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## CHANGES IN THE ORGANIZATION AND LOGISTICS OF SUPPLIES IN SUGAR FACTORIES (METHODOLOGICAL ASSUMPTIONS FOR THE STUDY OF EFFECTIVENESS)

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**Abstract.** The article attempts to determine the methodological assumptions for further research on the effectiveness of changes in the organization and logistics of supplies in sugar factories. For this purpose, data were collected on historical ways of organizing transport of sugar beets to various sugar factories. Preliminary analysis of the data shows that the direction of development of the organization and logistics of beet deliveries is towards a process fully organized and supervised by individual sugar producers. This approach allows for better use of existing resources and the development of new directions of the organization processes. All actions taken by the sugar sector are aimed at introducing optimization, acceleration of movement and use of the latest communication techniques in order to reduce effort and time in the organization of the process.

**Key words:** logistics, organization of deliveries, transport of sugar beet

### INTRODUCTION

In the past ten to twenty years, the sugar processing industry has undergone significant changes not only in the area of applied technologies, but also with regards to the organisation of individual processes<sup>1</sup>. One of the pro-

<sup>1</sup> This issue has been extensively discussed by the employees of the IERiGŻ for years – see e.g. the works of P. Szajner (Ed.)

cesses that has been subject to major transformation is the delivery of beets from farmers to sugar factories. It is carried out in a number of ways. The most important of them include:

- own transport by farmers – sugar beet producers,
- transport by a sugar producer commissioned by a sugar beet producer.

The example of Polish sugar factories shows that at the end of the last century deliveries carried out using farmers' own transport were still in the majority<sup>2</sup>. In the period of ownership transformations in the Polish sugar industry, the process of reorganisation of beet purchase began.

At present, most beets (over 90%) are delivered to individual sugar factories using lorry transport organised

for the magazine "Rynek Cukru", which is a detailed report on the macroeconomic conditions of the operation of the industry (situation on the world market, production of sugar beets, state of sugar processing industry, demand and retail prices, sugar market interference etc.).

<sup>2</sup> As late as during the 1995 campaign, in sugar factories of Pfeifer & Langen Polska Group (11 sugar factories from the Wielkopolska region) there operated 56 buying stations, to which farmers delivered beets. Farmers also delivered beets using their own transport directly to sugar factories. Transport using small capacity vehicles involved a great number of single deliveries. Additionally, under such conditions it was impossible to deliver beets at night, so in order to meet the factories' processing needs, beets from buying stations were delivered to sugar factories on an ongoing basis using lorries and rail transport.

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**Fig. 1.** Map of location of sugar factories operating in Poland. Source: Sesevanderhave (2016).

**Rys. 1.** Mapa położenia cukrowni działających w Polsce. Źródło: Sesevanderhave (2016).

by sugar producers. In the analysed sugar factories of Pfeifer & Langen Polska S.A., farmers' own transport accounted for 31% of total deliveries as late as in 2003, but by 2014 this number shrunk to a mere 0.2% of total deliveries.

The above changes in the organisation of beet collection processes logistics were prompted by the need to improve the effectiveness of these processes. It is not only the question of the effectiveness of deliveries measured by the quantity of beets delivered and collected in a given time (tonnes/hour), but also of the economic effectiveness of the processes.

The increase in the processing capacity of individual sugar factories and the related increased demand for stock forced organisational changes in beet transport. Before the ownership transformation and the reforms of sugar market carried out after Poland joined the European Union in 2004 (see Urban et al., 2005), 75 sugar factories were in operation all over the country<sup>3</sup>. At present, there are eighteen sugar factories operating in Poland (Fig. 1).

The article presents methodological principles for the studies of effectiveness of changes in the organisation

and logistics of stock deliveries in sugar factories. Moreover, the paper contains preliminary results of analyses that have already been conducted.

## PRINCIPLES, STRUCTURE AND SCOPE OF STUDY

The main aim of the presented discussion is to find the answer to the question if and how the changes in the organisation and logistics of stock deliveries implemented so far contributed to the increased effectiveness of operation of the given sugar company. The search for the answer to this question, including the widening of knowledge about the organisation of similar stock and commodity flows in other branches of food industry should produce a full picture of the current situation.

The identification of the current state of affairs taking into consideration the changes implemented so far shall make it possible to proceed to the second stage of study related to the selection of a further path of development and changes concerning the optimisation of logistics processes in sugar industry<sup>4</sup>. On the basis of the results of the analysed historical data, it shall be possible to suggest possible changes in the organisation of individual processes ensuring the delivery of sugar beets from farmers' fields to the processing plants (sugar factories). Then, considering the proposed changes with relation to the model constructed on the basis of historical data shall make it possible to analyse and estimate their impact on the final economic performance of a given department, the entire company or sector.

The main source of data on the basis of which the effectiveness studies of processes related to organisation and logistics of beet deliveries to sugar factories were conducted is one of the sugar companies operating in Poland. The data comes from years 2005–2014 and shall be supplemented by new data from the following years subject to their availability until the study is completed.

The objective scope of studies includes issues such as:

- organizational structure of the company
- the amount of financial means engaged
- the economic effect of undertaken activities

<sup>4</sup> The authors assumed that despite the differences in the ways sugar factories operate, which are related to different standards applied in given companies' home countries, it is possible to draw general conclusions applying to the entire sector from the results of analyses of individual entities.

<sup>3</sup> <http://www.stc.pl/cukrownictwo.php?d=2>.

- the involvement of related entities providing transport services.

Due to the fact that the observations and studies are based on actual data (coming from one of the sugar companies) and that further detailed interpretation of the data is planned, the applied methodology is based on the analysis of case studies.

### THE PROBLEM WITH ASSESSING THE EFFECTIVENESS OF LOGISTICS PROCESSES

The logistics of sugar beet deliveries for processing may be defined as processes related to planning, execution and control of their efficient and effective transport from the farmer's plantation to the sugar factory, including also the flow of necessary information (Abt, 1998, p. 30). The introduction of any changes to the delivery management system or the logistics process applied in the given company must involve the specification of the "effectiveness" of the implemented changes of both material and non-material nature (Krawczyk, 2001, p. 34–42). This term shall be understood as an expression of not only economic and financial values, but also social, moral or ecological ones.

In general, effectiveness is understood as a measure defining relations between achieved results and involved resources, which enables the analysis and comparison of changes that are being introduced to the delivery logistics system in financial terms. However, with regards to process organisation – with particular focus on changes in the rate of use of production resources per product unit, e.g. the improvement of work effectiveness, effectiveness of used means of transport – we may refer to so-called operational effectiveness.

Only such dual approach to the assessment of effectiveness of logistics processes gives a sufficiently full picture of the current status of processes and their impact on the company's operation and integration with the environment.

The effectiveness of logistics processes may be evaluated from different points of view. When selecting effectiveness indicators and performing an assessment, one should also pay attention to the wider context of the analyses that are being conducted – they may give the company important information on:

- solutions, locations that generate costs

- changes in logistics processes with regards to any deviations from the established limits
- emerging chances and risks
- flow of information within logistics processes
- activities that are worth performing and those that should be stopped or reduced
- identification of areas that require changes, modifications
- profitability of introduced changes in individual processes, taking into consideration their impact on the end product and the „clients" of logistics processes. Conducting the measurements of effectiveness of logistics processes enables better use of available resources. The following prerequisites are required:
  - giving all the participants to the delivery chain appropriate feedback regarding the results of activities that were undertaken
  - specification and assignment of cost carriers for given activities.

### ASSESSMENT OF ORGANISATION OF STOCK DELIVERIES TO SUGAR FACTORY – CHANGES AND CURRENT STATUS

As late as at the end of the last century, most sugar beet deliveries in Polish sugar factories were carried out directly by farmers using their own transport vehicles. The most common means of transport was a farm tractor with trailer. The average volume of beets delivered in this way was approx. 8 tonnes of pure beets per transport<sup>5</sup>. Assuming that in the 1990s, the average daily beet processing capacity in a sugar factory was approx. 2800 tonnes<sup>6</sup>, around 350 deliveries of the kind mentioned above were needed each day in order to meet the processing demands.

Organisational changes related to the privatisation of sugar industry in Poland and the reorganisation of sugar market in the European Union caused the drop in the number of operating sugar factories to 18 in 2013. Average daily beet processing capacity in each of these sugar factories more than doubled and amounted to 6200 tonnes<sup>7</sup>. As a result of the above-mentioned changes,

<sup>5</sup> Clean beets, meaning beets without organic contamination, e.g. remnants of leaves, weeds, tops, soil and stones.

<sup>6</sup> <http://stc.pl/cukrownictwo2.php?d=3>

<sup>7</sup> <http://kzpsc.com.pl/wyniki-produkcyjne-w-polsce,50.pl.html>

new solutions had to be found and sugar beet deliveries to individual sugar factories had to be reorganised. Meeting processing demands of approx. 6000 tonnes a day using farmers' individual transport would require operating from 500 to 700 transport batches (and the same number of delivery weighings).

Operating this number of events (stock deliveries to production), assuming transport is performed just to meet processing needs (without taking into consideration the maintained and rotated reserves) of individual sugar factories, would trigger the appearance of many weak spots in the supply chain (where the occurrence of errors or undesirable fluctuations of deliveries would be highly probable).

The organisation of beet collection process in the case of such inefficient transport would require:

- the introduction of detailed beet delivery schedule to meet the processing demands of a given sugar factory, taking into consideration a large number of carriers, small capacity transports and different transport and unloading techniques
- continuous updating and verification of the completion of delivery schedule, which would be troublesome or impossible due to the number of independent participants thereof
- introduction of appropriate technical infrastructure in sugar factories regarding: waiting areas, scales, locations and methods of unloading, including the method for feeding beets directly for processing, as well as the need for additional washing of beets in the sugar factory area and waste disposal (farmers do not have their own beet washers).

The implementation of the above requirements would require considerable investments in technical, infrastructural and organisational solutions aimed at improving the organisation of reception of this volume of deliveries in a unit of time.

In view of the above, the organisation of beet deliveries was based on lorry transport carried out by the sugar producer. Assuming that each lorry can deliver 24 tonnes of pure beets at a time, in order to meet the processing needs of sugar factories, approx. 260 deliveries a day will suffice, which is around 60% less than in the case of individual deliveries carried out by farmers. Another factor in favour of this method of organisation is the fact that deliveries are performed by specialised transport groups that have appropriate, unified transport

equipment adapted to the technical needs of a sugar factory (e.g. the method of unloading). As a result:

- there are only a few transport groups to be managed, which makes it easier to prepare schedules of deliveries and verify their completion
- the flow of important information between individual participants of the processes is increased
- technical infrastructure in the sugar factory of a given sugar producer is limited and standardised
- the influence of an individual (a farmer who delivers beets to the sugar factory himself) on the beet delivery process is reduced – the transport group driver is involved in the process for the whole duration of the beet campaign.

## EFFECTIVENESS OF LOGISTICS OF STOCK DELIVERIES TO SUGAR FACTORIES

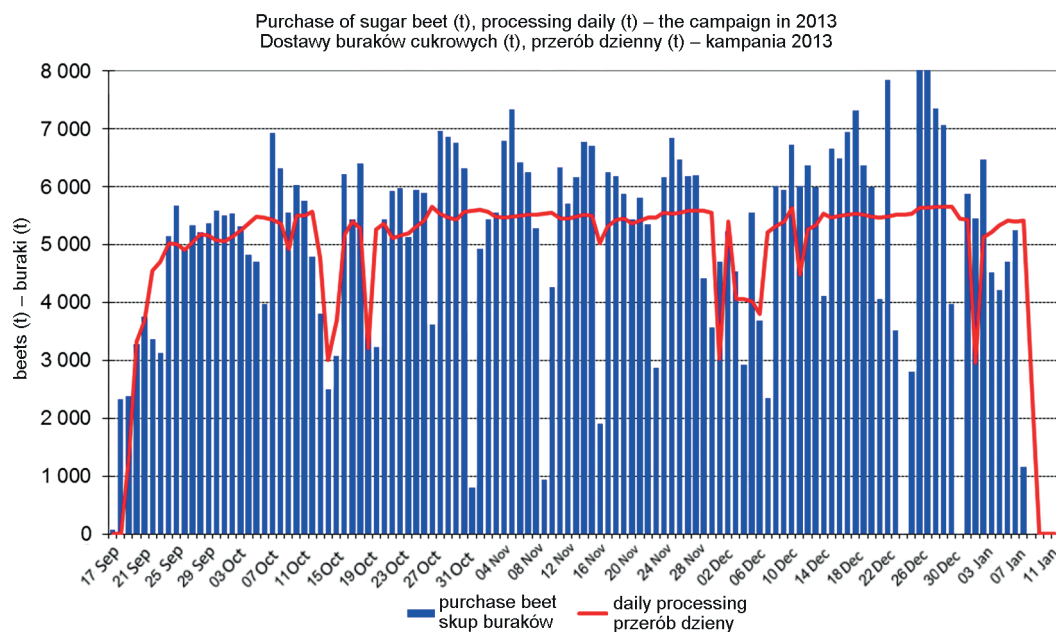
Prior analyses indicate that the introduction of organisational changes and changes in the logistics of beet deliveries in sugar factories in the past few years is linked to the need to specify the achieved economic and organisational effects.

The effectiveness of logistics processes may be evaluated from different points of view. When selecting the assessment criteria it is necessary to determine which of them will allow the introduction of supervision over the process of stock deliveries for processing and the modification of the process.

In the case of deliveries of sugar beets to sugar factories, the evaluation should take into account the change of values (parameters) typical for the process. The following issues must definitely be taken into consideration in the course of the study:

- minimising costs related to the execution of delivery process (transport costs analysis)
- optimisation of deliveries with regards to the use of full processing capacity of sugar factories (aiming at reducing the average beet reserves during the campaign to the level of reserve sufficient for 8 hours of operation)
- reduction of time of beet transfer from fields to sugar factories (reduction of the number of days)
- speeding up the information flow between participants to the process (reduction of time necessary to inform the participants to the process about the changes that took place)





**Fig. 2.** Comparison of beet deliveries to their daily throughput in the sugar factory no. 1  
Source: own study based on data from the 2013 campaign in the sugar no. 1.

**Rys. 2.** Porównanie wielkości dostaw buraków do ich dziennego przerobu w cukrowni nr 1  
Źródło: opracowanie własne na podstawie danych z kampanii 2013 w cukrowni nr 1.

- optimization of the number of participants to logistics processes (analysis of the use of lorries expressed by the daily operation time and in the case of beet washers, the volume of reloaded beets during the entire campaign).

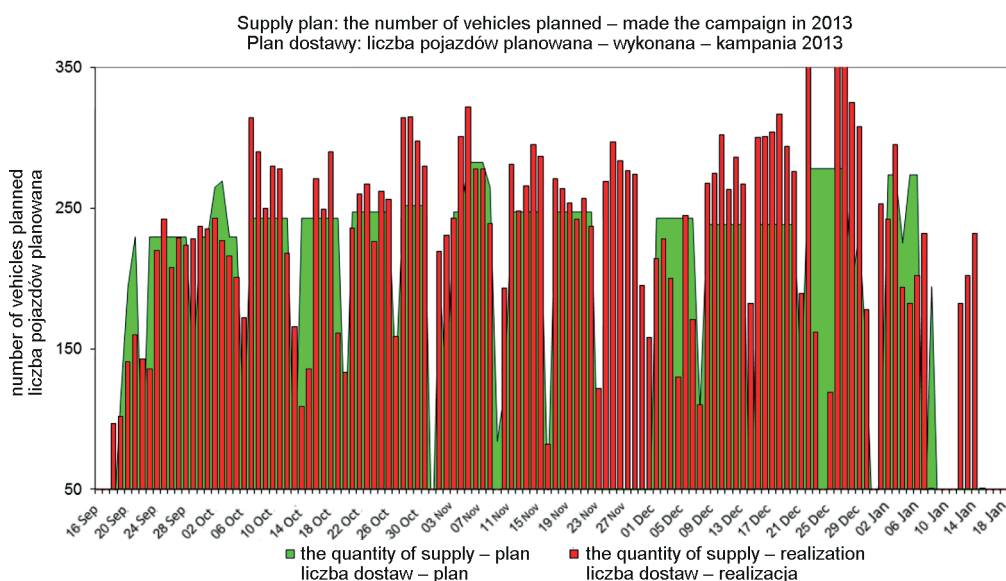
Previous economic analyses conducted for sugar beet delivery process in the analysed sugar processing company were aimed exclusively at the determination of total costs related to the organisation of the process and the loading and transport of beets.

Costs determined in this way, calculated based on the data from the analysed sugar factory, compared to the amount of processed beets, give information only on the level of unit costs of beet transport borne by the company. Meanwhile, the lack of more detailed information makes it impossible to conduct full analyses of the entire logistics process related to beet deliveries. One example of the lack of full flow of information<sup>8</sup>

<sup>8</sup> The flow of information is the most important issue, although other factors, e.g. economic stimuli encouraging producers to complete deliveries on time, or even the weather, may also have some impact.

between individual participants to the process may be the comparison of data on beet deliveries and the daily processing in one of the sugar factories of the analysed company – Figure 2. Another evidence of the incomplete optimisation of processes is the information about the purchase of beets expressed as a difference between the numbers of planned and executed deliveries (Fig. 3). The analysis of this data (Fig. 2 and 3) reveals that it was impossible to maintain an adequately low and stable reserve. According to the example presented above, the average reserve during the campaign was 3409 tonnes. However, the deviation from the execution of principles related to the planned number of vehicles/deliveries presented in figure 3 was on average 15 transports/day. As far as the difference between the number of executed deliveries and the number of planned deliveries is concerned, the deviation may result e.g. from the averaging of the weight of the load carried by one lorry performed at the planning stage (beets are not weighed upon loading on the farmer’s field).

When comparing this data and current reality of sugar beet deliveries to the situation in sugar factories in the 1990s, one may notice the following changes:



**Fig. 3.** The planned and executed the delivery of beet for the sugar factory no. 1

Source: own study based on data from the 2013 campaign in the sugar no. 1.

**Rys. 3.** Planowana i wykonana dostawa buraków do cukrowni nr 1

Źródło: opracowanie własne na podstawie danych z kampanii 2013 cukrowni nr 1.

- reduction of number of vehicles necessary to execute the planned daily deliveries of sugar beets<sup>9</sup>
- reduction of reserves, which has a direct impact on the undertaken activities. As late as 10-15 years ago, reserves maintained in the sugar factories of the analysed company from September to November amounted to between 5 000 and 10 000 tonnes of beets. This corresponded to a quantity processed in 1-2 days. Yet, in the second half of October, the purchase of beets for storage began. In this period, in the most extreme cases, reserves reached 50 000 tonnes of beets.

Introducing an appropriate system for assessing the effectiveness of undertaken activities should make it possible to gain fuller knowledge about the analysed problems. In order to do this, it is necessary to:

- identify in detail individual processes and their stages
- identify basic and key criteria defining each process,
- specify and prepare appropriate measure(s) for each process and stage
- precisely define goals that are to be achieved in each process<sup>10</sup>.

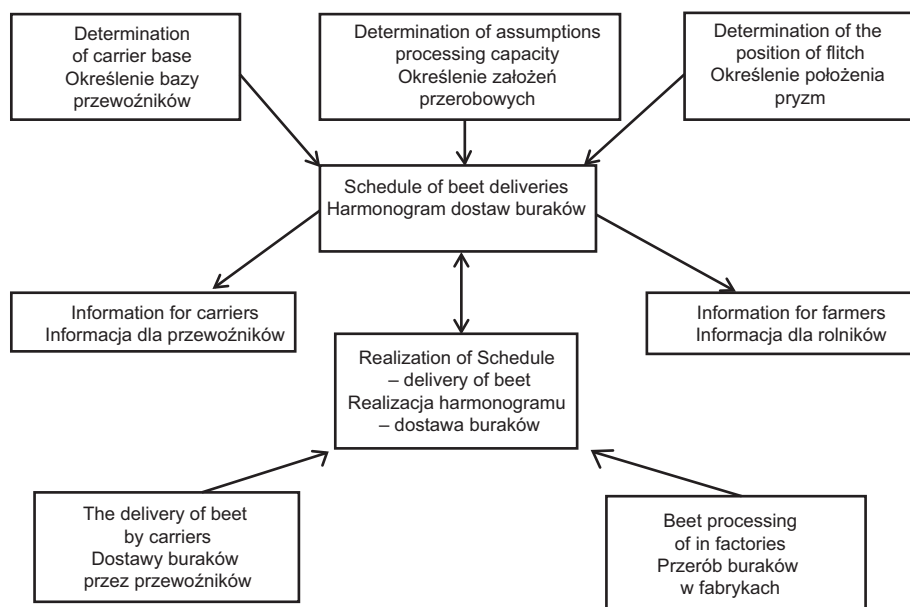
The completion of these tasks will also affect the sugar factory's ability to implement the company's strategies related to the use of the available production potential and current market situation while making reasonable use of resources and expenditures (Skrzypek, 2002, p. 190)<sup>11</sup>.

At the same time, the specificity of organisation and logistics of stock deliveries to sugar factories requires a systematic approach. The implementation of a holistic approach is the result of the multidimensional nature of the analysed problem (technical, technological,

<sup>9</sup> It must be noted that the change of the method of sugar beet transport to specialised transport organised by sugar factories involved also certain adjustments of costs (the need to purchase or lease vehicles or use external services), which should be taken into account if the present process effectiveness analyses are to be considered multidimensional.

<sup>10</sup> See the principles of the activity cost management system Activity-Based Management (ABM).

<sup>11</sup> One needs to take into account the fact that the way sugar factories operate is linked to the standards of activities in the home countries of the given companies.



**Fig. 4.** Diagram of the organization of the delivery of beet for sugar factories

Source: own elaboration.

**Rys. 4.** Schemat organizacji procesu dostaw buraków do cukrowni

Źródło: opracowanie własne.

economic and other determinants). According to this view, the organisation of the beet delivery process may be seen as a system (or more accurately, a web) in which information and resources are exchanged. Information passed by the employees and individual subsystems (i.e. stock, technical, production, storage and packing departments of the sugar factory) shall lead to the completion of the planned tasks. Individual parts of this system are closely linked to each other (Stabryła, 2006, p. 218).

The holistic approach to this issue (combined simultaneously with a detail-oriented approach within individual processes) shall enable the creation of an optimal and economically justified model of activities concerning sugar beet deliveries for direct processing in sugar factories. It is assumed that the structure and functions of the organisation and logistics of stock deliveries will be built up in such a way as to achieve the maximum synergy effect while ensuring high economic effectiveness of the processes (Grontkowska and Klepacki, 2006, p. 56).

The complexity of issues related to the process of beet deliveries to sugar factories is reflected in Figure 4.

Two basic stages of undertaken activities are related to:

- the preparation of beet delivery schedule for a given season while taking into account the processing location of these beets and the division into transport groups
- the implementation of the beet delivery schedule including an ongoing effectiveness analysis and the introduction of changes required by the current situation, e.g. crops, weather, operation of factories.

## SUMMARY

The presented analysis shows that there is a need to optimise logistics processes related to the performance of beet deliveries for processing in sugar factories. The previous approach did not ensure a detailed economic analysis of these processes.

Reaching the above listed goals and in particular, the examination and improvement of the effectiveness of delivery processes, require the implementation of procedure compliant with the presented principles which focus on:



1. The optimisation of the vehicle fleet used for beet deliveries, in particular taking into account the date of delivery of sugar beets – the impact of weather on performed deliveries and the farmers' bases, the sizes of beet piles and their spatial distribution. At the stages of planning and control of beet delivery schedules, it is necessary to take into account the cooperation between individual sugar factories belonging to one company. Cooperation in real time will enable smooth and optimal management of the available transport fleet – e.g. in the case of processing problems of one of the factories.

2. Speeding up the flow of information between participants to the process. Taking into account all the entities taking part in the entire beet delivery process, starting with farmers, through carriers and ending up with sugar factories in the logistics system, shall make it possible to speed up the flow of information between participants. This applies in particular to feedback flow.

3. Using latest communication and information transfer technology between the participants to the process. The flow of information between the participants to the delivery chain shall make use of the Internet, including dedicated web pages containing continuously updated information on the schedules of sugar beet deliveries to individual sugar factories, taking into account the division into transport groups. This information, updated on an ongoing basis, shall take into account the impact of all occurring disturbances in the beet delivery and collection system.

4. Optimisation of processes taking into account the labour factor. At this point, particular attention should be paid to the fact that the sugar beet delivery process is very resource-consuming, especially with regards to labour. This concerns the involvement of sugar factory employees and employees of external companies. Labour optimisation shall enable not only the reduction of costs, but also (within the limits of social responsibility of the company that commissions services) the improvement of profitability of the work of hired employees.

5. Creating as a result a model solution for the deliveries of sugar beets to sugar factories that mimics the relationships between the sugar factory and suppliers as well as carriers and takes into account the internal structure of the sugar factory and its subsystems (stock, technical, production, storage and packing departments).

The changing situation related to the liberalisation of the sugar market in the European Union will also affect the decisions taken by sugar producers<sup>12, 13</sup>. The liberalisation of the sugar market and the introduction of free market rules will further motivate sugar producers to look for the ways to reduce the costs of their activity. One of these elements will be looking for ways to optimise logistics costs. That is why this is the field in which to conduct further analyses and studies aimed at creating or improving the tools for economic effectiveness analysis of introduced changes.

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<sup>12</sup> <http://eur-lex.europa.eu/legal-content/PL/TXT/PDF/?uri=CELEX:32013R1308&from=pl>

<sup>13</sup> <http://eur-lex.europa.eu/legal-content/PL/TXT/PDF/?uri=CELEX:32013R1370&from=pl>

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## ZMIANY W ORGANIZACJI I LOGISTYCE DOSTAW SUROWCA W CUKROWNIACH (ZAŁOŻENIA METODYCZNE DO BADAŃ NAD EFEKTYWNOŚCIĄ)

**Streszczenie.** Celem artykułu jest próba określenia założeń metodycznych do dalszych badań nad efektywnością zmian w organizacji i logistyce dostaw surowca w cukrowniach. W tym celu zgromadzono dane historyczne dotyczące sposobów organizacji transportu buraków cukrowych w różnych zakładach. Wstępne analizy zgromadzonego materiału wskazują, że kierunkiem rozwoju organizacji i logistyki dostaw buraków staje się proces w całości zorganizowany i nadzorowany przez poszczególnych producentów cukru. Takie podejście umożliwia lepsze wykorzystanie istniejących zasobów i rozwój nowych kierunków organizacji procesów. Wszystkie działania podejmowane przez sektor cukrowniczy mają na celu wprowadzenie optymalizacji oraz przyspieszenie przepływu i wykorzystania najnowszych technik komunikacyjnych, tak by ograniczyć nakłady pracy i czasu na organizację procesu.

**Słowa kluczowe:** logistyka, organizacja dostaw, transport buraków cukrowych

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