych oferowany jest model symulacyjny tworzenia strumieni ekonomicznych przedsiębiorstwa budowlanego, uwzględniający funkcjonowanie zestawu połączonych i połączonych strumieni odpowiadających niektórym procesom biznesowym. Zdefiniowano etapy przepływów logistycznych, tworząc podstawę do utworzenia zintegrowanego systemu logistycznego. Opracowano mechanizm funkcjonowania firmy budowlanej w systemie logistycznym na strategicznym i taktycznym poziomie zarządzania, który umożliwia koordynację działań jednostek związanych z działaniami logistycznymi.

Słowa kluczowe: proces biznesowy, system logistyczny, proces logistyczny, branża budowlana

Introduction

In modern conditions of market economy companies have to solve problems connected with effective material resources management. That's why the effectiveness of companies` functioning considerably depends on the integration of present management systems of delivery, manufacturing, transportation and sales processes. The concept demands new approaches to the management of the companies' business processes taking into account integration processes on the market. Integrated processes are accompanied by the development of logistics that is based on the system approach to organization and management.

Lately, many Ukrainian companies, use a system approach to business processes organization and pay considerable attention to the implementation of integrated logistics management of input and output material flow. It is mainly explained with the establishment of commodity market structure and strengthening of competition [Amitan et al., 2003]. However, not all characteristics of integration processes development are fully researched what demands the necessity of their analysis.

The purpose and the research methods

The main objective of the study is to develop the ideal image of the business process management system of a construction enterprise in the context of the implementation of the integrated logistics concept.

The example of a company from the construction industry was used and based on its system, the place of logistics in the process of achieving strategic goals was identified. Literature in the field of logistics was used, primarily authors from Ukraine and Russia, because the considerations undertaken in the study were embedded in the realities of the post-Soviet economy. The conclusions constructed at the end of the study are global, referring to all the phenomena occurring in the environment of modern enterprises, whose success is also determined by logistic excellence.

Logistics as a part of the enterprise system

The modern practice of management is characterized by an intensive transformation from the management of separate logistic functions or operations to management of the business processes that demand implementation of integrated logistics concept. Logistics

business process is an interconnected complex of operations and functions that change over resources of the company into the result according to the logistics strategy of the company [Bowersox and Closs 2008].

In the time of the Soviet Union, the companies were interdependent in the border of the unitary environment. Breakdown of the USSR led to the severance of effective inter economic ties among the companies. The modern period of the Ukrainian economy development is characterized by a high level of production separation, and lack of elements necessary for the provision of the non-stop working cycle.

Logistics business processes of the company are concentrated on the planning and coordination of material flow, purchase, production and delivery of products to consumers [Frolova 2004, Uoters 2003]. Effective management of the business processes allows to shorten stocks, provides the control over the volume of incomplete production, decreases risks, fastens material flow and capital turnover, provides coordination of material-technical resources delivery, production and technological packing with work that leads to high effectiveness of the whole production cycle [Krykavskyi and Chornopyska 2012].

It is important to work out mechanisms of informational interaction of participants in the delivery chain. Application of the mechanisms allows achieving maximum coordination of logistics operation fulfilment, providing coordination of actions of all the participants in the delivery process of the company. Such an approach can be realized on the base of integration as a union of participants in the logistics chain with the purpose of organization of balanced movement of material, informational and financial flow.

Integral logistic approach oriented on all the participants of the process consists of:

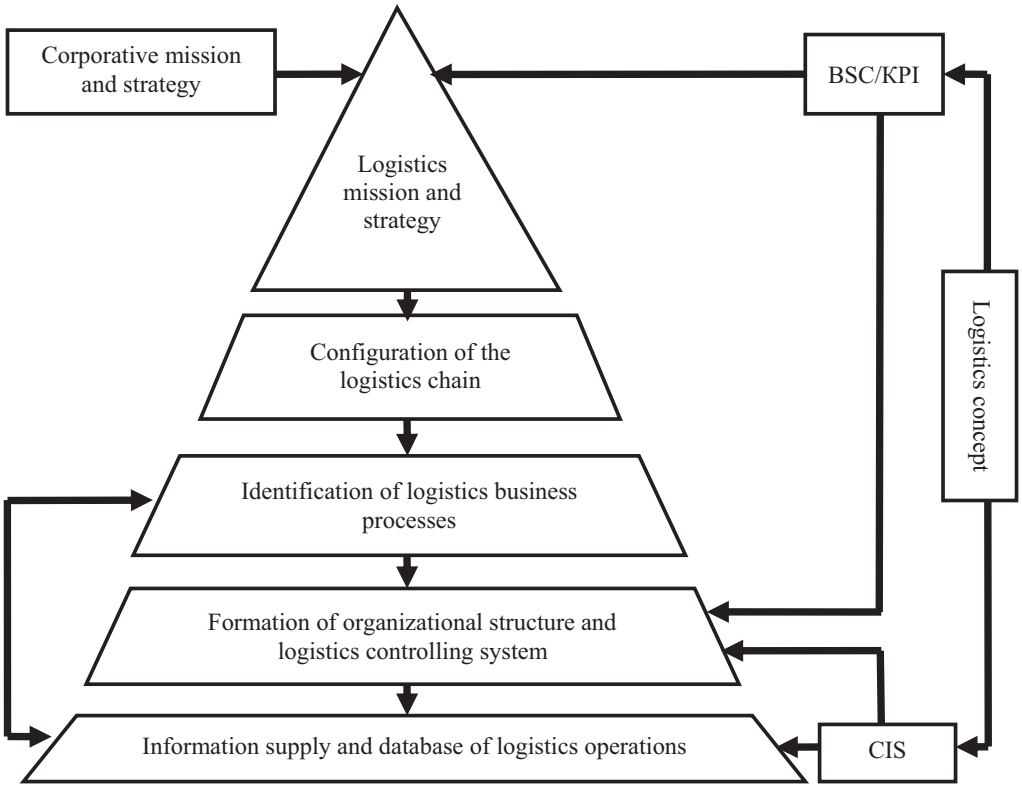
– technological processes within one department of the company,
– logistic processes among the departments within the company,
– logistic connections among the companies in the logistic chain,
– suppliers,
– consumers.

The main reasons that cause the necessity of logistic approach implementation for the strategic management of the companies are:

– integral features of logistics that unite all the participants of the regional complex: factories-suppliers of materials and products, buying, delivery, packing, transporting and other organizations,
– logistics creates the conditions for effective cooperation among all the participants of the process because it is based on the satisfaction of common economic interests of all the participants of logistics chains and systems,
– the logistical approach leads to the economical use of resources because logistics is based on the system approach to the organization of material, labour, financial and informational flows in the process [Tkachova and Zahorna 2012].

Formation of the enterprise`s logistics is described by a certain sequence (Fig. 1).

On the first stage, a corporative strategy is formulated, on its base configuration of the network is made. It determines the main business processes that initiate organizational structure of management. After that informational support, the system of indicators' control and record for the estimation of logistics effectiveness (controlling) are determined [Cherchata 2016]. The base of the hierarchic structure of the logistics system makes logistics functions and operations individual for each building company.



CIS – Corporation Information System; BSC – Balanced Scorecard; KPI – Key Performance Indicators

Figure 1. Logistics in the system of a created enterprise
Rysunek 1. Logistyka w systemie tworzonego przedsiębiorstwa
Source: own elaboration.

Process control of any object must be based on a system approach. It is necessary to consider an object or a subject matter, a methodology and method for the management process as a system.

An object of logistic management is logistic flow as a complex of material, information and financial flows. A subject is an effective organization of logistic flows based on synchronization of their interaction and synergy using [Holweg and Rich 2004]. Therefore the result of logistics usage is creating an effective logistics system where the coordinated motion of flows providing rational business-processes operating during the whole life cycle of the project is fulfilled.

The logistic system is determined as an adopted system with feedback that performs certain logistic functions, consists of several subsystems and has a connection with the external environment [Vasylevskyi et al. 2008].

Let us consider the process of forming a logistics system on the example of a construction company in the building industry. With the increasing of economic flows intensification necessity in logistics usage for the building industry is up.

Effective using of logistical approach in the construction industry is provided by the following factors:

– technological for ensuring non-stop duration of the building process, constant and full loading of manufacturing capacity.

– economical, their basis is an interdependence of financial and economic results of the activity of all the participants of the building process and their influence on the final economical results of the building process. The most important organizational and technical precondition for the formation of stable macro logistical systems in the building industry is providing effective technology of building material and products manufacturing. It means one must provide the correspondence between characteristics of material, products, constructions and their technology manufacturing, transportation and installation. The total technological flow of material resources is the sum of technology manufacturing, transport technology, installation technology, and operation technology [Popovychenko and Cherchata 2017].

The management of engineering and construction processes includes differentiation of material and connected flows on all the stages of the project life cycle within the logistic system (Fig. 2). On that figure conformity between the flows and certain business processes within the project is shown.

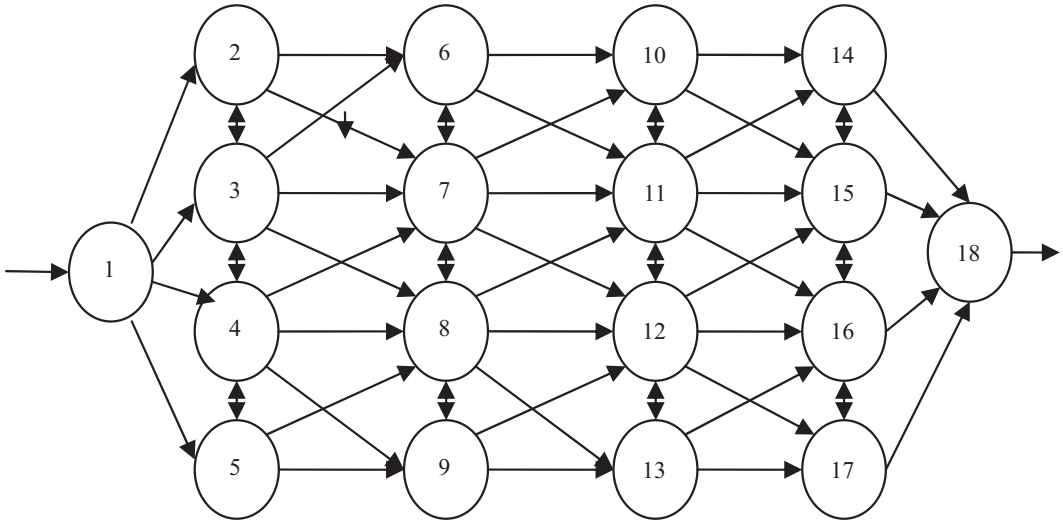


Figure 2. Formation of construction enterprise`s flows in the logistic system

Rysunek 2. Formowanie przepływów przedsiębiorstwa budowlanego w systemie logistycznym

Source: own study.

The identified symbols mean:

1. Input flow (resourcing of construction process).
2. The flow of the material resources (resourcing of construction process).
3. The flow of financial resources (financial resources management).
4. Information flow (penetrates all the business processes of a construction company).
5. The flow of labor resources (provision of human resources).
6. Purchase of material and technical resources (resourcing of the building process; equipment and material procurement for production).
7. Payment of material and labor resources as well as information (financial flows management).
8. Designing estimates (design and prospecting operations and engineering).
9. Recruitment and training of the workforce (human resources management).

10. Transportation, storage and industrial consumption of material resources (transportation of material resources, storage of stocks, constructions, products; production business processes, electricity, water, gas supply).
11. Payment of construction, installation and subcontract work (financial flows management).
12. Current calendar planning of the construction process.
13. Labour process organization (human resources management).
14. Sale of the building products (marketing activity management).
15. Payment for finished building products (financial flows management).
16. Advertisement and other informational and commercial communications marketing activity management).
17. Intracompany migration of labor resources and motivation (human resources management).
18. Output economical flows (construction operations, capitalized repairs, repair and construction work, mounting of engineering systems).

The model simplifies real economical flows of the building company and enables to observe its types and interconnections. In the model the material flow is shown as a complex of operations: 1-2-6-10-14-18, financial flow: 1-3-7-11-15-18, informational: 1-4-8-12-16-18; labour: 1-5-9-13-17-18.

The strategy of logistic implementation must be formed on the level of high management of the building company and includes the following tasks:

– economic justification of the implementation of the logistics,
– formation and support of the long-term programs of material and technical supply and building products manufacturing,
– formation and management of logistics chains of the building production,
– financial flows of the logistics system management,
– formation of the long-term strategic directions for the organization of production and technological supply of the construction projects,
– control over informal internal business information and its harmonization the logistics procedures,
– organization of the management accounting for the building process.

In general planning of the building process using a logistic system as well as the interconnection of strategic and operative subsystems is shown on Figure 3.

On the first step of the business project, tasks are checked on the correspondence of mission and corporative purposes.

On the second step marketing researches of the real estate market are held for market situation estimation and making a forecast of the demand parameters. Preplanning of sales, estimation of material needs and its assets backing is worked out. Taking into account predicted orders the construction program and calendar plan of projects realization is formed including determination demands in production facilities.

On the third step demands in construction facilities are detailed over the types of building equipment according to the requirements of the construction project. According to the calendar plan of the construction demand in materials for the project is estimated. Calendar plan of the project is differentiated to the purchase plan and service plan. Provision of each plan with facilities is estimated.

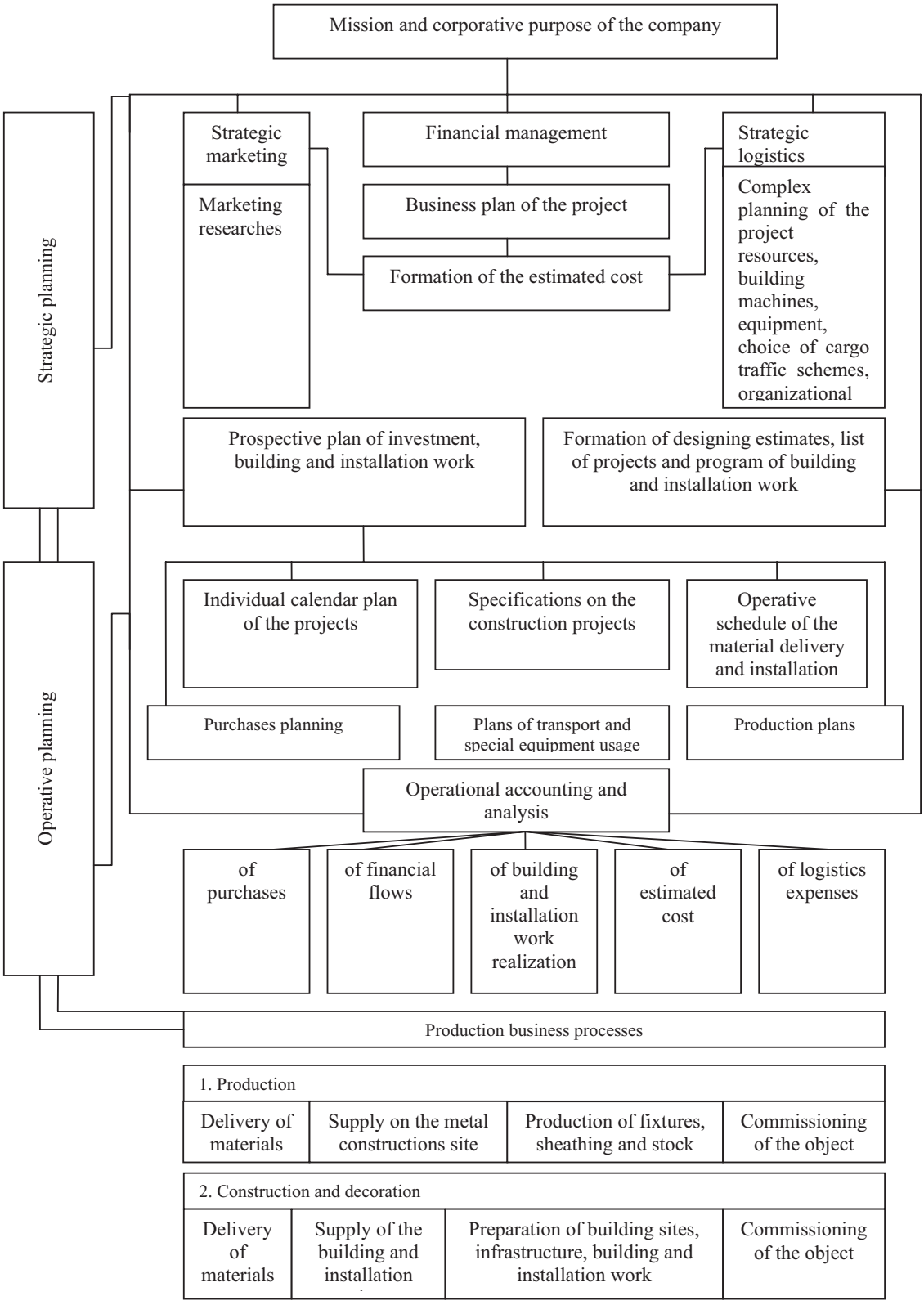


Figure 3. Construction company logistics management

Rysunek 3. Zarządzanie logistyką przedsiębiorstwa budowlanego

Source: own study.

On the fourth step operative management of subsequent and parallel business processes, accounting, controlling and analytical functions are realized. They provide plans realization and analysis and final construction cost and expenses of the building company estimation.

In general, the whole planning cycle includes solving the following tasks:

– specification of the construction projects taking into account their changes and additions,
– preparation of long-term installation schedule taking into account manufacturing resources,
– preparation of the month's operative installation schedule,
– supply schedule preparation of the construction projects with ferroconcrete structures and items based on the installation schedule data and/or operative installation schedule, labour and material resources,
– preparation of material procurement plan according to the balance of stock and operative installation schedule (or prospective schedule while forming long-term plans),
– preparation of applications to the material and technical supply department,
– control of the realization of the plans.

Conclusions

Fierce competition in the construction services market has led to significant changes in the basic foundations of logistics, which has turned from an auxiliary tool to support individual business processes into a powerful tool to increase the competitive advantages of organizing and conducting business. Enterprises of the construction industry demanded a transition from a marketing logistics concept to the concept of integrated logistics, based on a synthesis of models for managing the flow of material, information and financial resources.

The approach presented in the study to create the ideal image of the business process management system of a construction enterprise in the context of implementing the integrated logistics concept allows making effective logistics decisions in the conditions of unstable development of the business environment.

The scientific results obtained on the development of the platform of the hierarchical structure of the enterprise's logistics system should guide the practical implementation of the construction industry enterprises in the economic activity. This will optimize real economic flows and identify the directions of their structuring in the process of creating a construction product.

The proposed model for the formation of an integrated logistics system allows us to solve the problems of analytical support for making logistics decisions on material and technical, transport and storage support for construction production in modern conditions.

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Correspondence addresses:

assoc. prof. Anzhela Cherchata, PhD in Economics
(https://orcid.org/0000-0002-6753-2891)
SHEE "Prydniprovska State Academy of the Civil Engineering and Architecture"
Department of Management, Project Management and Logistics
Chernyshevs'kogo St., 24a,
49600 Dnipro, Ukraine
e-mail: acherchataya@gmail.com

Konrad Michalski, PhD
(https://orcid.org/0000-0001-6997-352X)
Warsaw University of Life Sciences in Warsaw - SGGW
Management Institute
Nowoursynowska St. 166,
02-787 Warsaw, Poland
e-mail: konrad_michalski@sggw.pl

prof. Tetiana Tarasova, DSc in Economics
(https://orcid.org/0000-0002-8129-7277)
Department of Finance, Analysis and Insurance
Kharkiv State University of Food Technology and Trade
Klochkivska St. 333,
61051 Kharkiv, Ukraine
e-mail: paluhtatiana@gmail.com

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