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Sandra Duda, Ewa Kulińska, Dariusz Masłowski
Opole University of Technology

Analysis and evaluation of transport exchanges in a selected TSL sector company

Analiza i ocena giełd transportowych w wybranej firmie z branży TSL

Abstract. The article shows the methods and tools used by the surveyed company in the transport process. Transport exchanges and GPS monitoring system play a key role here. A process map is presented, which shows the individual stages of transport tasks realization using the exchanges and other tools. On the basis of the examined entity, the transport exchanges were also compared and evaluated against various criteria. The research took into account three stock exchange platforms used by the company: TimoCom, Trans and Teleroute. As a result of the research, it was found that TimoCom exchange received the highest evaluation for the selected company – 4.74, Trans with a score of 3.84 and Teleroute 3.6. For the audited entity, TimoCom platform turned out to be the best in terms of the criteria compared.

Key words: transport, company, exchanges, freight exchanges, transport process

Synopsis. W artykule przedstawiono metody i narzędzia wykorzystywane przez badaną firmę w procesie transportowym. Kluczową rolę odgrywają tu giełdy transportowe i system monitoringu GPS. Przedstawiono mapę procesów, na której przedstawiono poszczególne etapy realizacji zadań przewozowych z wykorzystaniem giełd i innych narzędzi. Na podstawie badanego podmiotu dokonano również porównania giełd transportowych i oceny pod kątem różnych kryteriów. W badaniu uwzględniono trzy platformy giełdowe, z których korzysta firma: TimoCom, Trans i Teleroute. W wyniku przeprowadzonych badań stwierdzono, że giełda TimoCom uzyskała najwyższą ocenę dla wybranej firmy – 4,74, Trans z oceną 3,84 oraz Teleroute 3,6. Dla audytowanego podmiotu platforma TimoCom okazała się najlepsza pod względem porównywanych kryteriów.

Słowa kluczowe: transport, firma, giełdy transportowe, proces transportowy

Introduction

Among the tools and methods that support the transport process, the GPS monitoring system and transport exchanges are commonly known and used [Chamier-Gliszczyński Szada-Borzyszkowski 2015, Neuman 2017]. Nowadays, it is difficult to imagine proper

and effective management of the transport fleet and customer relations, and above all the functioning of companies from the TSL sector without these devices [Łukasik 2016]. One can even say that it is practically impossible. According to [Podolski and Szafulska 2017], it is necessary to efficiently plan, implement and control the flow of raw materials for economic and environmental reasons. At the same time, it should be emphasized that it is important, for example, to choose the right tools for handling transport processes. Malesa [2017] in his research emphasizes that solving transport issues requires taking many actions, but criteria that are important for the decision-maker should be determined. Continuous development of the economy and growing requirements of customers, as well as a constant influx of competitors, makes companies are forced to use various and increasingly better methods and tools supporting the transport process. Using these methods and information tools influences the basic management functions in a company, i.e. planning e.g. travel routes, coordinating activities in the transport process and controlling all processes connected with the transport service [Grad 2010, Kisielewski 2016, Kulińska 2016]. They constitute a basic source of information, which is an integral part of the logistics service. The use of information solutions, such as transport exchanges, primarily affects the minimization of costs and empty runs in the transport process, as well as an efficient and high level of customer service and the synchronization of the activities of logistics process partners, as well as their efficiency [Kusiakiewicz 2010]. These devices significantly improve the coordination of transport and shipping processes, and serve as basic tools in the organization of work [Woźniak 2017]. The selection of appropriate tools and methods supporting the transport process requires determining their functionality, the way they are used and the costs incurred, as well as many other factors that have an impact on it [Starkowski 2017]. The article shows the course of the transport process with the use of transport exchanges and other tools, as well as the comparison and evaluation of transport exchanges used by a selected company in terms of various criteria.

Transport exchanges

The transport exchange, using information technology, takes the form of an Internet platform in which it is possible to exchange information and conclude transactions concerning free cargo and cargo space among transport, forwarding and production companies [Ministerstwo Edukacji Narodowej]. These platforms allow to place detailed information about the cargo or free vehicles that can be used for transport services, or information about the possibility of contacting the disposers [Kos 2011].

There are many freight exchanges in the market, each one is different, but all have the same principle of operation, namely they offer free loads, return loads and free vehicles. Some of the exchanges also offer a number of other services in addition to data exchange, such as applications supporting the management of a transport company, calculators of various kinds, or applications for route planning [Trans.eu].

Depending on the range, you can distinguish between the existing exchanges [Ministerstwo Edukacji Narodowej]:

- locally (in a given region),
- within the country,
- in Europe,

– internationally.

Nowadays, freight exchanges are one of the basic tools for optimizing routes, reducing empty mileage or planning freight optimally [Jurczak 2014]. Thus, transport exchanges are not only a place for offers in the desired relationship, they are also a source of new contacts, transport planning tools, maps or communicators. For carriers and freight forwarders they are a valuable tool integrating a huge number of functions [Jurczak 2014]. However, in order to manage the trips effectively, it is necessary to have reliable and up-to-date information from the vehicles consulted on the orders [Klecha 2014]. Transport exchanges, also known as freight exchanges, are an effective way to find new, yet beneficial, orders. This is because it is the exchanges that provide an opportunity to constantly research the market and find new contractors. Undoubtedly the exchange is not equal, each of them is different, but the operation is the same. Among the transport exchanges, the following can be distinguished [Loos 2014]:

– Timo com,
– Trans.eu,
– Wtransnet,
– Teleroute.

The advantages of electronic freight exchanges include [Romanow 2014]:

– improving the company's external communication,
– through them you can manage all cargoes and direct freight information to specific recipients,
– can serve as a platform for improving communication with customers and collecting transport orders,
– provide access to the pan-European freight market,
– they prove the effective controlling of all entities working in the system,
– they save time because the system enables simultaneous communication with many potential contractors,
– enable global freight management,
– they affect the savings related to fuel costs and fleet maintenance,
– reduce the level of office administration costs in forwarding companies.

When using the stock exchanges, it should be remembered that there are several tens of thousands of participants from different countries, therefore they cause great competitiveness, which is one of the few disadvantages of the exchanges. Additionally, due to the large number of users, many companies reduce the costs of their services, which may lead to lower profits. There is also a risk that a company with which a contract has been concluded may turn out to be insolvent. Of course, the exchanges use different systems of evaluation of their participants, which allows for the selection of reliable contractors [SpediGo 2019].

The aim and extent

The aim of this study is to present the course of the transport process with the use of transport exchanges and other tools in the examined company. The scope of the work included the analysis of three freight exchanges used in the transport planning process in the shipping company. The criteria of amenities for the examined enterprise were devel-

oped, which influenced the use of one of the three transport exchanges in the process of organizing transport services. The results were compared and discussed.

Data and methodology

Research was carried out in a service, trade and forwarding company. The research concerned the use of transport exchanges in the company. Three transport exchanges were distinguished, which the company uses on a daily basis. A survey was prepared among 20 users of transport exchanges in the surveyed company. The survey concerned the enterprise's needs in relation to transport exchanges, where 13 criteria were proposed and weights were assigned to them, where the total value of all criteria was equal to 1. The respondents assessed the individual criteria on a scale from 1–5, where 1 meant completely unacceptable, and 5 meant very good. From the average of the scores obtained by the respondents, the weight was multiplied by the score and a weighted score was obtained. On this basis, a comparative chart of 3 freight exchanges was prepared. For the examined company, a SWOT analysis was also prepared in order to assess the company's market.

Characteristics of the researched enterprise

Subject of the research entity

As the name suggests, The Service, Commercial and Forwarding Company deals with the provision of transport, forwarding and commercial services. As far as transport is concerned, it is the main field that the company deals with. The company offers transport services:

- canvas cover transport,
- cooling transport,
- oversized transport,
- transport of hazardous materials.

From the above mentioned transports, mostly tarpaulin and refrigerated transport is performed, because the company has the highest demand for this type of transport. It is conditioned by the fact that a particular group of the company's regular customers requires such services. Oversized transport is highly limited because the company does not have specialized equipment to perform this type of transport. This does not mean that the company does not provide this type of transport at all. The company only transports loads adapted to the capabilities of its low-loader trailers. However, as far as the transport of hazardous materials is concerned, it is still limited to a large extent because the company is still developing in this area, i.e. it is currently authorized to transport hazardous materials only, with the exception of liquid materials, which are the main subject of these transports.

The company provides transport services in the country, however, most of them are in Europe. The main directions of the transport are the western European countries such

as: Germany, Holland, France, Belgium, Luxembourg, Switzerland and Spain. However, most of the transports are made to Germany. This is due to the fact that the company has regular customers, who most often want the goods to arrive there. In order to optimize the costs, the company immediately performs cabotage transport in Germany. All this does not mean, however, that the company does not provide transport services in the above mentioned countries. Most of the transports that the company's dispatcher has found on the freight exchange are carried out to individual countries. The loads are selected in such a way as to minimize the costs of getting to the place of loading as little as possible. In the field of forwarding services, the company obtains cargoes on the freight exchanges selected appropriately for the company's means of transport. However, in this industry, it happens that not everything is just in time. Namely, there are situations when a company acquires an order and does not manage to complete it, e.g. due to delays or lack of equipment. Then the order is sold by the freight forwarder on the freight exchange. However, the freight forwarder of the company has constant supervision over the sold cargo, despite the fact that he sold the cargo to another company. As a last resort, the examined company is settled by the Customer. In other words, it is a sub-contracting, where the execution of the action is commissioned, in a situation when the company does not have adequate capacity to perform.

Transport process flow

In order to show the realization of the transport process using tools such as transport exchanges, process maps were presented. Figure 1 illustrates the realization of the transport order in case the freight forwarder is looking for free cargo on the freight exchange or when the goods are in the company's warehouse. Whereas Figure 2 shows the order received directly from the client and its execution or the order to the carrier

The whole process of order execution can be divided into three stages:

1. Activities performed before the transport process.
2. Activities performed during the transport process.
3. Activities performed after the transport process.

In the first stage, the key role is played by the customer and the company's dispatcher, who are in contact with each other and determine, among other things, the conditions of transport, such as price or choice of means of transport.

In the second stage there is a dispatcher-driver relationship, i.e. the driver is notified by the dispatcher about taking up a new order. According to the guidelines of the order, the driver goes to the loading, carries out the transport process, and then passes the goods to the recipient.

In the third stage after unloading the documentation is handed over by the driver to the person responsible for receiving the goods. Other documents and payment for the carriage are transferred electronically.

Figures 1 and 2 show exactly how the individual tasks performed by a forwarder, driver, accountant, warehouse keeper or other persons involved in the transport process take place in turn.

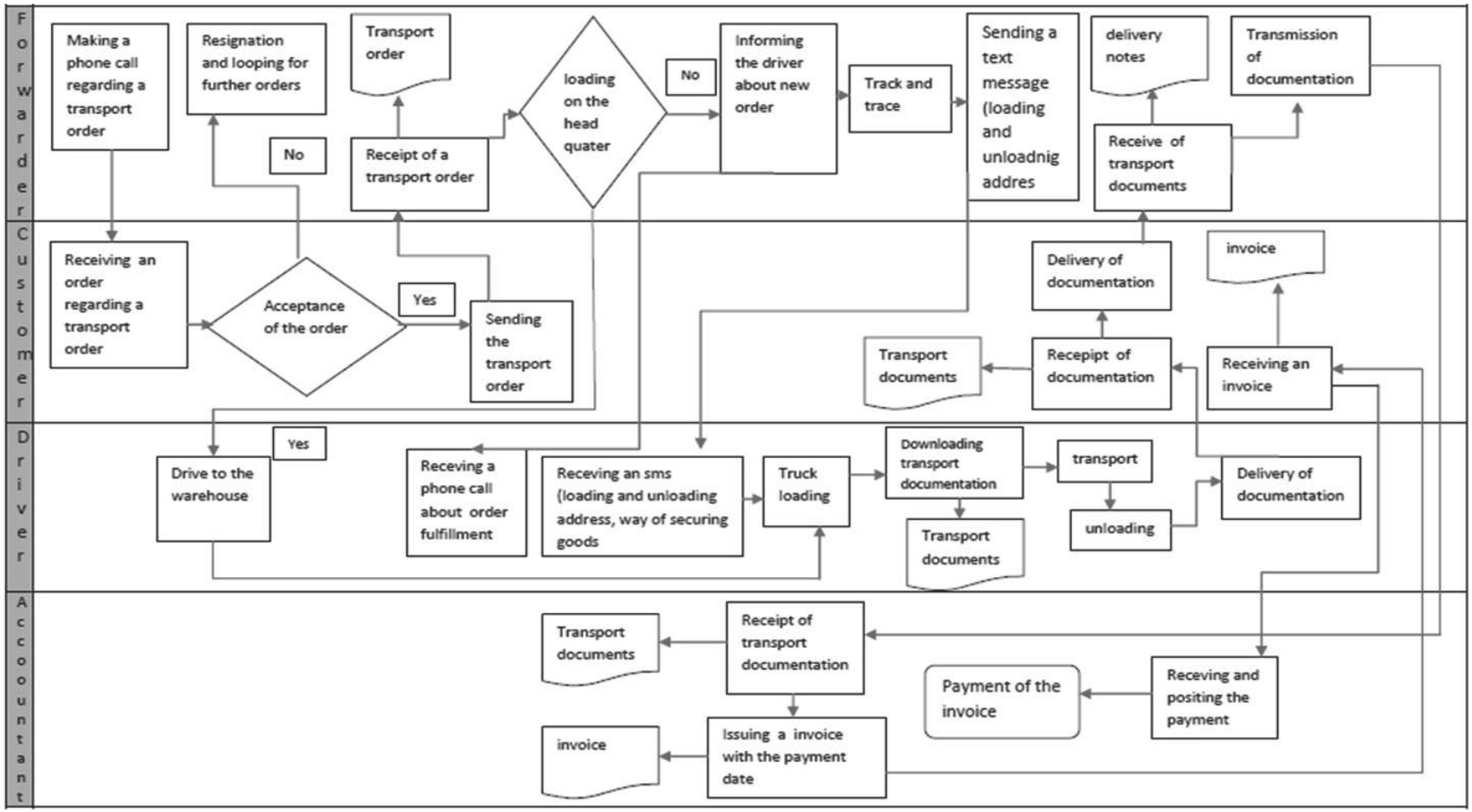

Figure 1. Process map – acceptance of the order by the forwarder from the customer

Rysunek 1. Mapa procesu – przyjęcie zlecenia przez spedytora od klienta

Source: own elaboration.

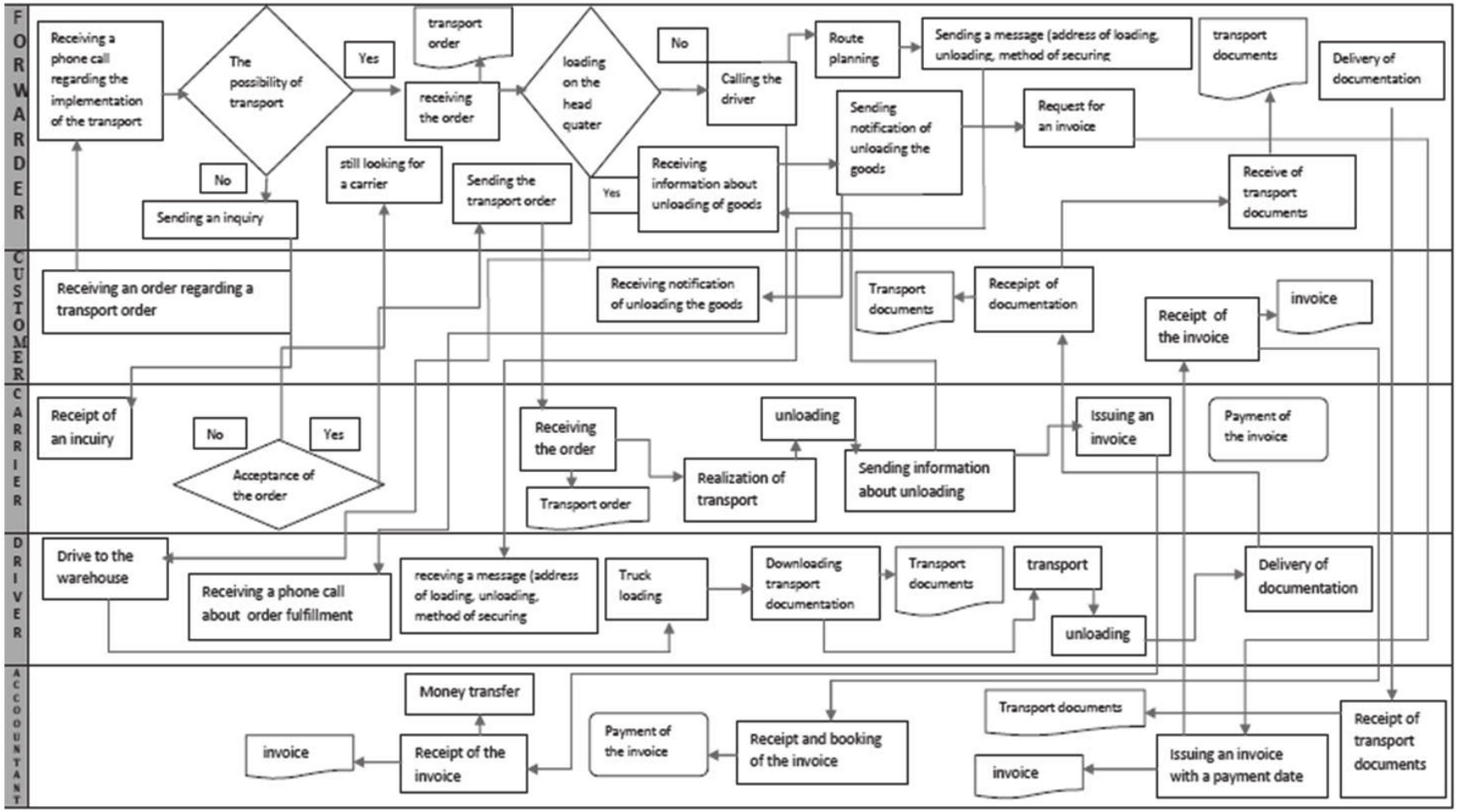

Figure 2. Process map – receiving an order from a client

Rysunek 2. Mapa procesu – otrzymanie zlecenia od klienta

Source: own elaboration.

Use of company transport exchanges

In the provision of transport services, the company uses from various types of tools supporting the transport process. The tools used in the company are a key role in the planning, organization, control and control of the transport process. Tools and methods used during transport management in a company can be listed:

- electronic transport exchanges,
- GPS monitoring system,
- wireless mobile telephony,
- websites,
- electronic document scanners,
- Viatoll toll system,
- fleet cards.

In order to provide transport services, it is practically impossible for a company to operate without a transport exchange. The company mostly uses exchanges such as TimoCom, Trans and occasionally Teleroute. The main functions of the exchanges include searching for cargoes, issuing cargoes and free vehicles. As a long-standing supply intermediary, the company uses the exchanges already in the first stage of the transport process. On entering the exchange platform, the company enters the relevant information about the desired cargo, i.e. vehicle address (country, zip code), type of bodywork or trailer, number of pallet spaces or weight. Then he selects the most advantageous offers selected according to preestablished criteria and makes calls to individual bidders. After finding a suitable offer, he receives an order and starts all activities related to the transport process.

The Trans has in its offer mainly export and import cargoes in Poland. It has a communicator that works like a reptile, so it facilitates fast communication. The platform is equipped with a very precise transport cost calculator. Trans notification of a new offer automatically by means of a sound signal and a message on the computer start bar. One of the main advantages is the ability to give marks to each other's users (companies), which consists of the overall company assessment. A big disadvantage of the Trans system is that the interface often hangs, which often prevents the smooth use of the exchange. Transaction security is provided by TransRisk, which is an indicator of payment reliability. Recently the exchange has introduced TransInkasso service which is used to recover paradise and foreign debts. Unfortunately, in contrast to the TimoCom exchange, this service is paid for.

Teleroute exchange is a basic platform in terms of the amount of cargo offered, which is rarely used by the company. It is mainly import and export cargo from France. This platform can be used by different users, not only those involved in the TSL sector. In addition to the cargo and vehicles offered, the exchange offers a route calculation system and a map of the location. However, it does not have additional functions such as compatibility with GPS monitoring system. Teleroute has a Start algorithm, it is an indicator that allows users to control the current reliability and reputation and quality of services provided by other platform operators. Teleroute also has a directory of transport companies which contains information about potential new partners. The exchange has in its assortment an E-confirmation, which is a tool that allows to automatically share transport and contract documents between the parties. The platform runs a financial rating, thanks to which the operator can check the financial condition of business partners. Teleroute has

a mediation service, which is used to collect the overdue invoices issued to forwarders by transport companies.

Another platform used by the company TimoCom is the TimoCom exchange, which is the oldest and most technically advanced platform. The exchange has a very extensive network of telematics suppliers so that the user can gather data on his vehicles which are equipped with systems provided by other telematics companies at one place. In addition to the freight exchange, TimoCom also offers a route calculation module, a platform for European transport tenders, a European index of transport companies registered with TimoCom and is the only one to offer a warehousing exchange. Transactions in this exchange can be verified by the contractor by contacting the customer service department free of charge after entering the number of the contractor called TimoComID. The platform is also operated by the collection department, which makes it possible to correct delayed payment dates on an ongoing basis.

Analysis and discussion of the results

Evaluation of transport exchanges used in the company

In order to show the functionality and usefulness of the exchanges, they were compared against selected criteria. The selection of the criteria was based on the needs of the company in question. These criteria inform the company about the attractiveness of a given exchange, which should be selected during the transport process.

Analyzing Table 1 you can see that each of the listed freight exchanges has international access to free vehicles and cargo. As for the annual fee for the selected platforms, TimoCom is the most expensive. Each platform has the same application, but the company's use varies, e.g. Teleroute's platform is used to obtain free import and export freight in France. The Trans exchange is used for freight coming from Poland. As far as TimoCom is concerned, the company's dispatcher uses the exchange in the international area, mainly Western countries such as Germany, the Netherlands, Switzerland, Portugal and Spain. The conditions for the platform are different for everyone. The easiest way to access Telerout and Trans exchanges is to meet more conditions, as can be seen in Table 1, while more conditions are needed to access TimoCom. In an interview with the company's dispatcher, TimoCom is the most advantageous and useful exchange. This is due to the fact that it offers a lot of free freight and vehicles, is very easy to use and, most importantly, is at the same time GPS-compatible for the service provider and the customer, which makes cooperation much easier.

In order to better illustrate the conditionings of the individual exchanges used by the subject of the survey, Table 1 is shown. This table shows the evaluation of individual transport exchanges. The adopted scoring scale for each criterion ranges from 1 to 5: 1 – unacceptable, 2 – mediocre, 3 – sufficient, 4 – good, 5 – very good.

Individual scales indicate the importance (usefulness) of a criterion. The assessment is weighted by the product of the weighting and the scoring of a given criterion. The maximum weighted total score that the exchange can obtain is 5, which is a very good score. The assessment was carried out by persons responsible for obtaining transport orders and organizing the transport process, i.e., among others, forwarders of the examined company.

Table 1. Comparison freight exchanges in the study company

Tabela 1. Porównanie giełd transportowych w badanym przedsiębiorstwie

Criterion	STOCK		
	Teleroute	Trans	TimoCom
Area of activity	international	international	international
Annual fees [EUR]	600	625	1600
Basic functions	displaying, searching for cargo and free vehicles	displaying, searching for cargo and free vehicles	exhibiting, searching for cargo and free vehicles and offering storage space
Distinguishing features	wide offer for Benelux and France	communicator facilitating contact with the contractor; a sound signal announcing the arrival of new offers	compatibility with GPS, a transport barometer – which allows you to track and evaluate the situation of free vehicles and cargo
Stock exchange holding conditions	the company must have a minimum of 2 months, recommended by at least 5 users	just have a number: Nip, Regon, KRS	the user must be at least one year old in the TSL industry and have positive opinions
Main application by the surveyed entity	import and export cargoes taking place in France	mainly in Poland	international
Free testing	only free software demo available	yes, a 30-day test	yes, a 4-week test to full software version
Transparency of the platform according to the users of the examined entity	difficult to use, not very understandable platform messages	the first contact with the stock exchange is quite complicated, however, after being tame it does not cause any problems	easy to use, clear information, intuitive to use
How to login	directly through the platform or the web browser	directly through the platform	directly through the platform or web browser and through the mobile phone application
Debt management	Start algorithm – a business indicator, providing stock exchange operators with an insight into the reliability and reputation of services provided by other users; Mediation service – facilitating the collection of overdue invoices	Certificate of reliable carrier – distinguishing companies characterized by professionalism and reliability; TransRisk – payment reliability indicator, gives the possibility to verify companies registered in the system.	secure, which takes care of detailed control of each user before they are included in the platform and technical security; Cash Care – a debt collection department ensuring fast and efficient enforcement of required payments; TC Profile – an index of proven companies offering logistics and transport services
Market operation of the exchange	from 1987	from 2004	from 1997
Ease of use of the interface from the point of view of the examined entity	straightforward	it often hangs out	easy to use
Number of offers on the exchange [daily]	200.000	150.000	450.000

Source: own study.

Table 2. Rating of freight exchanges according to the audited entity
Tabela 2. Ocena giełd transportowych według audytowanej jednostki

Exchange	Criterion number	Criterion	Weight	Scoring criterion	Weighted evaluation
Teleroute	1	area of activity	0.05	3	0.15
Trans				4	0.2
TimoCom				5	0.25
Teleroute	2	basic functions	0.2	4	0.8
Trans				4	0.8
TimoCom				5	1
Teleroute	3	distinguishing features	0.03	3	0.09
Trans				5	0.15
TimoCom				5	0.15
Teleroute	4	main application by the surveyed entity	0.2	3	0.6
Trans				4	0.8
TimoCom				5	1
Teleroute	5	free testing	0.01	3	0.03
Trans				4	0.04
TimoCom				5	0.05
Telerout	6	transparency of the platform according to the users of the examined entity	0.1	3	0.3
Trans				4	0.4
TimoCom				5	0.5
Teleroute	7	how to login	0.03	3	0.09
Trans				4	0.12
TimoCom				5	0.15
Teleroute	8	Debt management	0.07	3	0.21
Trans				5	0.35
TimoCom				5	0.35
Teleroute	9	market operation of the exchange	0.02	5	0.1
Trans				3	0.06
TimoCom				4	0.08
Teleroute	10	ease of use of the interface from the point of view of the examined entity	0.07	4	0.28
Trans				2	0.14
TimoCom				5	0.35
Teleroute	11	number of offers on the exchange [daily]	0.1	4	0.4
Trans				3	0.3
TimoCom				5	0.5
Teleroute	12	annual fees [€]	0.05	4	0.2
Trans				4	0.2
TimoCom				3	0.15
Teleroute	13	stock exchange holding conditions	0.07	5	0.35
Trans				4	0.28
TimoCom				3	0.21
Sum of weights			1		
Sum of ratings:	telerout		3.6		
	trans		3.84		
	timocom		4.74		

Source: own study.

So, as shown in Table 2, the ratings of the individual freight exchanges are as follows: The TimoCom exchange was rated best and scored 4.74, which is almost a very good rating, followed by the Trans exchange with a rating of 3.84, which is close to a good rating and finally Telerout with a rating of 3.6. The list of ratings is shown in detail in Figure 3.

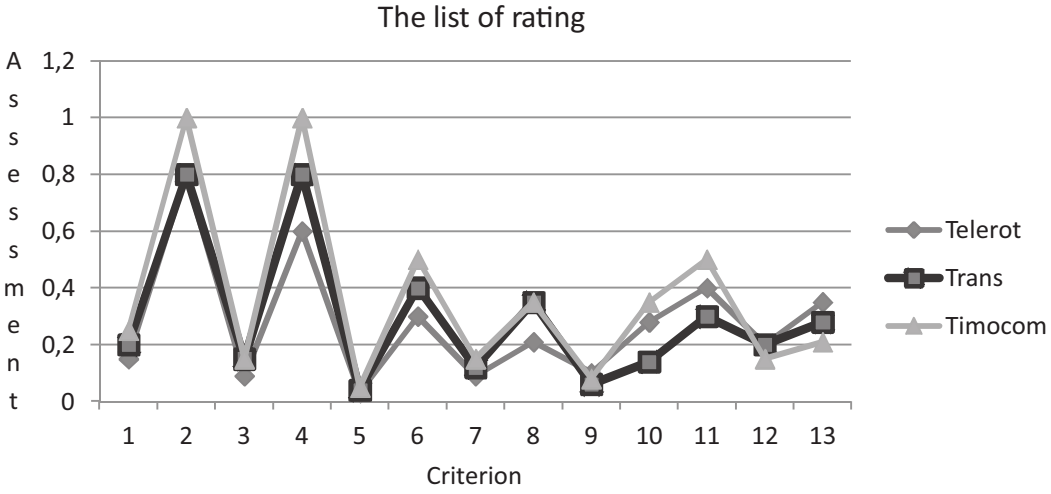

Figure 3. Rating of freight exchanges according to the audited entity
Rysunek 3. Ocena giełd transportowych według audytowanej jednostki
Source: own study.

The above chart presents the ratings of individual exchanges according to criteria. The criteria are numbered consecutively from 1 to 13. The chart shows that TimoCom's stock exchange is highly dominant, which is also due to the platform's rating. Almost every criterion is rated higher than the other exchanges. The Trans exchange comes second and

Table 3. SWOT analysis of the examined entity
Tabela 3. Analiza SWOT badanego podmiotu

Strengths	Weaknesses
– convenient location, – many years of experience, – very good knowledge of foreign languages, – modern rolling stock, – very good advertisement, – individual customer service, – wide range of services (forwarding, transport, storage), – very good reputation with the customer.	– rolling stock loading restrictions, – not using 100 % of the cargo space, – lack of proper division of duties, – too little storage space, – possibility of dismissal of employees, – poor price negotiation - adapting to competition.
Opportunities	**Threats**
– favorable changes in the law (working time standards, costs of roads and highways, emission standards), – signing of contracts and transport agreements, – certificate of a reliable carrier, – development of road infrastructure.	– the possibility of the competition appearing, – increase in vehicle operating costs, – unstable financial situation (unpaid customer payments), – decrease in demand for transport services (displacement by foreign carriers and other transport modes, competition).

Source: own study.

Teleroute third. On this basis, it can therefore be concluded that the surveyed entity makes the most and most use of the TimoCom platform.

Table 3 presents the SWOT analysis for the examined enterprises.

The company is in a stable market position, but constantly has to search for new transport planning tools. The use of new load planning methods and techniques can increase their competitive advantage. It is therefore necessary to adapt the best stock exchange platforms that will streamline and improve the performance of the surveyed enterprise. Many years of experience make the company known among customers, which gives greater recognition of the company. Irregular payments of customers can be a major threat to the company. Too little storage space in warehouse can lead to loss of customers or failure to earn extra money.

Conclusions

In the implementation of transport processes, the examined entity uses various tools and information methods to support these processes. The main ones used by the company include: fuel cards, Viatoll toll collection system, electronic document scanners, wireless cell phone system and GPS system. The main tools and methods that form the basis of the company's operations include transport exchanges. TimoCom, Trans and Teleroute are among the company's exchange platforms. These exchanges serve as the basic tool for searching transport orders for execution. The company continuously obtains and executes orders.

The research showed that for the selected company TimoCom exchange scored the highest score of 4.74, followed by Trans with a score of 3.84 and Teleroute with a score of 3.6. Thus, TimoCom platform proved to be the best in terms of the criteria compared.

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Correspondence addresses:

Sandra Duda, MSc Eng.
(https://orcid.org/0000-0002-0464-6074)
Opole University of Technology
Faculty of Production Engineering and Logistics,
Department of Logistics,
31 General Kazimierza Sosnkowskiego St., 45-272 Opole, Poland
e-mail: sandra.duda.log@gmail.com

assoc. prof. Ewa Kulińska
(https://orcid.org/0000-0002-3227-057X)
Opole University of Technology
Faculty of Production Engineering and Logistics,
Department of Logistics,
31 General Kazimierza Sosnkowskiego St., 45-272 Opole, Poland
e-mail: e.kulinska@po.edu.pl

Dariusz Masłowski, PhD Eng.
(https://orcid.org/0000-0002-3964-540X)
Opole University of Technology
Faculty of Production Engineering and Logistics,
Department of Logistics,
31 General Kazimierza Sosnkowskiego St., 45-272 Opole, Poland
e-mail: d.maslowski@po.edu.pl

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Jadwiga Grabowska
Silesian University of Technology

Identification and analysis of potential disruptions in warehouse processes in the distribution centre of the food industry

Identyfikacja i analiza potencjalnych zakłóceń w procesach magazynowych w centrum dystrybucyjnym branży spożywczej

Abstract. This paper is an attempt to identify and analyse disruptions that occur in the warehouse processes in the selected distribution centre of the food industry. The food sector has been briefly discussed and the distribution centre role within the distribution network as a link between suppliers, producers and consignees shown. Distribution centres play special role in the logistics and are the source of many benefits such as reduction of logistics costs, time cycles and stock as well as increase in the level of customer service quality. They also create value within the chain [Tomczak 2014]. In order to correctly implement the tasks put before a distribution centre, the warehouse processes taking place inside it should be performed efficiently and effectively. The performed A3 report has shown the potential disruptions that may affect the correctness of the warehouse processes implementation within the analysed distribution centre. The paper proposes improvements of the warehouse processes.

Key words: distribution, distribution networks, food industry, warehouse processes, A3 report, logistic indexes

Synopsis. W opracowaniu podjęto próbę identyfikacji i analizy zakłóceń, które występują w procesach magazynowych w wybranym centrum dystrybucji z branży spożywczej. Opisano branżę spożywczą w Polsce oraz ukazano rolę centrum dystrybucji w sieci dystrybucji jako łącznika dostawców i producentów z odbiorcami. Z badań wynika, że centra dystrybucyjne odgrywają szczególną rolę w logistyce, przynosząc tym samym wiele korzyści w postaci redukcji kosztów logistyki, cykli czasowych oraz zapasów, a także wzrostu poziomu obsługi klienta i tworzenie wartości w łańcuchu [Tomczak 2014]. Aby móc prawidłowo realizować zadania, jakie stoją przed centrum dystrybucji, procesy magazynowe w nim zachodzące powinny być wykonywane sprawnie i efektywnie. Przeprowadzony raport A3 ukazał potencjalne zakłócenia, jakie mogą wpływać na poprawność realizacji procesów

magazynowych w analizowanym centrum dystrybucji. W artykule zaproponowano usprawnienia procesów magazynowania.

Słowa kluczowe: dystrybucja, sieci dystrybucji, branża spożywcza, procesy magazynowe, raport A3, wskaźniki logistyczne

Introduction

The food industry in Poland can be characterized by relatively high stability therefore it should be included in the group of the least exposed sectors to the crisis, because the crises usually result from deviations of demand for durable goods, not for food. However, such drastic changes and results of these changes that took place within in the economy within the past year surely affected this sector also, to some extent. The impact of the pandemic can be seen among other things in the Statistics Poland data related to evaluation of the volume of purchase form foreign companies [FilaryBiznesu.pl 2020]. The food industry is one of the most important and strongly developing sectors in Poland. Figure 1 presents the value of food market in Poland. It is especially important to take a look at the stores operating within modern distribution channels because this is the channel that develops fastest from the value and quantity standpoint.

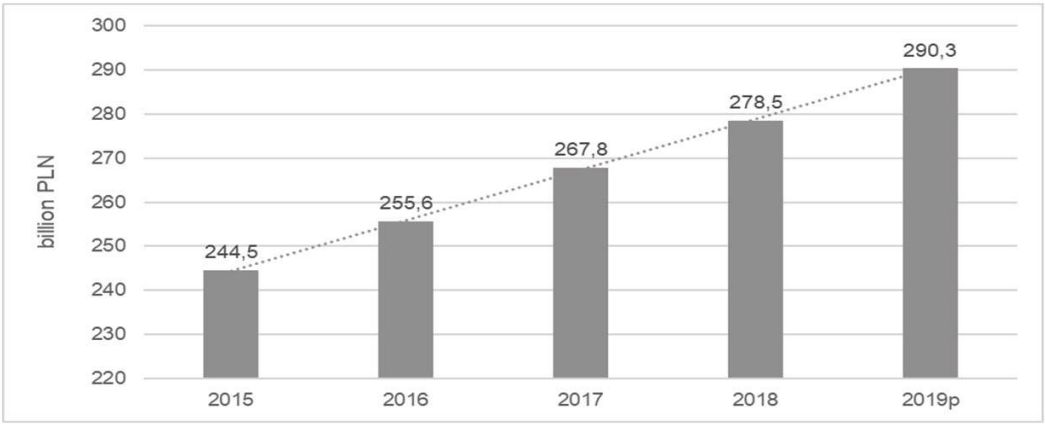


Figure 1. Value of food market in Poland [in billion PLN]
Rysunek 1. Wartość rynku żywności w Polsce [w miliardach PLN]
Source: developed based on [ZPP 2020, p. 11].

In order to deliver products to stores of the food industry, based on the 7W logistic principle, properly adapted, equipped and located distribution centres are needed. Distribution centres play the most important role within the distribution networks [Kozerska 2016]. In both these objects, the products are usually subject to picking process and dispatch to a consignee. The challenges put before the distribution centres are as follows [Kozerska 2016]: versatility, necessity of IT support, multimodality, creating added value related to the dispatched products, availability and integration option of many companies from various disciplines.

Distribution centres operate within networks. Network is a system composed of cooperating nodes in order to widen the range of impact and penetrate the consignee market [Kramarz 2008, Rushton 2014]. The essence of the network is implementation of the same or similar tasks, functions in different areas (geographic, market niches, disciplines, etc.) [Kramarz 2011]. Distribution centre within a distribution networks fulfils a role of a logistic node [Onstein 2018]. It consolidates cargo streams from a few suppliers to one consignee and distributes cargo streams, i.e. from one supplier to many clients; when dividing a cargo stream, clients are distributed at various locations and order products any time [Śliwczyński and Koliński 2013]. It provides the services of warehousing, temporary storage and distribution of products. The task of distribution networks is to maintain and preserve product quality that passes the distribution channels and to deliver it as fast as possible to a final client [Śliżewska and Zadrożna 2014]. In order to optimise the distribution network operations, it is necessary to analyse: currently possessed storage capacity, transport means, external and internal infrastructure, costs, improvement and provision of better distribution quality. To some extent, food market forces the design of various organizational forms of the distribution centres from companies that depend e.g. on the client service form and standards [Odlanicka-Poczobutt and Brodnicka 2015]. This necessitates skillful selection of logistic objects based on functions and tasks such objects should perform.

Objective and methodology of research

Based on the literature analysis within the fields of distribution, distribution centre and analysis of operational tasks taking place in warehouses, an attempt of disruption identification was made that occurred during acceptance, storage and delivery of goods from a distribution centre. A3 report was used in order to identify the root causes of disruption within the said processes. One also proposed the directions of improvements of the warehouse processes related to food products at a distribution centre. A3 report is based on its versatile implementation for different purposes. The most common include: solving problems, identifying persons responsible for a given project, its monitoring and tracking the status, more effective and efficient learning by an organization and employees, common development of good practices, continuous correction of reports = continuous improvement, presentation of a project or making decisions [Kołodziejczak nd, Richardson 2014]. The A3 report is an effective tool with which errors, problems and their causes can be clearly defined. In addition, you can put a sketch of a solution, new ideas and use supporting tools [Ćwiklicki 2009]. The following procedure was proposed as an action plan: Observation – the first step in any scientific inquiry is to observe a phenomenon in reality. Formulation of the model (cause-and-effect relationship using the A3 report). Looking for inconsistencies and defining the problem. Proposing a solution and its verification.

In conducting this research, the indicators were used that were calculated before the A3 analysis was carried out and after some solutions were proposed.

Tests results

The analysed distribution centre (DC) has a centralized distribution network that serves stores within Górny Śląsk area and performs a function of a consolidation point within the supply network. Utilization of this type of network is beneficial because it allows for keeping the minimum level of stock in a warehouse and minimizes transport costs based on the supplies consolidation. Advantageous location of the centre, close to main transport nodes and distance from clients allows for more frequent supplies to the stores. The analysed DC performs warehouse processes that include problems affecting effective functioning of the whole distribution network. Processes performed in the DC include:

- acceptance of deliveries – from a specified dispatcher together with quantitative and qualitative inspection,
- storage process – including acceptance from the acceptance zone and placement within the storage zone using the FEFO method,
- picking – includes acceptance from the products storage zone according to clients order,
- internal transport of goods using a forklift truck between warehouses and during unloading and loading,
- delivery of goods from the warehouse and its handing over to consignee,
- completion of client's order, i.e. completion of products based on the order from a consignee,
- inspection of warehouse inventory,
- organization of return of containers, boxes, pallets from clients to the distribution centre.

The process of accepting food products to the DC is as follows: The first task within the food products delivery acceptance at the cold store department is the control of the letter of advice by a warehouse administrator, who registers the delivery in the WMS (Warehouse Management System) system under appropriate number and then he / she hands it over to warehouse keepers in the cold store department. WMS is a program for managing products in warehouses. Warehouse Management System type solutions, coordinating warehouse works. These are specialized systems that improve all processes that take place in warehouses. They are of great importance, first of all, for the logistics warehouse (services), which support changes in the selection of shipments from multiple senders and directed to multiple recipients in their warehouses and terminals [Kownacka 2020]. Warehouse keepers at the acceptance department check the product temperature and then unload the delivery in the cold store buffer. The next task is the qualitative inspection which is very important because at the moment of finding potential products damage a delivery discrepancy protocol is made, the delivery is rejected and returned to supplier. After a successful quality control, quantitative inspection takes place through counting the goods on the pallets. In case of any discrepancies between the order and actual delivery, a delivery discrepancy protocol is made. In case of a surplus, warehouse keepers must contact the stock department in order to verify current stock status. If it is possible to accept the surplus of goods, another order is made related to the goods surplus

and the order is sent to the cold store department. In case of goods shortage, the delivery is accepted to the WMS system using a scanner. After the acceptance to the system, warehouse keepers perform another inspection of the accepted delivery, and then the External Acceptance document is created. The created document together with the copy of the External Delivery document are sent to the deliveries department where the documents are verified. If the documents are inconsistent, they are corrected. Another task is to issue a suitable document – invoice for the accepted goods – by the accounting department. Correctly accepted delivery is transported to the storage zone.

In order to quantify the occurring non-conformities in the warehouse, logistic indicators were used (quantitative warehouse compliance, warehouse utilization rate, delivery acceptance rate):

– quantitative warehouse compliance – the indicator informs about the compliance of the actual stock levels in the warehouse with those stored in the system. It is calculated according to the following formula:

  quantitative warehouse compliance = (number of items according to the system) / / (number of items physically converted in the warehouse) · 100 [%]

  $$\text{quantitative warehouse compliance} = \frac{10405}{11236} \cdot 100\ [\%] = 92.6\%$$

– the storage utilization index is calculated according to the following formula:

  warehouse utilization index = (number of occupied warehouse spaces) / (total number of warehouse spaces) · 100 [%]

  $$\text{warehouse utilization rate} = \frac{1480}{1620} \cdot 100\ [\%] = 91.36\%$$

– the correctness of the delivery acceptance is calculated according to the following formula:

  correctness of the delivery acceptance = (number of correctly accepted deliveries) / / (total number of deliveries) · 100 [%]

  $$\text{correctness of the delivery acceptance} = \frac{1456}{1499} \cdot 100\ [\%] = 97.13\%$$

The analysis of the above indicators shows that in the distribution centre there are differences between the stock levels in the system and the real stock levels. The warehouse utilization rate is within the normal range, but should aim at full utilization. There are numerous errors in accepting deliveries and completing orders, causing differences in stock levels and errors in deliveries to stores (recipients). In connection with the obtained results, it is necessary to propose an improvement that will improve the product distribution process as well as the efficiency and effectiveness of internal processes in the distribution centre.

Information about the order placement by a client is exported to the WMS system. Information about the order placement is sent to the deliveries implementation department that orders picking of the order to an external company. External company performs

picking of the delivery based on the order and its identification. The prepared delivery is transported to the delivery zone where it is additionally secured. Driver loads the goods on a truck and delivers them to a designated location. In the face of so many tasks to do in order to accept the goods to the DC and then send them to a consignee, there is a risk of many problems and inconsistencies within efficient implementation of these processes. Information about delays in deliveries received from clients and reports from the warehouse personnel concerning errors in the documents and the noticed quantitative and qualitative inconsistencies during the goods acceptance, necessitated detailed analysis of the occurring signals. A3 report was used to solve these problems and to find their root causes. The said report is used to analyse and solve problems of companies based on standardized scheme (Figure 2).

All causes mentioned in the A3 report directly or indirectly affect the problem of inconsistencies during acceptance of goods to the warehouse. This problem generates additional losses in the company, because the existing surplus in products generates costs related to disposal or resale of the products at lower value.

The objective of the preventive actions (corrective actions) proposed in the A3 report is to reduce the number of inconsistencies during goods acceptance, improve indexes identified in the report and specify the way of progress monitoring and define issues to solve. Of course, before any preventive actions can be implemented, it is necessary to answer the questions concerning problems with implementation of e.g. the Pick by voice system and what to do to prepare for them. It is necessary to specify concrete dates of implementation and completion of these actions and the form of their control to check if the results correspond with expectations.

The proposed solution – implementation of the Pick by voice [Złoch 2012] system, alike pick by light or pick by point, is an innovative technology employed in logistics and warehousing [Funk 2015, Bartczak and Barańska 2016, Dujmešić 2018]. One of the ways to increase the processing power of the warehouse is to strengthen the picking process through application of an intuitive voice technology. The WMS system, supported with the voice technology, significantly facilitates the work of operators in the warehouse. The support consists in substituting system messages transmitted to data collector with voice commands read to the operator's headset. Return communication is also very intuitive, namely based on voice commands said by an operator to a microphone integrated with the headset. Implementation of this technology frees the operators hands which is a very important thing when handling small or large-sized orders. Application of the intuitive technology, such as voice operation, affects also the increase of rate of warehouse flows and reduction of errors quantity.

In order to verify the correctness of the introduced improvements, the used logistic indicators were recalculated. The results of the indicators are definitely better.

$$\text{quantitative warehouse compliance} = \frac{14227}{14530} \cdot 100\ [\%] = 97.91\%$$

$$\text{the degree of utilization of the warehouse} = \frac{1580}{1620} \cdot 100\ [\%] = 97.53\%$$

$$\text{correctness of delivery} = \frac{1469}{1473} \cdot 100\ [\%] = 99.73\%$$

	A3 report	Problem: Inconsistencies during goods acceptance	Responsible Designated person	Date of preparation:	Report No.: 1	Status:

1. Problem description

During goods acceptance to the warehouse, qualitative and quantitative inconsistencies have been noticed and a problem related to the fact tha t employees "didn't know" where to put the goods.

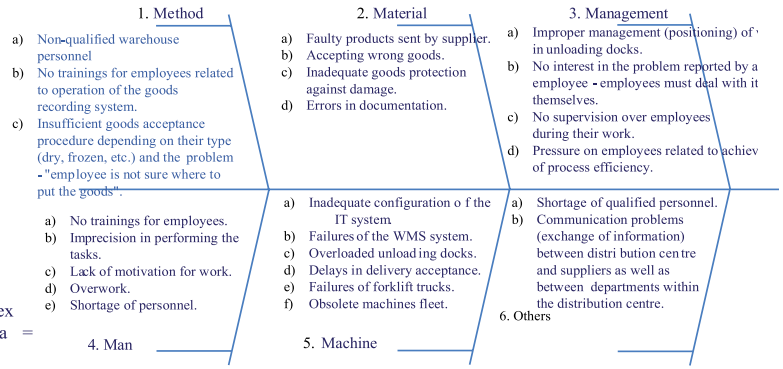
2. Current status, measures, numbers

Quantitative measurement of warehouse conformity was performed - the index informs about conformity of actual stock in the warehouse with the system data = 97.45%.
correctness of delivery acceptance = 97.67 %
The analysis of the aforementioned indexes show that there are differences between the warehouse inventory in the system and the actual numbers. There are many errors during acceptance of deliveries and picking of orders that cause the warehouse difference.

3. Target condition

Significant increase of warehouse quantitative conformity and delivery acceptance correctness indexes. The objective is to achieve the index at the level o 99% within six months.

4. Cause and effect analysis



5. Preventive measures

Proposals:

1. Accurately develop the path of development, training, raising professional competence. Pass the information and systematically monitor the development. Training for the employees.
2. Meeting of employees with a superior in order to discuss the problems and the methods of their solving and preventing them in the future.
3. Developing goods acceptance procedures (SOP) depending on their types and passing them to the workstations.
4. More frequent inspection of devices operation in the warehouse.
5. Substituting hardcopies with e-documentation.
6. Contractual penalties for failure to deliver the goods (from qualitative, quantitative and time standpoint).
7. Creating a "queue" system for vehicles delivering goods to DC.
8. Implementing the Pick by voice system connected with the WMS system.

Figure 2. A3 report for solving the problems of inconsistencies during goods acceptance
Rysunek 2. Raport A3 dotyczący rozwiązywania problemów niezgodności podczas przyjęcia towaru

Source: own elaboration.

Summary and conclusions

Warehouse is of fundamental meaning in the distribution logistics, because it is a home for both operational phase processes (acceptance, storage and dispatch of goods) and management processes (predicting stock level, planning actions and tasks related to implementation of orders). In order to efficiently react on continuous changes within the distribution logistics, it is necessary to identify the most important challenges related to it. Continuous control of the implemented processes and planning their course allow to minimize the risk of downtime and identify areas to optimize. Because of the real-time access to all data on warehouse functioning and products circulation, the company is able to quickly react to any changes on the market or in the supply chain and smoothly adapt operations of an object to actual needs. Another task is to optimally use the available warehouse area. This may entail change of the warehouse logistic design, use of new storage solutions, including object automation or implementation of WMS system to manage all stages of the warehouse economy. Company should employ qualified employees and motivate them adequately. Experienced and properly trained personnel affects the acceleration of warehouse operations and minimizes costs and time necessary to train new employees. It is also important to ensure proper cooperation between transport, stock management, warehouse operations, administrative issues organization, etc. Only the full coordination would allow for obtaining the highest level of effectiveness both of the warehouse operations and the supply chain itself. However, the applied innovative solutions in the food industry logistics may be treated as one of the sources of gaining competitive edge through the search and implementation of new solutions that allows to overtake market competitors. Innovative technologies, organizational solutions and new distribution concepts may represent a key factor of a company success as well as the whole supply chain. When efficiently implemented, they increase effectiveness of logistics process and warehouse economy, decide about higher sale efficiency, reduction of distribution process costs and allow to expand the range of commercial service, including especially these that increase comfort or save time related to purchases made by clients [Ciechomski 2016]. For example, further automation of these processes and shortening the supply chain can be used to minimize disputes related to warehousing in a distribution center in a commercial link. Further research will develop on the continuous validation of the accepted receipts upon admission to the warehouse and its use.

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Correspondence address:

Jadwiga Grabowska, PhD
(https://orcid.org/ 0000-0001-6596-2217)
Silesian University of Technology,
Faculty of Management and Logistics
26-28 Roosevelta St., 41-800 Zabrze, Poland
e-mail: jadwiga.grabowska@polsl.pl

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Mariusz Kruczek[1]***, Zbigniew Żebrucki***[2]
[1]GIG Research Institute
[2]Silesian University of Technology

ICT solutions supporting the customer services in the process of collecting secondary materials

Rozwiązania informatyczne wspomagające obsługę klienta w procesach zbiórki surowców wtórnych

Abstract. The limited availability of natural raw materials leads to a search for solutions facilitating their acquisition from already manufactured goods, which at the end of their life cycle become a source of secondary raw materials. To ensure the availability of secondary raw materials, it is necessary to organize logistics processes in such a way as to ensure the synchronisation of material and information flows. An important role for the efficiency of the logistics system of secondary raw materials is the organisation of the subsystem of their collection, including setting collection dates and delivery of appropriate logistic units to customers. The article presents the results of a survey on a group of individual customers assessing their customer satisfaction with the organisation of secondary raw material collection. The CSI index was used to assess satisfaction. This evaluation became the basis for identifying the information gap in customer service. A conceptual solution to improve the information flow between operators and customers in the form of a mobile application was proposed as a solution to the disruption in this area.

Key words: secondary materials, circular economy, reverse logistic, ICT solutions

Synopsis. Ograniczona dostępność surowców naturalnych powoduje, że poszukuje się rozwiązań ułatwiających ich pozyskanie z już wyprodukowanych dóbr, które po zakończeniu cyklu życia stają się źródłem surowców wtórnych. Dla zapewnienia dostępności surowców wtórnych konieczna jest taka organizacja procesów logistycznych, by zapewnić synchronizację przepływów materiałowych i informacyjnych. Dużą rolę dla sprawności systemu logistycznego surowców wtórnych odgrywa organizacja podsystemu ich zbiórki, w tym ustalanie terminów zbiórki i dostarczanie odpowiednich jednostek logistycznych do klientów. W artykule zaprezentowano wyniki badania ankietowego na grupie indywidualnych klientów oceniające ich satysfakcję z organizacji zbiórki surowców wtórnych. Do oceny satysfakcji wykorzystano wskaźnik CSI. Ocena ta stała się podstawą do identyfikacji luki informacyjnej w zakresie obsługi klienta. Jako propozycję rozwiązania zakłóceń w tym zakresie

zaproponowano koncepcyjne rozwiązania usprawniające przepływ informacji pomiędzy operatorami a klientami w postaci aplikacji mobilnej.

Słowa kluczowe: surowce wtórne, gospodarka o obiegu zamkniętym, logistyka zwrotna, rozwiązania ICT

Introduction

Management of waste and recyclable materials is an important aspect for companies in supply chains. The amount of waste and recyclable materials is constantly growing, which on the one hand makes it a problem, whereas on the other hand it provides opportunities for the development of innovative solutions, in both the technological and organizational sphere. Waste and recyclable materials that end up in landfills are a real threat to the environment and have a direct and indirect impact on living conditions, as well as on health and functioning of the society and economy. The issues related to the management of waste and secondary materials are becoming important, primarily from the point of view of European regulations contained, inter alia, in the Green Deal [European Commission 2019] and of increasing pressure to find alternative sources of materials and energy. Efficiency of logistic processes in the management of waste and recyclable materials is becoming crucial for the fulfilment of environmental and economic goals not only for companies but also for regions and whole countries [Szołtysek 2009]. In order to achieve these goals, it is necessary to provide access to and exchange information between various entities, which is only possible with the use of appropriate IT solutions. IT solutions in logistic chains, where waste and recyclable materials are the subject of the flow, serve mainly to control and optimise the flow going through all the links [Daugherty et al. 2005].

Efficient information flow is crucial not only for meeting the environmental requirements but also for gaining competitive advantage, and often also for effective functioning within the market. The specificity of the secondary material market, particularly the sources to obtain these materials, makes it a challenge to develop dedicated IT solutions [Morgan et al. 2016].

The aim of the article is to present an ICT solution supporting the process of servicing customers who deliver secondary materials. The research used source data coming from a survey conducted among the customers of recycling companies, which then allowed to determine the CSI index. The survey was conducted among 200 randomly selected entities from the provinces of Silesia and Lesser Poland (Małopolska) which used the services of secondary material collection in the period between January and June 2020. The results of the survey were used to develop a concept of an IT tool to support the processes of collecting recyclable materials.

Secondary material management system

The term ‘secondary material’ has not been defined in the Polish and European legislation. This term usually refers to production waste or used products that can be reworked or reused after being recycled to recover valuable materials [Cepriá and Hiniesto 2015]. Hence, terms such as post-consumer waste, production waste (post-production, indus-

trial), post-depreciation waste (post-depreciation scrap), mining waste, electronic scrap, etc., are sometimes used interchangeably. Secondary materials are seen as value recovered from waste [Rogers and Tibben-Lembke 1999]. According to the provisions of Directive 2008/98/EC and its Polish equivalent [Ustawa z dnia 14 grudnia 2012 r.], waste is defined as substances or objects which the holder discards, intends or is required to discard. Production of waste is related to various human activities and thus waste has various form and composition. Due to a wide variety of types, waste can be divided into several groups [Rozporządzenie Ministra Klimatu z dnia 2 stycznia 2020 r.]. This division can be made according to: physicochemical composition, origin, level of danger to the environment (including humans), state of matter, toxicity and potential of further processing. To organize the classification, specific legal regulations have been adopted, which includes a waste catalogue and systematizes waste according to the following criteria: origin, properties of hazardous waste and potential threat to the environment. In practice, the waste catalogue makes it possible to distinguish 20 groups depending on its origin, including one group which comprises municipal waste [Rozporządzenie Ministra Klimatu z dnia 2 stycznia 2020 r.]. Vast majority of waste retains some characteristics and/or properties that give them the potential of being re-used. This approach creates environmental opportunities: reduction of the environmental impact that waste causes, as well as economic opportunities due to savings on acquisition of resources and materials [Mai et al. 2012]. Resources and materials that are obtained from waste are called secondary materials. Those are a type of waste that can be reused or processed for production and consumption. In strategic policy documents such as the National Waste Prevention Programme [Krajowy program zapobiegania powstawaniu odpadów z dnia 26 czerwca 2014 r.], the term 'secondary material' is generally not used. Instead, the term 'waste for selected groups of industries' is used, including, among others: mining waste, waste from the metal processing and chemical industries, as well as energy production waste (waste from the iron and steel production and, most of all, from the energy production industry). Hazardous waste from economic activities is also distinguished, including used batteries and accumulators, used electronic and electric equipment and decommissioned vehicles [Bendkowski and Wengierek 2004]. Whereas, a different classification is given in the National Waste Management Plan 2022 [Uchwała nr 88 Rady Ministrów z dn. 1 lipca 2016 r.].

The term "secondary materials" appeared in the draft document of the Ministry of Development entitled "Secondary materials for the industry. Action plan for securing the supply of non-energy mineral materials" [Ministerstwo Rozwoju 2017] but without providing a definition. At this point it is also necessary to refer to the classification given by the Statistics Poland where secondary materials are divided into natural secondary materials, processed secondary materials and waste materials, which are divided into post-production waste (generated during production processes) and used products, i.e. post-consumer waste [GUS 2019]. The latter can be used by another user after appropriate preparation, replacing the primary material. There are also a number of definitions in the available literature that refer to secondary materials and their classification. The multitude of waste classification in law and strategic documents as well as a lack of unified approach to secondary materials makes it difficult to classify and categorize them and to choose dedicated solutions related to the management of their flow throughout the whole reverse logistic chain.

In the context of intensive promotion and development of the circular economy concept in the European Union [European Commission 2018], it is necessary to verify the approach to the problem of waste, with particular emphasis on the notion of secondary materials, legislative and organisational solutions for handling them so as to transform waste management into sustainable management of material flows. In this respect, implementation of the circular economy concept involves, among other things, sorting out definitions and classifications of waste and identifying it as a source of potential secondary materials, ensuring availability and security of their supply and limiting the negative environmental impact by closing material cycles and promoting recycling and wider use of waste [European Commission 2015].

From a logistics point of view, management of secondary materials is a very broad issue, described, among others, by [Szołtysek 2009]: its structure, methods of collecting, used means of transport, treatment procedures, recovery and disposal. There are several processes involved in the waste and secondary material management system (Figure 1).

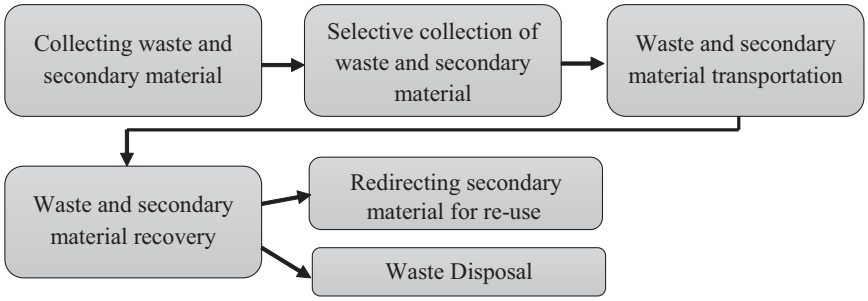

Figure 1. Processes in the logistic system for waste and secondary material
Rysunek 1. Procesy w systemie logistycznym zagospodarowania odpadów i surowców wtórnych
Source: adopted from [Zębek 2018].

The first stage in the management system for secondary materials is collection, which involves placing them in locations and / or containers suitable for that purpose. This also includes on-site storage of secondary materials. The second step is selective collection of secondary materials. There are different solutions for selective collection of secondary materials [Smolnik and Kozerska 2012]:

- containers located in the vicinity of houses, blocks of flats and other buildings – a system based on a selection of locations where containers for selective collection of recyclables will be placed,
- a special, limited area with full equipment - bins and containers in which various types of recyclables are collected,
- 'collection at the source' – collection of recyclables directly from households, which is considered to be the most effective system of selective collection of recyclables,
- regional collection points for secondary materials, which are designed to collect and pre-sort them.

Transport is another process in the management system of secondary materials, which is carried out using a technically advanced vehicle fleet or a pneumatic transport system. The final stages are recovery, sharing and disposal of secondary materials.

Survey of customer satisfaction with secondary material collection services

The secondary material market in Poland is estimated to be worth PLN hundreds of millions or even billions. Its significant resources and untapped potential are the reason why more and more business entities start activities in that area. Development of the secondary material market is fostered by increasing environmental awareness of the society and needs of entrepreneurs that use secondary materials. Legislative and economic aspects are also important. Year after year, the share of selectively collected waste and secondary materials that can be recycled or reused is increasing. According to Statistics Poland data for 2018, about 128.6 million Mg of waste was produced in Poland, of which about 115.3 million Mg was post-production waste and 12.5 million Mg was municipal waste [GUS 2019a]. In the case of municipal waste, a positive development is the increase in the share of selectively collected waste – in 2018, about 28.9% of municipal waste was collected selectively (in 2010 it was only 8.6%).

Intensive development of the waste and secondary material management sector means that new and existing companies are subject to the same rules of competition as companies in the supply chain. Above all, competition is intensifying at the contact stage with customers to ensure better adaptation to customer needs and requirements. In the second half of 2020, a customer satisfaction survey was conducted on the quality of service provided by recyclers. The survey made it possible to develop proposals for innovative customer service solutions for collection of recyclables. The questionnaire included 9 questions, which asked customers about, among other things: the type of recyclables returned to the companies who collect them, the frequency of use of recyclables collection services, the importance of factors affecting the choice of recyclable collection company, the level of satisfaction with the implementation of the collection of recyclables, a comprehensive assessment of the process of recyclable collection. The collected results allowed to calculate a Customer Satisfaction Index (CSI), which is one of the basic tools used to assess customer satisfaction. The index is a measure that allows for integration of logistical customer service elements and the results made it possible to identify areas for improvements in the customer service process. CSI is calculated by means of the satisfaction rates expressed by users, weighted on the basis of the importance rates, according to the following formula:

$$CSI = \sum_{i-1}^{N} \left(c_i \cdot w_{iw} \right)$$

in which:

c_i – the mean of the satisfaction rates expressed by users on the service quality i attribute

w_{iw} – (importance weight) is a weight of the i attribute, calculated on the basis of the importance rates expressed by users.

Specifically, is the ratio between the mean of the importance rates expressed by users on the *i* attribute and the sum of the average importance rates of all the service quality attributes:

$$w_{iw} = \frac{w_i}{\sum_{k=1}^{N} w_i}$$

CSI represents a good measure of overall satisfaction because it summarizes the judgments expressed by users about various service attributes in a single score. The more accurate the selection of the attributes, the more accurate the measure of the overall satisfaction. For this reason, the selected attributes should describe the service aspects exhaustively.

In the survey, respondents identified 4 main types of recyclables that are collected by local waste collection operators (Figure 2). The most frequently collected recyclables are waste paper (30%) and plastics (as much as 40%).

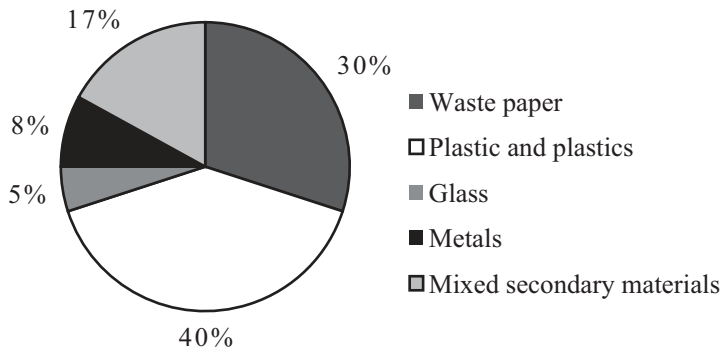

Figure 2. Main types of recyclables that are collected by local waste collection operators
Rysunek 2. Główne rodzaje zbieranych surowców wtórnych przez firmy odbierające odpady
Source: data from survey.

The CSI index was developed on the basis on the results of the questionnaire survey for questions regarding customer satisfaction and the importance of logistical customer service elements for the collection of recyclables from the customer [Wolniak and Skotnicka-Zasadzień 2008]. The mean value of the weights of the selected logistics customer service elements (c_i) and the mean value of customer satisfaction (w_i) were then calculated. A summary of the results is presented in Table 1.

Analysis of the results shows that the values obtained for the indicators are comparable. The lowest value of the satisfaction index is 2.57 and relates to the timeliness of order fulfilment, while the highest value (3.57–3.65) was obtained for the following three parameters: service fulfilment costs, variety of payment methods and complaints. When analysing the significance indicator, the lowest value is 3.03 and it concerns the variety of payment methods. On the other hand, the highest value of the significance indicator relates to the timeliness of service execution and the costs incurred for order execution. The values are 3.92 and 3.83, respectively. The CSI index was then calculated, which is 65%.

Table 1. Calculation of CSI
Tabela 1. Obliczenia wskaźnika CSI

Elements of logistical customer service	w_i	c_i	w_{iw}	CSI	CSI max
Service availability	3.40	3.03	0.095	0.287	0.474
Timeliness of service delivery	3.92	2.57	0.109	0.281	0.546
Comprehensiveness of the service	3.73	2.85	0.104	0.296	0.520
Time of order realization	3.83	3.17	0.107	0.338	0.534
Reliability	3.68	3.20	0.103	0.328	0.513
Competence of employees	3.40	3.37	0.095	0.319	0.474
Communicativeness and involvement of employees	3.60	3.53	0.100	0.354	0.502
Costs of service execution	3.83	3.57	0.107	0.381	0.534
Variety of payment methods	3.03	3.57	0.084	0.301	0.422
Complaints	3.47	3.65	0.097	0.353	0.483

Source: own calculations.

The literature sources quote 60% as a satisfactory value. However, this is a threshold value, which indicates the need to seek and implement new solutions that would improve the level of customer service, especially in the matter of collection of recyclables.

Design of an application to improve the implementation of a secondary material collection service

The results of the conducted customer satisfaction surveys, CSI assessment and conclusions coming from them indicate the need to develop a conceptual solution that would support activities of enterprises collecting recyclable materials in such areas as service availability, comprehensiveness, delivery time and timeliness. Current trends in that matter indicate the need to use solutions based on electronic communication with the customer. The development of a mobile application, which will enable online handling of secondary material collection orders and enable the exchange of necessary information in that matter is a key step in the development and improvement of customer service. Thanks to the application, the customer will more easily and quickly obtain information on service availability, timeliness and delivery time.

The concept of the product (the mobile application) is based on the assumption that it is software that will allow mobile devices to quickly and easily order collection of recyclable materials. In this way, some traditional documents will be eliminated from circulation and access to current information will be provided anytime and anywhere. The designed application would support the following operating systems: IOS, Android, Windows Phone. The mobile application would be designed in such a way as to make it easier for customers to place orders. The first stage of using the software is to download it and provide identification and contact details. The main view (Figure 3) includes such elements as:

– due date – this will mainly concern the choice of date of service and checking the availability of a given term, customers will be able to see which due date is occupied and which is free, therefore allowing them to choose a convenient date;

- execution timeframe – by clicking on this icon, the customers can specify the times at which they would like collection of recyclables to take place, thus saving time while waiting for people responsible for the service;
- recyclables – using this template customers can select the type of recyclable material from the following: recycled paper, plastics, metals, glass and mixed; in addition, the customers can specify the size of the recyclable material, so as to choose an adequate means of transport;
- cost – this icon will allow customers to see the price list for the service, which will be divided up according to the size and type of recyclables purchased;
- monitoring – this window allows customers to monitor how the service order is progressing and whether everything is progressing correctly;
- service evaluation – by opening this window customers will be able to assess the service after it has been rendered by the company and communicate whether they are satisfied with the service or not. The providers will be able to determine which aspects of the service require improvement. Therefore, the company will have an insight into what should be further improved.

Figure 3. Control panel of ICT solution for operator collecting secondary material (own design)
Rysunek 3. Panel kontrolny rozwiązania teleinformatycznego dla operatora zbierającego materiał wtórny (własny projekt)

Source: own elaboration.

The proposal to introduce a mobile application in handling of recyclable materials is primarily intended to improve the processes of logistical customer service. The introduction of timeliness, time and cost modules will allow customers to individualize the service. The introduction of a mobile application to the service providing company brings the following benefits:

- improvement of customer service quality,
- increase in customer satisfaction, thus increasing company revenue,
- streamlining the order placement and fulfilment process,
- saving time for both customers and the company employees, as everything is saved on the platform and employees do not have to enter it manually,
- quicker flow of information between the customer and the company,
- increased usability of this way of ordering,
- customers have access to information on costs, deadlines,
- increased efficiency of the company.

The app can be a way for better communication with a customer in a situation when the customer is offering the secondary raw materials for collection (pick up option). At the same time, the application would fulfill the needs of building ecological awareness of customers and responsibility for the way of waste management.

Summary

In order to reduce the negative impact on the environment and to ensure the availability of materials, more and more emphasis is being placed on solutions related to waste management, especially in relation to secondary materials. The concept of circular economy plays a particularly important role, which indicates the possibility and necessity of a new approach to systems and logistics processes of managing secondary materials (reverse logistics). The conducted literature study indicates a number of legislative and organisational barriers related to secondary material management, the most important ones being those currently focused on definitions. The survey carried out among the customers of companies that collect secondary materials indicates that the biggest disturbances in the process of secondary material collection and collection service implementation occur in the process of their aggregation and collection. Irregularities are mainly related to the timeliness and span of service delivery. Lack of customer satisfaction affects the functioning of the system of secondary material management as a whole, and thus heavily impacts the effectiveness of implementation of circular economy objectives. The article proposes an improvement of logistics customer service processes in the area of secondary material collection by using an Internet communication channel with a dedicated mobile application. The main functionalities developed in the application are a response to the identified disruptions in the customer service process. The application can be one of the elements to improve the efficiency of activities aimed at better use of waste, in particular the transparency of material flows, monitoring and tracking of waste / recyclables.

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Correspondence addresses:

Mariusz Kruczek, PhD, Eng.
(https://orcid.org/0000-0002-5052-3729)
GIG Research Institute
1 Gwarków Sq., 40-166 Katowice, Poland
e-mail: mkruczek@gig.eu

Zbigniew Żebrucki, PhD
(https://orcid.org/0000-0002-6426-2814)
Silesian University of Technology
Faculty of Organization and Management
Department of Management and Logistics
2A Akademicka St., 44-100 Gliwice, Poland
e-mail: zzebrucki@polsl.pl

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Konrad Michalski[1]***, Marek Nowakowski***[2, 3]
[1] Warsaw University of Life Sciences – SGGW
[2] State Higher Vocational School in Suwałki – PWSZ
[3] STEKOP S.A.

The use of unmanned vehicles for military logistic purposes

Wykorzystanie pojazdów bezzałogowych do celów logistyki wojskowej

Abstract. Nowadays the innovations and inventions allow the development of new technologies that can be implemented in various fields, including logistics. Technologically advanced robots and unmanned vehicles can not only support activities, but also in many cases they replace human being activities, such as controlling, identifying and managing goods, warehouse and critical infrastructure, or transport routes. Smart devices can eliminate human presence in the most advanced activities like firefighting or contamination of storage or transhipment. The aim of the study overview is to diagnose the current state and trends in the development of military technologies of unmanned vehicles. For this purpose some of the solutions in the field of unmanned ground vehicles and possibilities of their use considering military missions requirements were presented. The status of global projects implementation was reviewed. Polish solutions and technologies related to autonomous vehicles were discussed. A comparative analysis related to the global and domestic solutions was used. Recommendations, directions of development and possibilities of advanced technologies in terms of safety logistics, transport or fighting the effects of natural disasters were defined.

Key words: innovations in logistics, UAV, UGV, military logistics

Synopsis. Współczesne innowacje i wynalazki pozwalają na rozwój nowych technologii, które można wdrażać w różnych dziedzinach, w tym w logistyce. Zaawansowane technologicznie roboty i bezzałogowe pojazdy mogą nie tylko wspomagać działania logistyczne człowieka, ale także w wielu przypadkach zastępować go, czego przykładem jest kontrola, identyfikacja i zarządzanie towarami, infrastrukturą magazynową i krytyczną, a także szlakami transportowymi. Inteligentne urządzenia mogą wyeliminować obecność ludzi podczas najbardziej zaawansowanych czynności, takich jak gaszenie pożarów, czy skażenie składowania lub przeładunku. Celem przeglądowego opracowania jest diagnoza obecnego stanu oraz trendów rozwoju wojskowych technologii pojazdów bezzałogowych. W tym celu dokonano przeglądu rozwiązań w zakresie bezzałogowych pojazdów lądowych oraz możliwości ich zastosowania z uwzględnieniem wymagań misji wojskowych. Dokona-

no przeglądu stanu globalnej realizacji projektów. Omówiono polskie rozwiązania i technologie związane z pojazdami autonomicznymi. Zastosowano analizę porównawczą w odniesieniu do rozwiązań globalnych oraz krajowych. Określono rekomendacje, kierunki rozwoju i możliwości zaawansowanych technologii w zakresie logistyki bezpieczeństwa, transportu, czy walki ze skutkami klęsk żywiołowych.

Słowa kluczowe: innowacje w logistyce, UAV, UGV, logistyka wojskowa

Introduction

New challenges of logistic as well as many tasks related to ensuring an appropriate level of security in transportation require implementation of modern solutions and concepts like unmanned aerial vehicles (UAV) or unmanned ground vehicles (UGV) [Galaret et al. 2020]. Nowadays, UGVs are gaining more and more interest in terms of military applications. It should be underlined that unmanned vehicles can greatly facilitate key industrial operations like optimization of flows and improving warehouse management according to just-in-sequence production and just-in-time logistics. The nearest future should bring more intensive developed regarding automation process. Significant trend can be seen in unmanned ground vehicle market size looking at the last years and the forecast for the nearest future (Figure 1).

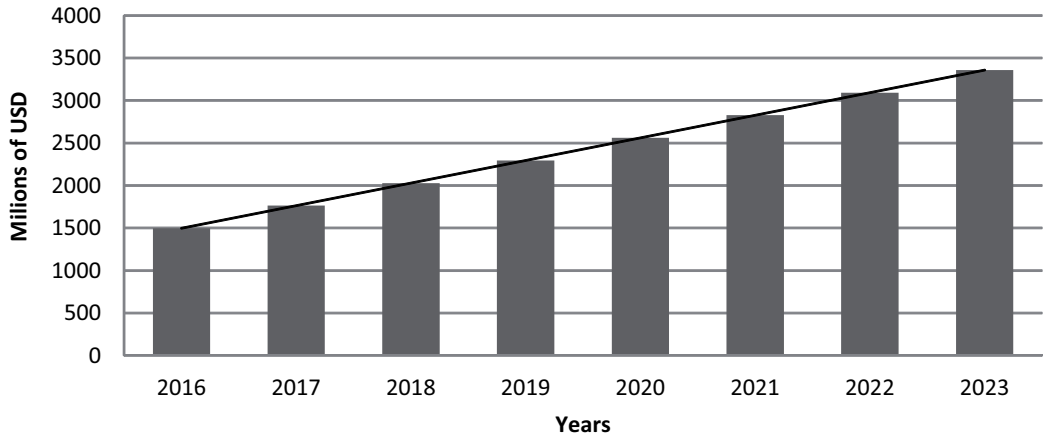

Figure 1. UGV market size in 2016–2023
Rysunek 1. Wielkość rynku UGV w latach 2016–2023
Source: [OpenPR 2020].

Published UGV protypes are intended as logistics carriers, remote weapons platforms, soldier companions, or surrogates for reconnaissance, surveillance, and target acquisition [National Research Council, 2003]. In USA authorities proposed unmanned vehicle called "mule robotic" which can perform variety of sustainment [Parker 2019]:

- carrying dismounted soldier loads
- operating in terrain requiring dismounted operations
- performing non-standard Casualty Evacuation and other services, such as battery recharging

– delivering classes of supply from battalion through company to the soldier to include resupply of ammunition
– performing combat tasks such as reconnaissance of high-risk areas.

Autonomous ground platforms without a human operator onboard covers a broad range of autonomy using technologies including navigation, mission sensing (object recognition), communications and piloting, machine intelligence for planning, learning and data analysis, mobile manipulation, energy storage and management, human-machine interface (HMI) [Ivanowa et al. 2016].

International applications of autonomous vehicles for land logistic

The unmanned vehicle can move freely in almost any environment under risk of explosion, fire, flooding, as well as operating in contaminated area. Unmanned platforms are suitable to carry out military activities also in urbanized areas. Their loss would not cause socio-political repercussions as death or serious injuries. Additionally we can noticed the manpower reduction in armed forces all over the world, so unmanned platforms and robotization can be a solution due to growing operational requirements.

In Europe and in the Western armies UGV`s are considered mainly as support for soldiers. Autonomous platforms should be capable to transport goods, ammunition, rucksacks, and to carry out missions when returning back from the fighting area. In the Middle East and Asia armies have a different approach, focusing on weaponised platforms, which allow to take part in warfare without risking soldier's life.

UGV implementation in UK

UK Ministry of Defence, Under Project Theseus, have purchased five unmanned ground vehicles type Horiba Mira. Three of technology demonstrators are wheeled Viking UGVs (Figure 2a) and two tracked Titan platforms [Advance 2020]. Project was launched for the development and operational field experimentation of autonomous logistic resupply systems.

Horiba Mira Viking is the UGV that has go an operational range of 200 km powered by diesel engine. It is equipped with hybrid drive allowing to move in the distance of 20 km using an electric drive for silent operation. Described demonstrator prototype is able to carry up to 800 kg of goods [Horiba Mira]. VIKING's 6-wheel independent suspension supporting troops using advanced AI-based autonomy with GPS-denied navigation. Vehicle is designed to travel at challenging terrain and tarmac as well as on the road up to 50 km/h. Despite of efficiently resupplying soldiers, Viking has got surveillance feature like providing a remote weapon station platform [Leigh 2020].

Armed Forces have also ordered Rheinmetall Mission Master vehicles (Figure 2b) under United Kingdom's Robotic Platoon Vehicle programme. It is the cargo version of unmanned vehicle which supposed to increase the combat capabilities of on the front line soldiers [Rheinmetall Mission…].

The ordered Cargo system will reduce the combat load, tactical kit, or medical equipment and boost soldier mobility and efficiency. It has got shoulder with payload

a) b)

Figure 2. View of Horiba Mira (a) and Rheinmetall's Mission Master (b)
Rysunek 2. Widok Horiba Mira (a) oraz Rheinmetall's Mission Master (b)
Source: own work based on [Eder Magazine 2018].

of up to half a ton of goods. Mission Master can operate in fully controlled, autonomous or semiautonomous mode due to implemented artificial intelligence allowing to execute a multitude of dull, dirty, and dangerous tasks.

Mission Master has got Lithium battery pack that allows to operate continuously for 8 hours at 30 km/h, carrying the full 600 kg maximum payload. Its sensors like Lidars, a front and a rear cameras and a 360° optronic system together with on-board computer , ensuring effectively operation in GPS denied urban areas and others [MilitaryLeak 2020]. Configuration includes bidirectional audio communication system and microphones.

UGV project supported in Europe

Estonian company Milrem Robotics is well-known for the development of the THeMIS (Tracked Hybrid Modular Infantry System) modular ground unmanned system, already validate in combat conditions. Based on this platform a new solution will be created under program called iMUGS (integrated Modular Unmanned Ground System). The main aim of this project is to develop modular and scalable solution allowing to create a whole family of manned and unmanned systems that would become the European standard for land unmanned vehicles [Sprenger 2020].

Milrem Robotics, as the leader of a consortium composed of several European defence, communication, cybersecurity and high technology companies expect the need of thousands of UGVs during the next 10–15 years growing the value of the market into billions of Euro [Cozzens 2020].

As it was mentioned above the modular construction makes the THeMIS effective autonomous ground vehicle for fulfilling missions in extreme environments. UGV has completed the first stage of implementation and combat trials supporting soldiers in Mali as part of the anti-terrorist Operation Barkhane [Milem Robotics]. The platform is designed to support troops by carrying everything what a soldier would normally carry (Figure 3).

It is a remote-controlled platform with a payload of 750 kg, powered by a hybrid system consisting of diesel and electric engines. UGV is equipped with many types of tie downs and restraints to prevent load movement. All the drive and control system are located in the side modules, inside the gap between upper and down part of tracks.

THeMIS allows to travel up to 10 hours, including about 90 minutes in silent mode when it uses only electric drive. The maximum speed is about 35 km/h and the range depends on the environment conditions. The vehicle is controlled by the operator via radio using sensors and the weapon system. It is also possible to transmit the collected data (an image form) to the appropriate command systems [Eder Magazine 2020].

a) b)

Figure 3. Themis UGV during misison in Mali: convoy (a) and anti-terrorist operation support (b)
Rysunek 3. Themis UGV podczas misji w Mali: konwój (a) i wsparcie operacji antyterrorystycznej (b)
Source: own work based on [Eder Magazine 2020].

Review of autonomous platforms under operation in the USA Army

US Army has developed a document called "Robotic and Autonomous Systems", referred to as the strategy for the development of vehicles in the future. Report includes a vision describing the cooperation of manned and unmanned controlled systems, as well as semi-autonomous and fully autonomous systems on the future battlefield. It also includes guidelines for robots, assisting troops which are considered as an urgent need [Walsh and Strano 2018].

The concept of a supporting soldiers robot, that was announced by SMET (Squad Multipurpose Equipment Transport) program, dominates the US Army (Figure 4). SMET focuses on creation of robots designed to relieve troops in the transport of weapons, ammunition, food and other necessary equipment, or to carry out reconnaissance and tasks related to the detection and removal of dangerous goods along the way. It means the proposed structures can also be armed.

The tactical and technical requirements assume that the vehicle can carry loads about 450 kg, which is related to four American military backpacks, six boxes of food rations and four water canisters. The range at maximum load should cover a distance of up to 100 km, and operate at lasts 72 hours [Cox 2020]. UGV should generate 3 kW of power (station-

Figure 4. The Army's Small Multipurpose Equipment Transport (SMET)
Rysunek 4. Wojskowy mały transport wielozadaniowy (SMET)
Source: [The General Dynamics…].

ary) and 1 kW (drive) keeping equipment and charging batteries during movement. The vehicle can be optionally armored, and potentially perform the function of electronic reconnaissance and neutralization of improvised explosives.

Technology applications in other destinations

Praesidium Global announced in 2017 that it was awarded to supply its UGV for validation by the Australian Army. The company offered Mission Adaptable Platform System (MAPS). It is semi-autonomous platform which can be equipped with additional on-board devices like charging generator, additional batteries, acoustic detectors and even low-recoil 30 mm cannon.

a) b)

Figure 5. UGV platform in Australian Army (a) and the Russian Marker roboti (b)
Rysunek 5. UGV platforma w armii australijskiej (a) i rosyjski robot Marker (b)
Source: [Drwiega 2020].

Proposed UGV version is suitable for tactical and non-tactical operations. According to an implement algorithm is designed to be controlled by operator, follow a soldier, or run between two defined points autonomously [Beurich 2019]. The Australian Army used the MAPS during the summer exercise Talisman Sabre 2019 (Figure 5a) held in Shoalw-

ater Bay Training Area, Queensland. The six-wheeled UGV has got payload over 500 kg of equipment to carry out missions [Wong 2019].

The Russian Foundation for Advanced Research Fund (National Center for the Development of Technologies) and Basic Elements of Robotics have shown new version of the modular unmanned ground vehicle called Marker (Figure 5b). The Marker is under validation by Special Operations Forces. The vehicle is very similar to a regular tank but design could be changed soon. According to published article by National Center the prototype managed mission in wild territory with a snow for 30 km in Chelyabinsk region [Papadopoulos 2020].

There are many more examples of developed unmanned ground vehicles playing an important role in support and assisting in logistics operations by army forces. UGVs are able to operate in very wide variety of situations require solving a number of difficult technical challenges.

Overview of domestic programmes in Autonomous Vehicles

In Poland, there are currently several centres dealing with robots dedicated to perform various tasks regarding land missions like Industrial Research Institute for Automation and Measurements (PIAP), the Military University of Technology and University of Technology allocated in Bialystok as well as Kielce.

The most recognized center under Łukasiewicz Research Network – PIAP is a manufacturer of Polish mobile robots, including for example C-IED applications and diagnosis [Łukasiewicz – Przemysłowy Instytut…]. In addition to the institute, the scientific and industrial consortium, consisting of ZM "Tarnów" S.A., Military University of Technology and STEKOP S.A., conducts research on the Perun platform called Autonomous wheeled vehicle with a weapon module for reconnaissance and combat tasks under support by National Centre of Research and Development of the Republic of Poland as part of the scientific research program for the defense and security [Nowakowski and Wacławik 2020]. It should be underlined that STEKOP has developed several variants of unmanned ground vehicles under TARVOS project powered by an electric motor and the internal combustion engine (Figure 6).

The first variant of TARVOS was based on a chassis from mass-produced quad. Company used a complete frame form the factory-manufacured vehicle along with the suspension and steering. The internal combustion engine and gearbox were replaced by an electric drive unit connected to the original drive shafts to carry out the project. Due to described modifications precise control of the platform was obtained with its diagnostics of the all driving conditions. Additionally, a new body was installed along with the necessary equipment including battery packs, a generator set, etc. The developed self-supporting body structure also allows to install all electronic devices controlling the vehicle, sensors, radio transmitters, cameras and an optoelectronic surveillance head [NCBR].

As part of the ongoing work, a conversion system was developed that allows to carry out a complete automation process of any special-purpose land vehicle, enabling remote control and data acquisition, both about the environment and the vehicle itself. The system consists of three elements: CVCP – Central Vehicle Control System, set of dedicated effectors and radio link. The proposed system will significantly expand the functionality

a) b)

Figure 6. Electric TARVOS CARGO (a) and TARVOS CARGO S90 equipped with combustion engine (b)

Rysunek 6. Elektryczny TARVOS CARGO (a) i TARVOS CARGO S90 wyposażony w silnik spalinowy (b)

Source: own work based on [Nowakowski and Wacławik 2020].

of the unmanned ground vehicle in line with the expectations of the modern IT-based battlefield.

Launched functionality allow to operate in remote, semi-autonomous and autonomous mode to transport goods, weapons, and related goods Additional value is simplification of maintenance. System is designed to be maintained easily as well as long-term usage can be managed sufficiently after basic training.

Technologies supporting autonomy of vehicles

The core element of the conversion technology is developed electronic control unit called CVCS (Figure 7). It is an operating unit containing the necessary IT infrastructure (IT) allowing for remote control of the whole vehicle as well as semi-autonomous and autonomous mode.

Operation of the system requires installation of additional effectors as mechatronic solutions that allows adaptation with the mechanisms like brake systems, electromechanical steering wheel and automatic gearbox operation system, etc.

Despite of components managing the chassis, an important role is played by sensors that enable the implementation of safety and autonomous functions. The platform should have an ability to detect surroundings for autonomous mobility. It should be stressed that environment is very dynamic so data fusion from navigation system, like global positioning system (GPS) and other devices is required. The vehicle must be able to use collected data from installed sensors to plan and follow a defined path avoiding obstacles.

The most important issue is to develop an effective system to recognize the vehicle's surroundings – including detecting and locating obstacles that may be dangerous during vehicle movement or insurmountable. Data fusion of vision systems with laser rangefinders may allow to create an effective system of environmental recognition. UGV

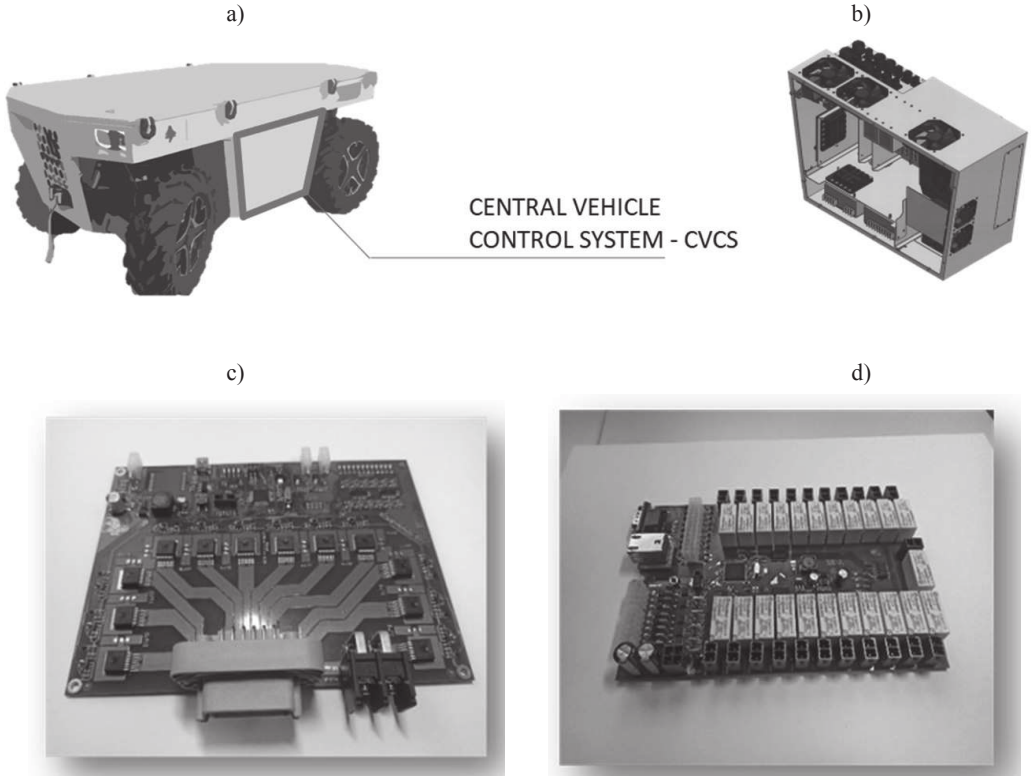

Figure 7. Location of CVCS (a) , central unit (b) and examples of designed internal modules (c, d)
Rysunek 7. Lokalizacja CVCS (a), jednostki centralnej (b) i przykłady zaprojektowanych modułów wewnętrznych (c, d)

Source: own work based on own materials of STEKOP company.

obstacle determination is based on the following devices: MRS1000 multi-layer scanner (LIDAR), Velodyne VLP laser scanner and cameras installed on each side of the vehicle (Table 1) [SICK Sensor Intelligence]. This enables the creation of a spatial model of the terrain and the determination of the location of terrain obstacles. Additionally the system allows to observe the environment through the installed Mobile Surveillance Solution Hikvision iDS.

Creation of spatial model of the area around the vehicle combined with a digital map of the terrain allows the vehicle to move autonomously. During parameter selection of the system, subsystems for determining the position and navigation should be considered. The issues of visualization of the environment must be related to the process of GPS tracking and automatic operation in case there is lack of signal transmission from satellite using build in gyroscopes and accelerometers contained inside an inertial measurement unit (IMU). Position accuracy can be improved when the INS is aided by Global Navigation Satellite System (GNSS) [InterialLabs].

Table 1. List of devices supporting navigation and anti-collision
Tabela 1. Lista urządzeń wspomagających nawigację oraz antykolizyjnych

Aided Inertial Navigation Systems (INS)	
Velodyne VLP	
SICK MRS1000	
Mobile Surveillance Solution Hikvision iDS	
IP cameras BCS	

Source: own work based on [Mapix technologies].

Tasks performed by autonomous vehicles

The four-wheeled autonomous vehicle is adapted for operation in urban and rural areas. TARVOS can be controlled on 3 levels: stationary, mobile and emergency (Figure 8). At the operator's position, the mission of the platform can be supervised by the operator by analysing the data transmitted from the installed vision systems and sensors on the unmanned vehicle.

Additionally (Figure 9), the vehicle can operate in the "follow me" mode by following the marked object. It can be a vehicle or a guide soldier.

The follow me system improves UGV functionality, because the platform is autonomously following the operator, recording his path and keeping safe distance, without

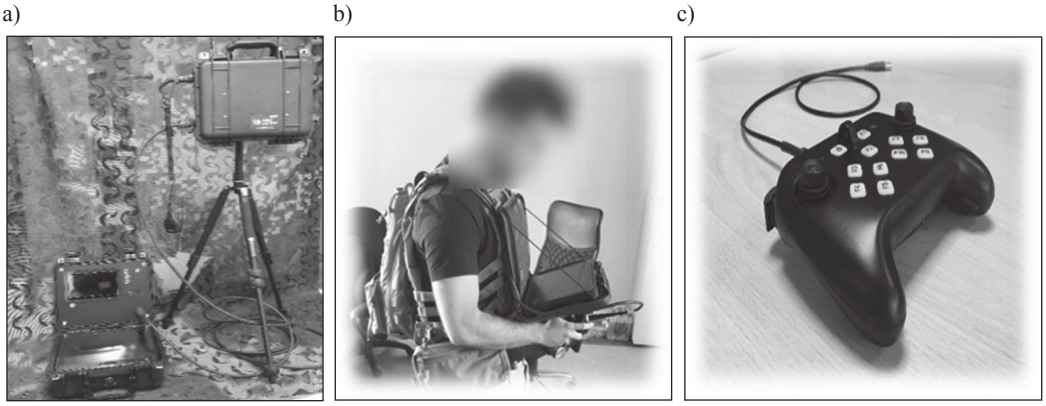

Figure 8. View of the control system: stationary (a), mobile (b), emergency (c)
Rysunek 8. Widok układu sterowania: stacjonarny (a), mobilny (b), awaryjny (c)
Source: own work based on own materials of STEKOP company.

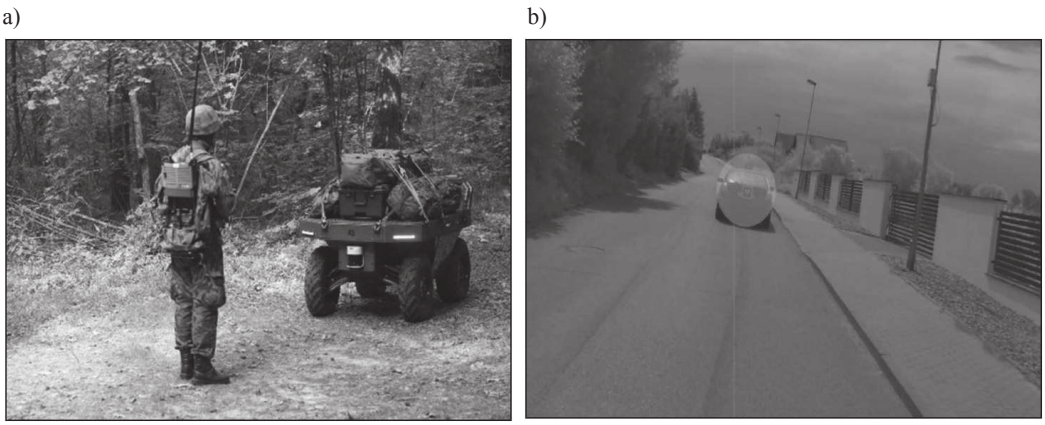

Figure 9. Follow me mode soldier (a), vehicle (b)
Rysunek 9. Żołnierz w trybie Follow me (a), pojazd (b)
Source: own work based on own materials of STEKOP company.

necessary actions from the operator side. The proposed system is based on printed pattern and cameras detecting its shape based on implemented algorithm. Based on measurements, system estimates relative operator's position and provide control signals for platform driving system.

Technology development plans

Unmanned Ground Vehicles received a lot of interest in recent years as a part of modern armed forces with an increasing number of dual use and civil applications. Current propulsion systems are based on different types of internal combustion engines related to fossil fuels. Due to the global energy policy alternative systems like fuel cells are consi-

dered for further development [Baldic et al. 2010]. More simple and faster to implement solutions is based on hybrid electric power train. Torsional moment electric motor allows to run in silent mode without using internal combustion engine. The combustion engine can recharge batteries and runs at a constant and efficient rate. Both option are under discussion for further development of TARVOS platform.

Taking into consideration safety issues and autonomous mode efficiency in all environmental conditions the perception system must be improved using more sensors like radars to detect, classify, and locate a variety of natural and manmade features.

An important research is the development of tools and specialist equipment allowing the implementation of various technological functions based on the fusion of data from advanced sensors. The accomplishment of this task requires the multi-level approach related to optoelectronics, computer science and radar technology.

Conclusions

Many autonomous unmanned vehicle technology is being used in more and more sophisticated areas, also civilian applications. An example is the use of drones for a long time to guard the warehouses of valuable cargo [Kuk 2015] or for logistics in the forest district [Michalski and Gębicki 2018]. These applications contribute to the increase of the broadly understood effectiveness of logistic activities, including bigger human safety.

Regarding UGVs, this technology is used widely in the teleoperation mode but one of the main directions of the armed forces is reducing human being involvement and risk, even in the most developed countries. High operational efficiency can be achieved by launching autonomous platforms in various defence applications to carry out transportation and rescue missions, combat support. In case of land platforms there are some challenges related to the requirements of the carrier as well as communication and control system. All authorities are working closely to define unification and standardization for unmanned vehicles.

There are various of common applications of unmanned vehicles for civilian and military purpose especially in rescue sector. Platforms support evacuation of the injured and managing transport rescuers. Such tasks require installation of additional sensors scanning the area by UGVs to search for the missing in debris or landslides. Many of introduced platforms can be also easily equipped with external fire extinguishing systems to assist in operations without human being presence like reconnaissance in the following places: industrial buildings, hazardous materials warehouses, underground parking lots, etc.

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Correspondence addresses:

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

Marek Nowakowski, PhD Eng.
(https://orcid.org/0000-0003-3864-076X)
State Higher Vocational School in Suwałki – PWSZ
Politechnic Department
10 Teofila Noniewicza St., 16-400 Suwałki, Poland
e-mail: marek.nowakowski@pwsz.suwalki.pl;
STEKOP S.A.
Director of Technical Department
9 Mołdawska St., 02-127 Warsaw, Poland

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Iwo Nowak, Jakub Bazela
Stanisław Staszic State University of Applied Sciences in Piła

Purchase of raw milk in Poland under coronavirus epidemic conditions – a proposal for organisational improvements

Skup mleka surowego w Polsce w warunkach epidemii koronawirusa – propozycja usprawnień organizacyjnych

Abstract. Purchase of milk in the conditions of the worldwide coronavirus pandemic 2019-nCoV, causing COVID-19 disease, since the first months of 2020, has resulted in numerous changes in the organization of the processes of raw materials acquisition and distribution, their processing and sale, as well as information flows accompanying these processes. One of the areas which is to some extent subject to specific changes is the organisation of passenger and freight transport, including transport to processing plants for raw milk obtained from farmers. The solution proposed in the article was created on the basis of interviews conducted in the spring of 2020 with 25 farmers – milk producers. The solution assumes maximum limitation of direct contacts between carriers and farmers during collection of raw milk from farms, as well as improvement of the system of transferring information about the quality of raw material obtained from farms and receivables for the producer.

Key words: transport, purchase of milk, coronavirus, tankers

Synopsis. Skup mleka w warunkach panującej od pierwszych miesięcy 2020 roku pandemii koronawirusa 2019-nCoV wywołującego chorobę COVID-19 spowodował liczne zmiany m.in. w organizacji procesów pozyskiwania i dystrybucji surowców, ich przetwarzania i sprzedaży, a także przepływów informacyjnych, towarzyszących tym procesom. Jednym z obszarów, który w pewnym stopniu podlega określonym przekształceniom, jest organizacja transportu osobowego i towarowego, w tym przewóz do zakładów przetwórczych mleka surowego pozyskiwanego od farmerów. Proponowane w artykule rozwiązanie powstało na podstawie przeprowadzonych wiosną 2020 roku wywiadów z 25 rolnikami – producentami mleka. Rozwiązanie zakłada maksymalne ograniczenie bezpośrednich kontaktów przewoźników i rolników podczas odbioru surowego mleka z gospodarstw, a także usprawnienie systemu przekazu informacji o jakości pozyskiwanego z gospodarstw surowca i należności dla producenta.

Słowa kluczowe: transport, skup mleka, koronawirus, cysterny

Introduction

In Poland, milk is one of the most important agricultural products – it has the highest share in commercial agricultural production [Wiza 2020]. The basic raw material for the dairy industry is cow's milk, obtained from producers – dairy cattle breeders – in the form of the so-called raw milk. The ingredients of raw milk in liquid form are water (about 88%) and dry matter (about 12%), consisting of about 250 ingredients, including protein, fat, mineral salts and lactose. Race, health, nutritional, individual and physiological factors influence the fact that the chemical composition of milk is not constant and its fluctuations – if they are within the accepted limits – are acceptable and do not prove e.g. abnormalities in the milk glands of animals [Czerniewicz 2010a].

In terms of quality, milk constituting a raw material for the dairy processing industry should have a specific chemical, microbiological (in terms of the number and type of microflora), cytological (the number of somatic cells coming from the udder), as well as technological suitability and required level of chemical and mechanical impurities. Moreover, as a raw material for industry, milk should be characterized by such elements as:

- freedom from pathogens,
- no harmful, poisonous or foreign substances,
- a small number of bacteria,
- no symptoms of enzymatic activity,
- low somatic cell content,
- having nutritional and functional properties,
- delicate, mildly sweet and slightly salty taste,
- fresh and natural scent.

In order to obtain the desired characteristics, which constitute the highest quality raw milk, it should be obtained and stored under hygienic conditions protecting it from infection and development of acidifying and harmful microorganisms; it should come from healthy animals; it should have an acceptable chemical composition [Czerniewicz 2010a]. It should be treated with due diligence by the farmer-producer himself, as well as during the whole process of transport and transfer from one tank to another in accordance with specific legal requirements, accepted procedures and generally applied principles of good practice. Moreover, seasonal changes in the physicochemical composition of milk, which are additionally influenced by the location of milk production (e.g. in lowland or mountainous regions), should be taken into account.

The development of the COVID-19 pandemic poses a real threat to farmers and milk processors. First of all, the spread of the virus has significantly reduced the demand for dairy products. The decrease in consumption was mainly due to the closing of the HoReCa market. The reduction in demand resulted in a drastic drop in prices, difficulties in exporting products, a sharp increase in packaging prices and an increase in freight prices. The supply of high-quality raw milk to processing plants has become a significant problem due to the risk of virus transmission with the transport of milk.

Aim and methods

The aim of the study was to develop a solution ensuring safe supplies of raw milk from the producer to the enterprise. The research used data from the Central Statistical Office and information from the literature on the subject on the latest technological solutions. The study was based on interviews conducted with a group of 25 milk producers from: Kościerzyn Wielki (commune Łobżenica, Piła county, Wielkopolskie Voivodeship), Woźnawieś (Rajgród commune, Grajewski county, Podlaskie Voivodeship) and the Augustów district, Podlaskie Voivodeship). The surveyed farmers delivered milk to: District Dairy Cooperative in Łobżenica and MLEKPOL Dairy Cooperative in Grajewo. The study presents the situation on the milk market in 2020, types of cisterns for transporting milk and devices used in the control and measurement system for milk collection.

Production and purchase of milk during the pandemic in Poland

The COVID-19 pandemic has heavily impacted many agricultural sectors around the world [Barichello 2020, Marton 2020, Zhang et al. 2020]. Among the sectors that have suffered the most is the dairy industry because dairy products are highly perishable and depend on integrated and time-sensitive supply chains [Drury 2020, Marshall 2020].

According to the data of the Polish Federation of Cattle Breeders and Milk Producers [Polska Federacja Hodowców Bydła i Producentów Mleka 2020], in December 2019, the number of dairy cows in our country was 2,164,459, while in June 2019 it reached 2,221,000, a decrease of 2.3% (Figure 1). Overall, between 2010 and 2019, the share of dairy cows in the total cow population decreased from 96 to 90%. Last December, a decrease in the number of dairy cows was recorded in 13 provinces, the largest of which were in Podkarpackie (by 13.7%), Małopolskie (by 9.6%), Lubuskie (by 9.2%), Opolskie (by 7.7%), Zachodniopomorskie (by 6.7%), and Kujawsko-Pomorskie (by 6.3%). An increase in the number of dairy cows was recorded only in 3 provinces: Śląskie (by 3.9%), Łódzkie (by 3.2%) and Wielkopolskie (by 0.3%).

Purchase of milk in June 2020 in Poland amounted to a total of 1,035.7 million l, which was 3.6% lower than in May this year and 4.4% higher than in June 2019. In the first half of 2020, the total of 6 156.2 million l of milk were purchased from producers, which is 2.6% more than in the comparable period of 2019. At the same time, from January to June 2020, the largest amount of milk was lost from the following provinces: Warmińsko-Mazurskie (292.9 million l), Kujawsko-Pomorskie (238.9 million l), Wielkopolskie (187.1 million l). From other provinces, milk was mainly delivered to Podlaskie Voivodeship (888.5 million l). For comparison, in May 2020, 13 192.0 thousand tons of milk was delivered to dairies in the 27 countries of the EU, i.e. 0.5% more than the year before and 3.3% more than in April this year. It should be noted that the five largest milk producers in the EU-27 (Germany, France, the Netherlands, Italy and Poland) purchased a total of 8,473.0 thousand t of cow's milk in the analysed month, i.e. by 0.1% less than in 2019 (this volume constitutes 64.2% of all milk purchased in the EU [Polska Federacja Hodowców Bydła i Producentów Mleka 2020].

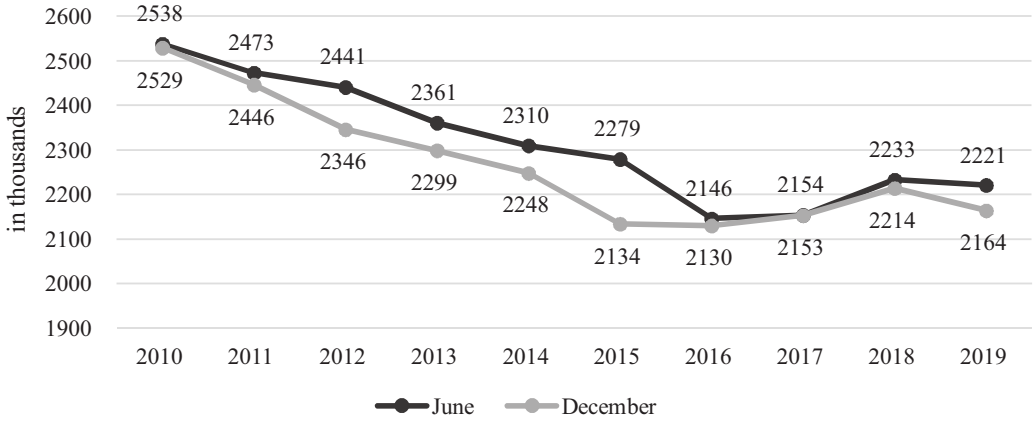

Figure 1. The number of dairy cows in Poland in 2010–2019
Rysunek 1. Pogłowie krów mlecznych w Polsce w latach 2010–2019
Source: own study based on data GUS.

According to the analysts of the Polish Federation of Cattle Breeders and Milk Producers, the upward trend in the price of purchased milk, which persisted in the second half of 2019, unfortunately did not persist in the first half of 2020, in which the downward trend has practically continued since February. According to the data of the Central Statistical Office, in June 2020 the average price of purchased milk amounted to 130.61 PLN/hl and was 0.2% lower than in May of the same year and 1.1% lower than in June 2019. Moreover, there are quite significant differences in the in the first half of 2020 of last year's upward trend in the price of purchased milk, which became a downward trend, did not automatically affect the deterioration of production indicators for dairy products, which could be influenced by imports of milk from abroad. As indicated in the July edition of the Milk Market report [Polska Federacja Hodowców Bydła i Producentów Mleka 2020], between January and May 2020, 1,447.1 million l of drinking milk was produced (6.1% more than in the same period of 2019). During the five months of this year, 142.5 thousand tons of ripened rennet cheese was produced (0.8% more than in 2019). According to CSO data, the total production of butter from January to the end of May 2020 reached 107.5 thousand t, which is 8.5% more than in 2019. In the first 5 months of 2020, the production of skimmed milk powder was reduced by 2.1% (compared to 2019) to 75.7 thousand t. The production of whole milk powder was also reduced by 8.2% (compared to 2019), which amounted to 14.5 thousand t.

As indicated by the Polish Federation of Cattle Breeders and Milk Producers, in the short term perspective for 2020 for agricultural markets in the EU, prepared by the European Commission, it is predicted that the volume of milk collection will be reduced while its export will increase. However, the observed growing retail demand for milk and its products will not be able to compensate significantly for the losses incurred by the whole catering industry as a result of restrictions introduced by the governments of the countries covered by the coronavirus pandemic. A certain factor mitigating the effects of the pandemic may be the increasing opening of the HoReCa sector (hotels, restaurants, catering), especially in the holiday season of 2020, however, the reduced purchasing power of con-

sumers and the sustained increase in prices may prevent a rapid return to the 2019 level. For Polish farmers, who own more than 80% of milk production in our country, the most important achievement during the pandemic was to maintain continuity of work, even though there were cases of unexpected termination of contracts for delivery of thousands of litres of raw milk per day by existing customers, which forced its producers to look for new contractors [Lewandowski 2020].

Transport of milk – from the producer to the processor

The milk transport process begins immediately after milking [Rozporządzenie (WE) nr 853/2004]. This means that it is necessary to observe all requirements and recommendations related to maintaining, among others, its hygienic, microbiological and cytological purity, as well as its nutritional value, until the delivery of raw milk to the processing plant (which should process raw milk within a day of its receipt). One of the elements is to maintain the appropriate temperature of the milk, which should not exceed +8°C if it is collected from the farm during the day, and +6°C if it is not collected daily. In case of high microbiological quality of raw milk, it is possible to keep the freshness longer – e.g. at +4 °C even up to 48 h [Czerniewicz 2010a]. Maintaining sufficiently low temperatures of the transported raw milk must be maintained at all times, as the temperature of the raw milk must not be higher than +10°C after its arrival at the final recipient. By observing these temperature values, it is possible to maintain milk quality even if the time of transport and marketing of milk by its producers and recipients is extended. The above mentioned thermal limitations in milk storage and transport may be omitted, however, in cases when milk from its milking is processed within 2 hours, as well as when, for technological reasons, higher temperature of the raw material is necessary in connection with the production of specific dairy products, however, on condition of receiving permission for it from the competent supervision authority [Kowalik 2011].

The smooth functioning of the milk supply chain, from collection, processing and distribution to the final retail consumer, is very much dependent on efficient transport. That is why it is so important to properly organize the transport process of milk, including the access to the farmer – the producer of the raw material, collection and transport to the processing plant and delivery of the obtained milk, as well as subsequent loading and unloading of finished products or semi-finished products for wholesale and retail recipients. Organization of the transport process must assume its proper functioning taking into account the use of the farmer's own vehicles – milk producer, processing plant or hired carriers (e.g. within the framework of outsourcing), having appropriate means of transport and properly trained personnel.

The transport between the milk producer and the processing plant takes place in two ways: direct or indirect deliveries, using an additional element of the supply chain, i.e. the collection point. The latter form may facilitate a more flexible management of the purchased raw material and a better adjustment of deliveries to the premises of the final recipient of raw milk, however, it brings with it the danger of mixing in stationary tanks or mobile tanks of milk with non-identical quality parameters, coming from different producers. A separate issue is the necessity of additional protection of raw material (espe-

cially when pumping and overflowing several times) against its aeration, temperature changes, increase in the amount of microorganisms and other negative elements, which decrease the quality of milk [Litwińczuk 2004].

The technological quality of the raw milk is also adversely affected by mechanical stimuli such as shocks (strokes) or vibrations (vertical and horizontal) at low and high frequencies during transport and pumping. Vibration in car transport, depending on the type of factors causing it, is in the range of 0.5–10 g (usually 0.5–1.5 g. occasionally 2–3 g), and 1–25 Hz. It was found that only the transport on a good quality asphalt pavement, in case of acceleration of 2 m/s, speed of about 60 km/h and over 60% filling of the tanker tank does not cause significant changes in the quality of transported milk [Czerniewicz 2010b].

High susceptibility of milk to mechanical influences damage to the structure of its components (mainly fat), which results in destabilization of the emulsion, manifested by the formation of butter grains. Passing vibrations through raw milk causes, first of all, mechanical deformation of fat globules, which leads to damage to their phospholipid-protein envelopes. All this favors the escape of liquid fat, which is the binder of the fat globules. As a result, shocks and vibrations of raw milk intensify the hydrolysis of milk fat. The destructive influence of mechanical influences on milk components, especially on fat globules, is intensified when the raw material is aerated. Mechanical interactions during transport of raw milk, resulting in the above mentioned transformations of its components, bring about an increase in acidity, a decrease in thermal and ethanol stability, as well as a significant conflict between rennet clotting time [Czerniewicz 2010b].

Milk transport equipment – specialised equipment

Modern means of milk transport are characterized by increasingly specialized systems of collection and analysis of milk collected directly from producers. The technical devices currently offered on the domestic market can be of great help in organizing milk collection from producers during the coronavirus pandemic. The most important are cisterns and The most important ones include tankers and control and measurement systems.

Tankers

On the Polish market, manufacturers offer tanks which can be mounted - depending on the customer's wish - on chassis of various brands, including DAF, MAN, MAZ, Mercedes-Benz, Mitsubishi, Renault, Scania or Volvo. These tanks are equipped with a raw milk collection system and their capacity may vary from e.g. 3000 to 17,000 litters. The tank is made of stainless steel and the number of internal chambers and their capacity is agreed with the customer before placing an order. The external surface of the tanker is made with the use of the technique of smearing or grinding – depending on the customer's preferences. Tank sections are also available: elliptical, circular or trunk sections. The use of an elliptical section guarantees lowering of the vehicle's centre of mass, which improves its traction. Moreover, the elliptical cross-section improves durability and reliability of the body structure. The use of polyurethane foam also provides 25% more effective thermal insulation of the tanker than many fillers used before. This solution protects

the transported milk against temperature changes of up to 1°C even after several hours of standstill with a difference in ambient temperature and tank content of up to 30°C. Equipment manufacturers can issue an ATP certificate[1]. Mounted on a road chassis, the tanker is also equipped with an installation enabling washing in the system CIP[2].

Figure 2. Tank (capacity 26,000 l), with a wheeled section on a self-supporting semi-trailer
Rysunek 2. Zbiornik (pojemność 26 000 l), z częścią kołową na naczepie samonośnej
Source: [WSK „PZL – KROSNO" S.A.]

Figure 3. Tank with elliptical section on Mercedes-Benz chassis
Rysunek 3. Zbiornik o przekroju eliptycznym na podwoziu Mercedes-Benz
Source: [WSK „PZL – KROSNO" S.A.]

[1] ATP (Aqreement Transport Perisahble) International agreement drawn up in Geneva on 1.09.1970 sets out the rules for the international transport of certain perishable food products using special means of transport and for checking the compliance of these means of transport with the applicable standards.
[2] CIP System (Cleaning in Place), i.e. on-site cleaning, refers to cleaning in a circular or continuous process of production installations and pipes – without the need to dismantle them beforehand.

Figure 4. Tank with elliptical section on Scania chassis
Rysunek 4. Zbiornik o przekroju eliptycznym na podwoziu Scania
Source: [WSK „PZL – KROSNO" S.A.]

Figure 5. Tank with elliptical section on DAF chassis
Rysunek 5. Zbiornik o przekroju eliptycznym na podwoziu DAF
Source: [WSK „PZL – KROSNO" S.A.]

Figure 6. Tank with chest section on MAN chassis
Rysunek 6.
Source: [WSK „PZL – KROSNO" S.A.]

Figure 7. Three-axle tanker – trailer with elliptical section
Rysunek 7. Cysterna trzyosiowa – przyczepa o przekroju eliptycznym
Source: [WSK „PZL – KROSNO" S.A.]

Figure 8. Two-axle tanker – trailer with a wheeled section
Rysunek 8. Cysterna dwuosiowa – przyczepa z częścią kołową
Source: [WSK „PZL – KROSNO" S.A.]

Control and measuring system for milk collection

Side cabinet made of stainless steel (heated), mounted on shock absorbers at the tanker, closed with a split door, contains a direct milk collection system with control and measuring equipment of the selected company. The devices of this system can be made in different variants, individually tailored to the customer's wishes. The control and measurement system consists of the following elements:

- hydraulically driven impeller pump with a capacity of e.g. up to 30,000 l/h. It is also possible to install a high-performance vacuum-pumping system – up to 60,000 l/h,
- air separator (e.g. 70 l capacity) providing accurate measurement, equipped with washing valve, venting valve and venting line, which thanks to its design guarantees reliability in all operating conditions, as well as ease of cleaning its individual elements and maintaining high hygiene of the separator,
- magnetic-inductive flow meter,

– mechanical filter,
– check valve,
– valve system – central drain collector,
– control panel – control box,
– the computer control unit,
– temperature sensor,
– liquid sensor,
– thermal printer,
– sample taker (with manual or automatic carousel bottle substitution mechanism).

Figure 9. Cases with installations for milk collection and analysis on elliptical tankers on three-axle self-supporting trailers

Rysunek 9. Przypadki z instalacjami do zbierania i analizy mleka na eliptycznych cysternach na trzyosiowych przyczepach samonośnych

Source: [WSK „PZL – KROSNO" S.A.]

Milk collection system

There are examples of functions:

– milk collection,
– measuring the quantity of milk collected,
– displaying data on milk parameters,
– measurement of the temperature of the raw material to be taken,
– automatic pump blocking in case of exceeding the present milk parameters,
– switch the milk pump on and off with the remote control,
– data recording in the control unit memory,
– programming of milk collection routes,
– printing receipts and other statements,
– automatic sampling of representative suppliers with automatic bottle change,
– storage of samples in a warehouse with an active cooling system,
– automatic representative tanker sample collection,
– data transmission from the road tanker to the processing plant computer using a cache module (USB stick, memory card), WIFI, cable,
– automatic bottle identification with barcode reader,
– identification of suppliers by means of GPS.

Figure 10. Open cabinet with installation for milk collection and analysis at a tanker with circular cross-section on a self-supporting semi-trailer
Rysunek 10. Otwarta szafa z instalacją do odbioru i analizy mleka w cysternie o przekroju kołowym na naczepie samonośnej
Source: [WSK „PZL – KROSNO" S.A.]

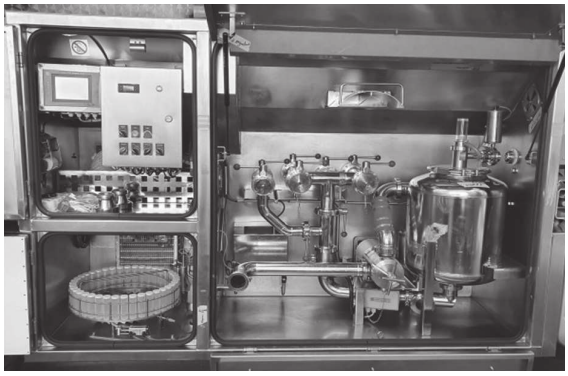

Figure 11. Cabinet interior with installation for milk collection and analysis at the tanker
Rysunek 11. Wnętrze szafy z instalacją do odbioru i analizy mleka przy cysternie
Source: [WSK „PZL – KROSNO" S.A.]

Figure 12. Installation for milk analysis on a tanker mounted on a Volvo chassis
Rysunek 12. Instalacja do analizy mleka na cysternie zamontowanej na podwoziu Volvo
Source: [WSK „PZL – KROSNO" S.A.]

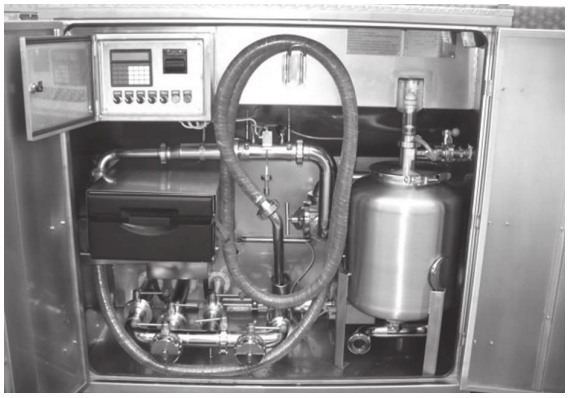

Figure 13. Installation for milk collection and analysis at the tanker
Rysunek 13. Instalacja do zbierania i analizy mleka przy cysternie
Source: [WSK „PZL – KROSNO" S.A.]

Conditions of milk collection and transport during the pandemic in Poland

The production of raw milk is combined with its frequent distribution to the processing plant. Therefore, there are understandable concerns about maintaining the continuity of this transfer between the milk producer and the recipient, resulting both from the maintenance of the health condition of people employed directly at milking, as well as personnel handling the direct collection of milk from the farmer, and the transport of raw material to the processor.

In March and April 2020, the Polish Chamber of Milk [Polska Izba Mleka 2020] developed and presented a document entitled "Procedure for handling coronavirus SARS-CoV-2 in dairy farms". At the same time, individual dairy cooperatives provided their suppliers with additional recommendations, especially concerning the handling of the risk of coronavirus infection of one of the farm inhabitants and keeping an appropriate distance from the staff collecting milk (e.g. tanker drivers), or avoiding contact with it at all [Tobojka 2020]. One of the national leaders in the production of ripened cheese, the Polish Spomlek Dairy Cooperative (having plants in Radzyń Podlaski, Parczew, Młynary and Chojnice), introduced during the pandemic, among others, the necessity to use gloves, masks and disinfectants by the drivers collecting milk from producers, while the hand disinfection takes place both before entering the area and after leaving the farm. The milk producers who cooperate with this company have also been supplied with disinfectant fluids, supporting activities aimed at minimizing the risk of infection. A special Crisis Team established at the beginning of the year in SM Spomlek has also developed a set of detailed recommendations for practical implementation by its suppliers – raw milk producers. Similar organizational and informational activities have also been undertaken by other producer companies in the dairy industry in relations with farmers supplying them with milk, and e.g. one of the largest dairy groups in Central and Eastern Europe, the Mlekovita Group (having 20 production plants and cooperating with 15,000 domestic milk suppliers) from Wysokie Mazowieckie (Podlaskie Voivodeship) asks for making

soap, disinfectant, paper towels and a container for waste disposal available to drivers collecting milk, among others. Moreover, it is pointed out that the access to the farm of people necessary to run it is limited[3].

Particular attention is also paid to the need to report on the current health situation of persons employed and living on the farm, as well as to the obligatory notification of the processing plant collecting milk about every case of coronavirus infection. In case of quarantine and epidemiological supervision of the farm, this information will enable people directly collecting and transporting milk to be particularly careful at all times of milk collection from the producer. Appropriate procedures to prevent the spread of coronavirus have also been implemented on the premises of dairy cooperatives and their production plants, where, among other things, the access of outsiders has been limited as much as possible, and drivers importing milk from farmers have their body temperature measured each time [Polska Izba Mleka 2020].

The proposed solution

The coronavirus pandemic 2019-nCoV, which caused COVID-19 disease, has continued uninterruptedly since the beginning of 2020 in Poland and many other countries in Europe and the world and has caused a number of changes covering almost all areas of life, including the economy and agri-food industry. Forced by, among other things, sanitary and epidemiological reasons, transformations in the organization of the process of collecting raw milk from producers induce the search for new solutions, eliminating to the maximum extent possible spread of coronavirus among the participants of the "milk supply chain". Due to the expected longer (than 1 year) duration of the pandemic, efforts should be made to improve the process of collecting and transporting raw milk from the farmer-producer to the processing plant.

One of the proposals may be to introduce stable or movable raw milk tanks, in places easily accessible to drivers picking up from the farm – without the need to enter the farm (if possible without disturbing traffic). Milk collection would take place without the necessity of any contact between the driver and the milk producer, and information about the collection of a certain amount of raw material, its quality parameters (analysed from the samples taken just before pumping the milk to the tanker), date and time of refuelling and data identifying the producer and the direct recipient (driver) would be transferred on-line to the processing plant. If there would be no need for additional tests of delivered milk at the recipient's place, then on the basis of electronically received data from the driver and available history of cooperation with a particular milk producer (especially in the scope of quality of the raw material received from him), the purchasing company could make a decision on quality qualification of the current delivery and start appropriate financial procedures for payment for the acquired goods (in this case raw milk). The proposed solution should not violate the existing conditions of contracting, but only allow for a completely epidemically safe functioning of milk collection in the conditions of the ongoing coronavirus pandemic.

[3] Data obtained from companies and company information materials.

The assumptions made can be specified in the following groups and points:

1. Prevention of the risk of coronavirus infection:
   - elimination of any contact between the person collecting raw milk and the producer and those living and working on the farm,
   - ensuring maximum epidemic safety of drivers collecting milk from producers' farmers guarantees uninterrupted, planned work of the existing staff, not causing the necessity of emergency start-up of replacements and obtaining additional people "from outside", requiring e.g. professional training on conditions during milk collection and transport to the processing plant.
2. Milk tank(s) to be collected by the driver:
   - if it is technically, organisationally and legally possible, a container/tanks for the raw material to be collected would be placed on the farm (or directly adjacent to it, belonging to the farmer – milk producer),
   - the number of tanks and their capacity would depend on the size of the milk batch to be collected directly by the truck driver (or, if necessary, by several vehicles with trailers during one collection),
   - the milk tank(s) ready for collection would be placed on a solid base or, if this is not possible, on a chassis allowing for slight movement,
   - the collection-ready milk tank(s) would be connected to an existing installation that transports milk from milking to the current milk storage areas. This connection could be permanent (providing better sanitary and quality conditions for the pumped milk) or temporary (installed only for the period of milk transfer from the farm),
   - the responsibility for keeping the collection-ready milk tank(s) clean would rest with the milk producer,
   - installation on the farm (or any other designated place) of a milk tank(s) ready for collection would be carried out under supervision and at the expense of the processing plant or with partial financial participation of the milk producer,
   - the milk tank(s) ready for collection would be owned by the entity collecting the raw material (e.g. a processing plant) and the farmer - producer would use it on a lease basis (free of charge or for a small amount which could be redeemed e.g. for delivering milk of a specific quality),
   - raw milk pumped by its producer to a leased tanker/tanker, at the moment of passing the information to the milk consignee (processing plant, other buying entity) would be the property of the latter and would remain at his disposal until collection,
   - maintaining a certain temperature in the milk tank(s) ready for collection, regardless of the season and weather, would be carried out by means of an installation installed in each of them, powered by energy from photovoltaic batteries (in case of a shortage of energy from the sun, e.g. during the winter period, it would also be drawn from the farm network. The cost of the energy taken – based on the reading of a separate meter – would be divided between the tank owner and the milk producer),
   - the area occupied by the place where the raw milk tank(s) are set up for direct delivery to the driver should make it possible – in case of development of milk production by the farm – to deliver further tanks for direct collection.

3. Making the organisation of milk collection by producers more flexible:
   - milk collection (in accordance with the conditions in force) can take place at the most convenient time from the point of view of the economy of using the tanker fleet,
   - in case of a vehicle breakdown, milk collection could be carried out without any disruption by another driver, at another time, without breaking the previously applicable schedule for collecting raw milk from the producer,
   - notification (by electronic means) by the farmer of readiness to hand over milk to the driver would make it easier for the consignee (the owner of the tanker fleet) to use the vehicles available at that time that are not working,
   - the information provided in real time by milk producers on their readiness to transfer milk from leased tanks would allow the processing plant to rationally manage their milk for this further storage and collection from farmers,
   - at the moment of transferring by the driver the information about milk collection and its quality and confirmation of the recipient's acceptance of these data, the processing plant or other entity collecting milk would start the procedure of transferring the receivables for purchased milk to the producer's account,
   - in case of necessity to perform additional tests collected from the producer by the milk driver in the processing plant, until they are completed and the raw material is evaluated, the duty transfer procedure would be stopped.

In the course of the conducted research, milk farmers – producers paid attention, above all, to the necessity of legal and financial regulations between a milk producer and its recipient, with regard to the foundation of leased tanks and their operating costs. They positively assessed the possibility of selling milk at the moment of its collection (after a positive assessment of its quality) combined with a quick transfer of receivables for the transferred raw material. About half of the surveyed persons had some controversy about the issue of separating a part of the farm's area, especially since the area is located as close as possible to a public road, which – if the conditions allow it – would make it possible to collect milk from the leased tanks without the need for a tanker truck to enter the private area and the possibility of introducing pathogenic viruses there. Possible "financial losses" resulting from separating part of the farm for these tanks could be compensated by free of charge lease of these devices, self-sufficient (if solar conditions allow it) in terms of energy – despite the necessity of keeping the tanks clean by the lessee. The overwhelming majority of dairy farmers emphasized the benefits of fast transfer of raw material to the leased tanks, which would automatically free up space for a new batch of milk and the preceding cleaning operations of the entire plant.

Another interesting aspect seems to be the possibility, arising as a result of the proposed solution, of temporary storage by producers in leased milk tanks, which would formally become the property of the recipient at the moment of collection by transport (after acceptance of the quality data of the raw material transmitted electronically by the driver), but can be transferred by the recipient not only to his own plants, but – in the case of e.g. unexpected failure or oversupply – directed to another processing plant or sold to another recipient.

Conclusions

The collection of raw milk from producers is a very important part of the supply chain in the milk and dairy products market. The offer of milk tankers available on the market and their equipment allow you to collect milk from producers in a safe way. Due to the coronavirus pandemic, however, organizational changes are necessary.

The paper presents a solution for safe delivery of raw milk to breeding enterprises. This proposal is particularly important during the development of the COVID-19 pandemic. Due to the limited timeframe of the field analyses, the studies conducted so far do not fully exhaust the signs of complementarity. Therefore, the adopted assumptions should be verified also on the basis of opinions of representatives of processing plants of the dairy industry and other institutions dealing with the purchase and marketing of raw milk, as well as unions and associations associating both milk producers and milk processors. This article may, however, constitute a pre-implementation proposal which will inspire other representatives of science and practice to deepen, among others, the subject of computerization and management of milk collection organization in the era of rapid development of digital economy, electronic transmission of information and means of payment, as well as awareness of proper behaviour during the ongoing epidemic. The authors are aware of the need for further research and analysis in this area, all the more so because the deadline for the definitive end of the coronavirus pandemic in the world, especially in Europe and Poland, is impossible in the foreseeable future.

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Correspondence addresses:

Iwo Nowak, PhD
(https://orcid.org/0000-0001-6795-0754)
Stanisław Staszic State University of Applied Sciences in Piła
Department of Transportation
10 Podchorążych St., 64-290 Piła, Poland
e-mail: iwo_nowak@poczta.onet.pl

Jakub Bazela, Eng.
Stanisław Staszic State University of Applied Sciences in Piła
Department of Transportation
10 Podchorążych St., 64-290 Piła, Poland

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Sławomir Stec
Ignacy Łukasiewicz Rzeszów University of Technology

The role of innovation in urban logistics on the example of Rzeszów

Rola innowacji w logistyce miejskiej na przykładzie Rzeszowa

Abstract. The article presents the role of innovation in city logistics, and above all the impact of modern logistics investments on the quality of life of residents. On the example of the proceedings of the local government of the city of Rzeszów, a brief description was made of activities related to innovations in urban logistics of various types: technological, organizational, structural, process and image-related. On the basis of a survey among the inhabitants of Rzeszów and the Rzeszów agglomeration, the impact of innovations in urban logistics was examined, among others on changing the behavior of society, lifestyle, preferences in movement, quality of life, as well as the identification of residents with the city. As a result of the research, it was found that the inhabitants perceive very well all already implemented and being implemented innovations in urban logistics. It was also recognized that modern investments contribute to improving the quality of life, lifestyle, air quality, health and safety. In particular, it can be said that the innovations made it possible, among others, to shortening travel time by public transport, smoothing traffic in congested areas, infrastructure integration of ecological forms of transport operating in the urban and suburban areas, connecting public transport with individual bicycle, pedestrian and car communication, improving the mobility of people with disabilities or people with reduced mobility, energy efficiency of urban transport by investing in transport with alternative propulsion systems, reducing the negative impact on the environment, including reducing noise and vibrations as well as greenhouse gas emissions, mainly CO_2.

Key words: urban logistics, innovation, transport projects, mobility

Synopsis. W artykule przedstawiono rolę innowacji w logistyce miejskiej, a przede wszystkim wpływ nowoczesnych inwestycji w obszarze logistyki na jakość życia mieszkańców. Na przykładzie postępowań samorządu miasta Rzeszowa, dokonano zwięzłej charakterystyki działań związanych z innowacjami w logistyce miejskiej o różnym charakterze: technologicznym, organizacyjnym, strukturalnym, procesowym oraz wizerunkowym. Na podstawie badań ankietowych wśród mieszkańców Rzeszowa i aglomeracji rzeszowskiej, zbadano m.in. wpływ innowacji w logistyce miejskiej na zmianę zachowań społeczeństwa, styl życia, preferencje w przemiesz-

czaniu się, jakość życia, a także utożsamianie się mieszkańców z miastem. W wyniku badań stwierdzono, że mieszkańcy bardzo dobrze postrzegają wszystkie wdrożone i wdrażane innowacje w logistyce miejskiej. Uznano również, że nowoczesne inwestycje przyczyniają się do poprawy jakości życia, stylu życia, jakości powietrza, zdrowia i bezpieczeństwa. W szczególności można stwierdzić, że innowacje umożliwiły m.in. skrócenie czasu podróży komunikacją miejską, upłynnienie ruchu na obszarach objętych kongestią, integrację infrastrukturalną funkcjonujących na obszarze miejskim i podmiejskim ekologicznych form transportu, powiązanie transportu publicznego z indywidualną komunikacją rowerową i pieszą oraz samochodową, poprawę mobilności osób z niepełnosprawnością lub osób z ograniczoną zdolnością ruchową, poprawę efektywności energetycznej transportu miejskiego przez inwestycje w transport o alternatywnych systemach napędowych, zmniejszenie negatywnego oddziaływania na środowisko, w tym redukcję hałasu i drgań oraz emisji gazów cieplarnianych, głównie CO_2.

Słowa kluczowe: logistyka miejska, innowacje, projekty transportowe, mobilność

Introduction

Urban logistics is a concept related to decision-making activities and activities aimed at improving the efficiency and reliability of media, cargo, cash and information flow control processes, and primarily related to the improvement of the movement of people in the city and adjacent suburban zones. Urban logistics is aimed at overcoming logistical difficulties, relieving the city from unnecessary transport, and also minimizing costs [Huk 2015]. In addition, as Tundys [2008] points out, urban logistics connects the flows of goods and services, controls them for supplying, cleaning and ensuring the internal functionality of cities, to reduce time losses, unnecessary transport, congestion, bottlenecks, and also tries to optimize the use of available resources. This concept, as urban logistics can be defined, is extremely important nowadays, when there is an intensive development of cities. In the European Union countries and Poland, the process of demographic urbanization has developed to such an extent that many cities are expanding in terms of topography and administration. The increase of areas of urban areas entails additional logistical problems in the form of inadequate technical infrastructure concerning, inter alia, transport and the entire management process [Zysińska 2019]. Hence, it is necessary to invest in urban logistics, which is usually of organizational and process-related character, in traditional and modern infrastructure, taking into account intelligent use of resources and participating management [Taniguchi et al. 2001]. However, the fact of investing in innovative solutions based on modern information technologies is of particular importance. On the one hand, innovations make it possible to significantly solve the logistic problems of large cities, on the other hand, investors, usually municipalities, benefit from funding from the European Union, which co-finances innovative solutions.

The above-mentioned processes of city expansion in the topographic and administrative sense are taking place more and more intensively in Poland. Over the last fifteen years, significantly increased their areas such cities as Zielona Góra (2015 by 219.98 km^2), Rzeszów (by 72.88 km^2 in 2006–2019), Opole (by 52.44 km^2 in 2017), Koszalin (by 15.03 km^2 in 2009). All these cities faced the need to invest in broadly understood

urban logistics. In each of these centers examples of innovative solutions can be found. However, as the authorities of the city of Rzeszów have been implementing the concept of developing the strategy of the brand "Rzeszów – Capital of Innovation" for several years, the role of innovation in urban logistics will be presented on this example.

Goal and methodology of research

The main aim of the article was to present the role of innovation in urban logistics. On the example of the proceedings of the local government of the city of Rzeszów, a concise description of activities related to innovations in urban logistics of various types: technological, organizational, structural, process and image-related was made. The first four types of activities were presented on the basis of source materials presented in publications, local, regional and national media, scientific articles and internet portals, as well as on the basis of mass statistics data provided by the Central Statistical Office. On the other hand, image-building activities were developed and presented on the basis of a survey conducted among 250 people, residents of Rzeszów and the Rzeszów agglomeration, who have a close relationship with the city on a daily basis, e.g. through work, studies, education, shopping, business in offices, etc. Among others, the impact of innovations in urban logistics on changing the behavior of society, lifestyle, preferences in movement, quality of life, as well as the identification of residents with the city. It was these studies that were crucial in confirming the assumed result indicators, and above all, the assumed goals of the investments carried out in the field of urban logistics. The discussed topic is extremely extensive, therefore the focus was on the main concepts and projects that play the greatest role in urban logistics. This way of presenting the topic is helpful in spreading the knowledge and disseminating useful innovation.

The methods of processing and interpreting of facultative knowledge were applied using the descriptive method, the method of descriptive analysis and graphical presentation, as well as the study of the literature on the subject.

The role of city logistics and the implementation of innovations in city logistics in theoretical terms

The introductory chapter explains the concept of urban logistics. From the various definitions of this concept, one can read the role played by city logistics in the daily functioning of a local government unit. According to the definition of Witkowski and Kiba-Janiak [2011], "urban logistics focuses primarily on planning, coordinating and controlling processes related to the movement of people and goods (raw materials, semi-finished products, goods, waste, etc.) and information related to them in a way that optimizes costs, minimizes congestion and increases the quality of life of residents". Therefore, it can be concluded that the role of urban logistics is to improve the quality of life of residents through investments and the maintenance of technical and social infrastructure by local governments. These activities contribute to the creation of conditions for efficient movement between individual city districts, both by own vehicle and by public transport (bus, tram, rail, ferry) [Jones 1981]. In addition, investments in technical infra-

structure are to contribute to the reliable supply of clean, healthy water for residents, and to ensure safe disposal of sewage. The task of city logistics is also to protect residents from floods using an effective sewage system. We should not forget about the efficient waste management or providing the society with access to energy and ICT infrastructure. The above-mentioned examples clearly show that the main role of urban logistics is to improve the living conditions of residents, and ultimately the quality of life. This quality of life is pointed out by many authors of publications on the role, function or goals of urban logistics. According to Borys and Rogal, objective and subjective quality of life can be distinguished. The objective quality of life is represented by indicators such as: monthly income, floor area, number of owned cars. In turn, subjective quality of life is an assessment of the degree of meeting the needs of society, e.g. satisfaction with income, the possibility of finding a good job, personal, health and sanitary safety, satisfaction with the apartment, the possibility of spending free time in an attractive way, efficient movement around the city, access for education, health protection, or convenient shopping, etc. [Borys and Rogal 2008].

However, it should be remembered that the quality of life is also influenced by the use of intensive technical and technological progress in almost every area of life. Also in city logistics. It is the application of all product and process innovations in city logistics that will contribute to the improvement of the quality of life in cities [Taniguchi et al. 2001].

An innovative city should be characterized by an infrastructure that improves the functionality of the city and contributes to the increase in the welfare of its inhabitants [Bryx 2013]. An important role in the process of improving the quality of the city's functioning is played by logistics management in its area, which should include passenger and goods transport, transit and export transport, securing and storing goods to meet the city's demand; city supplies; transport of waste and refuse from the city [Szymczak 2008]. Moreover, logistic innovation means the use of new information technologies, streamlining processes, increasing the level of employee involvement and ways of managing them and the inhabitants [Brdulak 2012]. "For the most anticipated solution to implement the idea urban logistics, which should be pursued, is considered to be supplementing the traffic management system with other systems and including them in a common network, which would create an integrated IT system supporting all areas of urban logistics " [Szymczak 2008].

The following chapters, and in particular the research of subjective opinions of the city society, will allow to verify the presented theoretical considerations on the impact of innovations in urban logistics on the quality of life of Rzeszów residents.

Innovations and their role in urban logistics on the example of Rzeszów

Rzeszów is the capital of the Podkarpackie Province, located in south-eastern Poland. It is a center with 196,821 inhabitants [Urząd Statystyczny w Rzeszowie nd.], and its area is 126.57 km^2 [Urząd Miasta Rzeszowa nd.a]. Since 2006, the city has incorporated 9 neighboring towns into its area, thus increasing by 72.88 km^2, from 53.69 km^2 in 2005, to 126.57 km^2 in 2019. From 1 January 2021, another village council – Pogwizdów Nowy

will be attached to the city, which will enlarge the city by another 2 km^2, and thus the number of inhabitants will increase by approx. 1,200. According to the data at the end of 2018, there are 267.6 km of municipal and poviat roads in Rzeszów with a significant number of vehicles, including 139,172 registered at the local communication department of the Rzeszów City Hall. The remaining infrastructure includes 634.8 km of water supply networks, 757.9 km of sewage network and 827.4 km of gas network. Public transport in the city is provided by the Public Transport Authority, which has created 62 communication lines, served by 220 buses.

The Wisłok river flows through the city, but it is not navigable. Sailing takes place only on an artificial retention reservoir named "Stopień Rzeszów", built on the aforementioned river, and only in the recreational form, with the use of kayaks, pedal boats and small catamarans. Thus, it has no practical significance in logistics in terms of transport.

As innovations are considered to be modern solutions or significantly improved already existing products or processes, investments from the last 5 years were chosen to present the topic. One of the most image-enhancing innovations, and at the same time facilitating the movement of the city's inhabitants, are investments in public transport. Since 2006, Rzeszów was the first city in the country to focus on the innovative use of alternative power sources for public transport vehicles. At that time, buses powered by natural gas CNG were purchased. However, in 2018, the first 10 new low-floor electric vehicles were purchased. These are Solaris Urbino 12 buses. As part of the investment, slow and fast vehicle charging stations were purchased. Importantly, these buses were designed to serve city lines with line numbers 0A and 0B, characterized by a closed-loop system of 9.2 km each and 20 and 19 stops on a given line, respectively. This area is covered by plans to create a zero-emission zone in Rzeszów, which will be served only by electric and gas buses. Innovative on a national scale in these vehicles is the method of drive, using two electric motors, which are located at the wheel hubs on the right and left sides. Their power is 2 × 110 kW. In order to supply energy to these buses, investments were also made in vehicle charging stations. The bus is equipped with a plug-in connector for charging energy storages (batteries) (plug connector). This connector is used to charge the batteries at the bus depot. This is called slow loading. The maximum current that can flow through the connector is 125 A, and the charging time is about 180 minutes. The vehicle is also equipped with the so-called power receivers - railings placed on the bus roof. With their use, the energy supplied from the charging platform (OppCharge, the so-called inverted pantograph) is transferred to the energy storage (accumulators). This is called fast loading. The maximum current that can flow through the device is about 550 A. The charging time is about 10–15 minutes [Zarząd Transportu Miejskiego w Rzeszowie 2019].

The above investments contributed to the improvement of the energy efficiency of urban transport by investing in transport with alternative propulsion systems. In addition, the negative impact on the environment has decreased, including the reduction of noise and vibration as well as greenhouse gas emissions, mainly CO_2. This, in turn, has a significant impact on improving the quality of life in the city [Potyrański 2020].

Another new activity in the field of public transport is the construction and reconstruction of 156 bus bays and 163 stop complexes. An investment that may initially call into question the name of innovation. Well, the innovation in this case comes in three

areas. First of all, as part of the reconstruction of the stop bays, a modern type of "concave" curbs was used, and the platforms were supplemented with facilities for the visually impaired. Modern curbs enable buses to precisely approach the stops, and allow passengers to get in and out more comfortably, mainly to people with disabilities and the elderly, as the bus floor is at the platform level. In addition, the concavity of the curbs prevents damage to the vehicle tires in the event of approaching the platform edge too close [transinfo.pl 2017].

An innovation on a European scale is an investment in modern bus shelters, the so-called smart stops. A dozen or so bus shelters have a heating and air-conditioning system. During the summer heat, the air conditioning inside the shelter is turned on, and in the winter, when the temperature drops below $0^{\circ}C$, the heating installed under the roof of the shelter and in the seats is turned on. These stops are integrated with the photovoltaic installation. The energy generated by the PV system is used on an ongoing basis, in particular, air conditioning or heating, LED lighting, charging phones, heating windows and benches, and the surplus energy is stored in batteries [elekronikab2b.pl 2019]. These two innovations will contribute to improving the quality of life in the city, improving the comfort of waiting of passengers for a public transport vehicle, as well as reducing the negative environmental impact of greenhouse gas emissions, mainly CO_2.

In the field of public transport, another innovation has been implemented, which allows to make payments with a payment card or credit card directly at the ticket validator. So far considered innovative methods of purchasing tickets through a telephone application or the use of a city card, they have become common and are used throughout the country. The new contactless payment system in validators allows to pay for a bus ride with a payment card, telephone or watch, without the need to have a paper ticket or city card directly in the validator. The ticket is validated by placing the payment card against the card reader in a specially marked modern validator – the KFT (Known Fare Transaction) system. The next stage of implementing the above-mentioned innovation, which can undoubtedly be considered an innovation on a global scale, will be the implementation of the MTT (Mass Transit Transaction) system that allows the passenger to automatically select the cheapest ticket depending on the number of journeys made within 24 hours and the way of travel (for example transfers with or without a change, time tariff, check in – check out system – stop tariff). This solution is the first in Poland.

According to the Public Transport Authority in Rzeszów, the system is implemented thanks to such partners as: R&G Plus, VISA, eService, Solveo, FCS (Fare Calculator System) [Zarząd Transportu Miejskiego w Rzeszowie 2020].

In 2015, the construction of the Dynamic Passenger Information System (E-info) was started, which uses and processes data from all systems, and then generates information useful for travelers, allowing them to plan a trip and control its course. This information is available on 154 double-sided stop boards, where the actual departure time of buses for each line is displayed. Additionally, on the boards on the buses, travelers are informed, among others about the route and about the current and next stop. Also recently, information about the actual departures of other bus lines from the nearest stop has been updated. As part of this project, stationary and mobile ticket machines were purchased, which include allow to check the line layout as well as the current timetable.

The dedicated application presents information related to travel planning and control of its course [Magdoń 2016].

A significant innovation was also the implementation of the Rzeszów Intelligent Transport System, which consists of the following subsystems: Public Transport Management; Dynamic Passenger Information, Electronic City Transport Ticket, Area Traffic Control. All subsystems use dedicated radio communication to transmit data, ensuring not only communication with traffic and public transport management centers, but also with stops and buses running around Rzeszów. For the safety of passengers and drivers, both buses and stops as well as intersections are subject to video surveillance. The Public Transport Management System enables the management of the bus fleet through, among others, ongoing identification and location of vehicles, as well as control of the quality standards of the services provided and passenger service. At the same time, the system allows to keep statistics related to the number of passengers using public transport and supports the optimization of the layout of bus lines and their timetables. In turn, the Area Traffic Control System (SOSRD) supports traffic management depending on its intensity, through dynamic optimization of traffic lights, giving priority to public transport. SOSRD includes 60 traffic lights operating throughout the area of Rzeszów, and with 35 variable message boards, it enables drivers to be quickly informed about obstacles, changes in traffic organization, or recommended detours, as well as about the meteorological situation using the installed weather stations [Stankiewicz and Michalski 2018].

Another innovation in urban logistics, this time on a European scale, is being implemented in the area of parking space management. The parking space monitoring system in Rzeszów, as this is the official name of the project, will be analyzing the image from cameras monitoring the parking lots, and then process it, checking whether a given parking space is free or occupied. In places where it is impossible to place poles or lead nets, neural networks mounted in the parking lot surface have been used, which have the ability to detect vehicles. Information about vacancies will be provided to interactive information boards located in the paid parking zone and via a mobile application made available to residents. It will also be integrated with external applications enabling the payment of the parking fee. It is certainly a unique project in the field of smart city. Additionally, a data transmission system is being built, which will act as a relay between the Supervision Center and all elements of the RIST system. The fiber-optic network infrastructure is also being built using the existing LMDS and MESH networks, which in the future will enable connection with other municipal facilities. Thus, Rzeszów is the first city in Poland to use the MESH 5G technology. The innovative paid parking zone monitoring system brings many benefits to the city. Residents will find a parking space faster, which will reduce car traffic and thus exhaust emissions in the city center. The camera system will increase the level of security, and the collected data will allow to manage and optimize the functioning of the zone [transport-publiczny.pl 2019].

In the area of the city of Rzeszów and the Rzeszów agglomeration, an investment is being carried out under the name: Suburban Agglomeration Railway, which covers municipalities located within the railway lines running from Dębica to Przeworsk and from Kolbuszowa to Strzyżów. It can be concluded that this is an innovation on a macroregional scale. The project includes the construction of a railway line to the Rzeszów Jasionka Airport, thanks to which the city center will be conveniently connected to the

airport. In addition, new passenger stops/platforms are being built along with accompanying infrastructure, new passages and station tracks are being built, platforms are being adjusted to TSI PRM requirements, the construction of a railway viaduct on DK 9, construction of interchange junctions and construction of park & ride car parks.

Thanks to the implementation of innovations, the driving time will be shortened, the frequency, communication and punctuality of the connections will be improved, the accessibility of rail transport in agglomeration traffic will increase, the mobility and accessibility of rail transport for the inhabitants of the Rzeszów agglomeration will be improved, and the quality of rail transport services of an agglomeration nature will be improved [Ministerstwo Funduszy i Polityki Regionalnej 2020].

Vehicle rental companies are increasingly used in city logistics. For several years now, Rzeszów has had an electric scooter, bicycle and scooter rental. These are fourth generation vehicles, you do not need base stations to rent them, you can rent them and return them anywhere [Urząd Miasta Rzeszowa nd.b]. Several companies also offer car rental under the so-called Car Sharing. Most of the cars offered for rent are electric. The above solutions offer residents the opportunity to move around the city on an individual basis, practically at any time of the day or night, for a reasonable fee. They contribute to the increase in mobility, reduction of the number of individual passenger cars, reduction of congestion on the road and, above all, reduction of air pollution, especially in the autumn and winter period, when smog is the most common. At the end of the presentation of examples of innovations in city logistics, it is worth paying attention to the implemented instant passenger journeys in the Bolt service. It is an example of modern taxis, the system of which is based on a mobile application for ordering and paying for rides. Payments are made in most cases without cash, and the passenger can track the location of the vehicle during the journey, the brand of the vehicle it will be traveling on, and the name of the driver. Importantly for passengers, fares for this service are approximately 50 to 70% lower than traveling by traditional taxi [Bolt.pl].

The role of innovation in city logistics and the quality of life in the opinion of the inhabitants

Each of the cited innovations had a greater or lesser impact on the quality and lifestyle of the inhabitants, changing behavior or preferences in moving around the city. In order to get to know the role of implemented innovations in city logistics, a study was conducted among 250 adult residents of Rzeszów and the Rzeszów agglomeration who have daily contact with the city. The 48% of women and 52% of men took part in the study.

Among the age groups, the most numerous participants were those aged 18–30 – 50.4%. Moreover, among the respondents there were 17.6% of people aged 31–40, 16.0% of people aged 41–50 and 12.8% of people aged 51–65. The smallest group of the surveyed inhabitants were the oldest people, as there were 3.2% of people over 65. In turn, in terms of professional status, the largest number of respondents was in the group of working people – 48%. Next, pupils and students responded – 39.6%, retirees and disability pensioners – 9.2%, and the smallest group of respondents were those who were not working, who constituted 3.2% of the respondents. The research was conducted in

November 2020, via online forms. The date of the study fell on the period of the coronavirus pandemic, therefore the survey indicated that the responses should eliminate situations related to limited mobility and the introduced restrictions in the field of public health protection.

First, the impact of innovations in urban logistics on the quality of life of city residents was examined (Figure 1).

According to the residents, the greatest impact on the quality of life in the city was the implementation of the Dynamic Passenger Information System, and above all the installation of variable message boards at stops and in buses, which indicate the actual timetable of vehicles. This innovation was indicated by as many as 94% of respondents. Subsequently, 84.4% of inhabitants emphasized that the fact that the air-conditioned and heated bus shelters in the city had a great impact on the quality of life. For every fourth inhabitant of the city, it was important to implement a payment system for traveling with an e-ticket or an electronic purse – a city card.

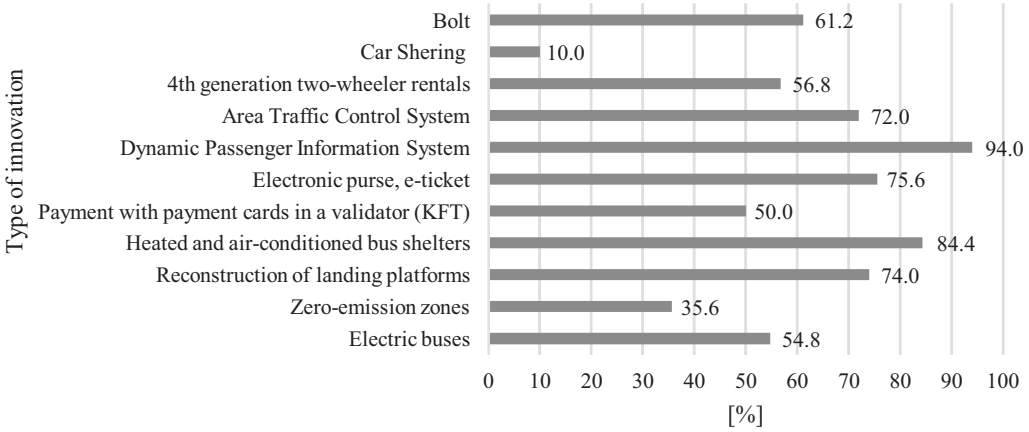

Figure 1. The impact of innovations in urban logistics on the quality of life of residents
Rysunek 1. Wpływ innowacji w logistyce miejskiej na jakość życia mieszkańców
Source: own research.

A similar number of people indicated an innovation having a large impact on the quality and comfort of life, an investment consisting in the reconstruction of stop platforms, enabling access to vehicles from the street level. In turn, more than half of the respondents considered that an important role in improving the quality of life is played by innovations in the form of modern Bolt taxis (61.2%), fourth generation two-wheeler rentals (56.8%) and the purchase of electric buses (54.8%). Every second respondent pointed to the significant importance of the possibility of paying for public transport with a payment card or a credit card. According to the respondents, the introduction of zero-emission zones or the possibility of renting a car in the Car Sharing system was of less importance.

The city authorities are not going to stop at these activities. The implementation and planning works are still underway as part of subsequent innovations. Therefore, the inhabitants were asked about the impact of the planned innovations in urban logistics on the quality of life (Figure 2). The research shows that the project of the Podkarpacka

Agglomeration Railway, which is at the stage of implementation, is the most enthusiastic, and the first trains will start on January 1, 2021. In this case, 74.4% of respondents considered this innovation to be very important, which will play a role in improving the quality of life in the city and agglomeration.

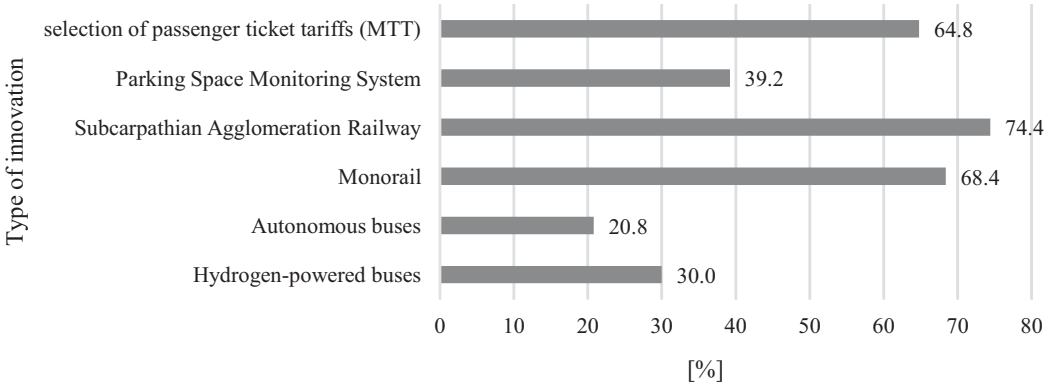

Figure 2. The impact of the innovations planned to be implemented in urban logistics on the quality of life of the inhabitants

Rysunek 2. Wpływ planowanych do wdrożenia innowacji w logistyce miejskiej na jakość życia mieszkańców

Source: own research.

Another innovation, indicated by over 68% of residents, is gaining considerable recognition. It is a monorail planned for construction, which is to cross and loop the main housing estates with the city center. Works on this project are advanced, and the biggest barrier so far has been the lack of appropriate legal provisions in the country recognizing the monorail as a public transport vehicle. Representatives of Chinese companies with extensive experience in implementing this type of investment were involved in the work on this investment [Urbanowicz 2020]. Another innovation, which is to improve the quality of life, is, according to over 64% of respondents, the implemented system that allows automatic selection of the fare to the passenger's needs. On the other hand, according to the inhabitants, the implemented Parking Space Monitoring System or the implementation of hydrogen-powered buses and autonomous buses are of less importance. The latter investment was postponed due to the prevailing coronavirus pandemic.

In a survey, the city inhabitants were asked about the role of all innovations in urban logistics (Figure 3). Most inhabitants (92.8%) indicated improvement in the quality of life. In turn, for 72.8% of respondents, innovations contribute to the improvement of life styles. Not much less people (76%) said that implementing new logistics solutions improves the city's image. Also, nearly every fourth inhabitant of the city believes that each innovation has an impact on improving air quality. The 66% of respondents believe that modern investments contribute to improving health. At this point, we can cite the opinions obtained during the hidden interview that the installation of automatic hand disinfection devices in all public transport buses was highly appreciated. In turn, more than half of the respondents indicated that innovations contribute to the increased identification of residents with the city, and according to over 46% of respondents,

innovations contribute to the improvement of air quality. The least role of innovation was seen by the respondents in contributing to the reduction of road congestion and noise reduction.

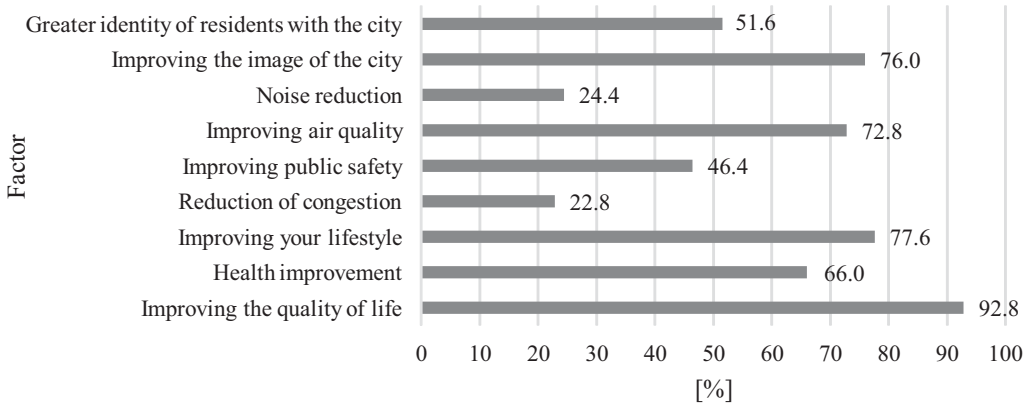

Figure 3. The role of innovation in urban logistics
Rysunek 3. Rola innowacji w logistyce miejskiej
Source: own research.

Summary and conclusions

For years, Rzeszów has been building its brand based on the slogan: "Rzeszów – the capital of innovation". This translates into a number of activities of local authorities in the field of implementing innovations in urban logistics. As it results from the presented analyzes, many innovations on a global and European scale have been implemented in recent years. On the other hand, the vast majority of investments in the area of logistics are innovative on a national scale. Most of the innovations have tangible effects in terms of improving the quality and lifestyle in the city. And this can be owed among others to:

- shortening travel time by public transport, smoothing traffic in congested areas,
- infrastructure integration of ecological forms of transport operating in the urban and suburban area,
- linking public transport with individual bicycle, pedestrian and car communication,
- improving the mobility of people with disabilities or people with reduced mobility,
- improving the energy efficiency of urban transport by investing in transport with alternative propulsion systems,
- reducing the negative impact on the environment, including the reduction of noise and vibrations as well as greenhouse gas emissions, mainly CO_2.

The above-mentioned positive effects of implementing innovations were also noticed by residents who rightly noticed that modern investments contribute to the improvement of the quality of life, lifestyle, air quality, health and safety. They also believe that an important role of innovation is to improve the city's image in country and abroad. It can therefore be concluded that the idea of the capital of innovation is also fully implemented in urban logistics, which plays an important role in the daily functioning of the urban unit.

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Correspondence address:

Sławomir Stec, PhD
(https://orcid.org/0000-0002-5645-7507)
Ignacy Łukasiewicz Rzeszów University of Technology
Faculty of Management
Department of Economics
12 Powstańców Warszawy Ave., 35-959 Rzeszów, Poland
e-mail: s.stec@prz.edu.pl

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Elżbieta Jadwiga Szymańska, Michał Wielechowski
Warsaw University of Life Sciences – SGGW

Pay-as-you-throw system as an innovative solution in waste management

System „Płać za tyle, ile wyrzucasz" jako innowacyjne rozwiązanie w gospodarce odpadami

Abstract. The study presents the waste management system in force in Poland and the related methods of calculating fees. Based on the analysis, we should assume that the implementation of the fee for waste through the principle of the pay-as-you--throw seems the most appropriate option to ensure reliability in paying for waste management services. Based on the analysis, we should assume that the implementation of the fee for waste through the principle of the pay-as-you-throw seems the most appropriate option to ensure reliability in paying for waste management services. Moreover, the experience of other regions in the world has shown that the system effectively supports the reduction of disposable packaging and creates incentives for at source segregation and composting.

Key words: waste management, PAYT system, indicators, fee, benefits, side effects

Synopsis. W opracowaniu przedstawiono system gospodarki odpadami obowiązujący w Polsce oraz związane z nim sposoby naliczania opłat. W analizach wykorzystano dane Głównego Urzędu Statystycznego. Następnie opierając się na przeglądzie literatury, opisano system „Płać za tyle, ile wyrzucasz" z uwzględnieniem stosowanych wariantów płatności. Na podstawie dokonanych analiz należy sądzić, że wdrożenie opłaty za odpady poprzez zasadę „Płać za tyle, ile wyrzucasz" wydaje się najbardziej odpowiednią opcją zapewnienia rzetelności w płaceniu za usługi gospodarki odpadami. Ponadto, jak wynika z doświadczeń innych regionów, system ten jest bardzo skuteczny we wspieraniu redukcji opakowań jednorazowych oraz stworzenia zachęt do segregacji u źródła i kompostowania.

Słowa kluczowe: gospodarka odpadami, PAYT system, wskaźniki, opłata, korzyści, skutki uboczne

Introduction

The increase in wealth increases the demand for consumer goods, which leads to an increase in the amount of municipal waste, both in the sphere of production and consumption. According to the Central Statistical Office of Poland – GUS, in 2019, there was data

for 332 kg of collected waste per one inhabitant of Poland, i.e. 7 kg more compared to the previous year. 10.8 million t of waste were collected from households, which accounted for 84.5% of municipal waste production.

The rapid pace of urbanization and industrialization, and technological advancement has ended up in the generation of huge volumes and quantities of municipal solid waste worldwide [Sing and Sarkar 2015, Sharma et al. 2018]. Given the increasing amount of waste, one of the most important challenges of the modern world has become proper waste management. Improper waste management endangers the environment and, consequently, the health and life of the inhabitants. Responsible waste management not only contributes to environmental protection but also saves natural resources and reduces economic losses.

Over the past 30 years, significant advances have been made in developing efficient schemes to charge households for their actual waste generation [Reichenbach 2008]. In line with the sustainable development principle, the priority in rational waste management should be recycling, i.e. reusing waste. The implementation of waste recycling is possible due to their selective collection and recovery, in particular, selective collection at source. In municipal waste, selective collection involves primarily secondary materials, including paper, glass, plastics, and metals [Kłos 2012].

Solid waste has become one of the global environmental issues [Song et al. 2015]. In recent years in Poland, municipal waste has been one of the most frequently discussed environmental issues. It is a great challenge for local authorities and the consumers, who play a crucial role in the waste management system. On the one hand, consumers' purchasing decisions and subsequent decisions regarding the post-consumer residues handling are important for the quantity and qualitative composition of the generated waste. On the other hand, consumers are service recipients, and their satisfaction with the level of services and prices offered on the market is important [Lorek 2015].

A new municipal waste management system has been in force in Poland since July 1, 2013. Despite many controversies and reservations, it introduced positive incentives stimulating the residents' responsible behaviour on waste generated in households. The system contributed, among others, to increase the level of recycling and recovery of selectively collected waste and reduce the mass of biodegradable waste sent for landfill. Its important features include the obligatory inclusion of all inhabitants, eliminating the benefit of dumping waste in illegal landfills. However, the implemented system does not sufficiently encourage waste segregation at source, and recycling. Thus, new solutions are sought to contribute to more effective waste management, particularly waste collection and management, which is an expensive process.

Aim and methodology

The research aims to identify the innovative system pay-as-you-throw – PAYT, which, as other countries' experience has shown, motivates residents to reduce waste production and segregate it. The study presents the waste management system in force in Poland and the related methods of calculating fees. Data from the Central Statistical Office were used in the analysis. Then, based on the literature review, the PAYT system was described,

including applied payment variants. The study also presents an example of the PAYT system implementation in the municipality of Parma in Italy and the benefits and possible side effects of this innovative solution.

Municipal waste management in Poland in 2019

Municipal waste is a mixture of waste, including packaging, green waste, biodegradable waste, minerals, and hazardous waste. In 2010–2012, the average amount of waste generated in households was over 12.0 million t (Figure 1). In 2013, it decreased to 11.3 million t. Moreover, the amount of municipal waste collected decreased from 10 to 9.6 million t in the same period. The difference between the amount of municipal waste generated and collected indicates that some of the waste has not been used legally or/and environmentally safe.

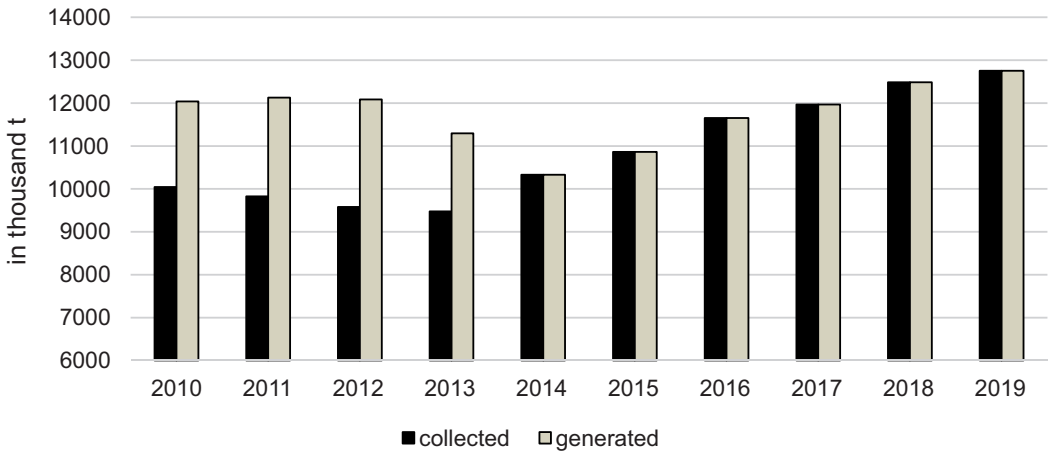

Figure 1. Municipal waste generated and collected in Poland in 2010–2019
Rysunek 1. Odpady komunalne wytworzone i zebrane w Polsce w latach 2010–2019
Source: own elaboration based on GUS data.

In 2014–2019, the amount of municipal waste generated and collected increased by almost a quarter, from 10.3 to 12.75 million t. This was probably due to a gradual increase in both household income and consumer goods purchase. Over 7.7 million t (56%) of collected municipal waste was recycled, and almost 5.6 million t (44%) of waste was neutralized. As part of the recovery, over 3.2 million t (25%) of municipal waste was recycled, while 2.74 million t (21.5%) were thermally transformed to recover energy (Figure 2). In terms of waste disposal, landfilling dominated, accounting for 5.5 million t of waste, which accounted for 43% of collected municipal waste. The 2190 separate municipal waste collection points operated in Poland in X. The 1352 enterprises provided the waste-collecting service from households.

At the end of 2019, there were 278 municipal waste disposal sites, with a total area of 1,670 ha. Over 92.0% of them were equipped with degassing installations, as a result of which about 91 million MJ of thermal energy and about 113 million kWh of electri-

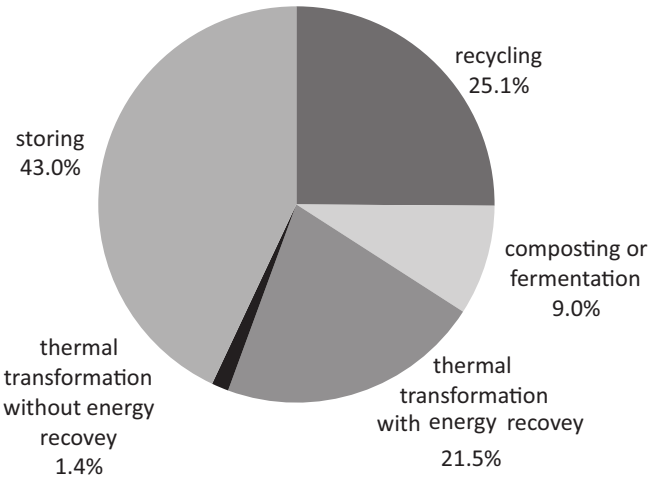

Figure 2. Management ways of collected municipal waste in Poland in 2019
Rysunek 2. Sposoby zagospodarowania zebranych odpadów komunalnych w Polsce w 2019 roku
Source: own elaboration based on GUS data.

cal energy. In 2019, 16 landfills were closed, with a total area of approximately 52.8 ha. Moreover, 11,371 illegal dumps were closed, of which around 26 t of municipal waste were collected in total. At the end of 2019, 1873 illegal dumping sites were recorded.

In 2018, the average amount of municipal waste generated per capita equalled 489 kg in the EU. The largest amounts of municipal waste were generated by the wealthiest countries, i.e. Denmark – 766 kg, Germany – 615 kg, Luxembourg – 610 kg, and small touristic countries, i.e. Cyprus and Malta – 640 kg per person. In turn, Romania generated the least amount of waste in the European Union per capita – 272 kg.

Although among all EU member states, Poland has one of the lowest rates of municipal waste generation per capita, unfavourable waste management is alarming as landfilling is still the most common method of municipal waste disposal. In terms of recycling, Germany is the leader in the EU market as 67.8% of municipal waste was recycled there in 2017. A high recycling rate was also recorded in Slovenia and Austria, 57.8 and 57.7%, respectively. Across the EU, more than 75% of municipal waste generated was processed, including 30% recycled, 17% composted, and 28% incinerated. Less than 25% of municipal waste was landfilled [Zalewska 2019].

The current system of waste payment in Poland (as of 2020)

To increase the efficiency of waste management in Poland, the Act of January 1, 2012 on amendments to the Act of September 13, 1996 on maintaining cleanliness and order in municipalities [Ustawa z dnia 13 września 1996 r.] came into force. From that date, municipalities had 18 months to introduce changes and implement new municipal waste management systems in their areas. The most important municipalities' tasks included:

– taking over responsibility for municipal waste,

– introducing fees for waste management,
– building new waste processing installations,
– selection (by a public tender) of entity/entities responsible for municipal waste collection in the commune area.

For the inhabitants, the most important change was abolishing the obligation to sign municipal waste collection contracts with entities (enterprises responsible for the waste collection that have the appropriate permit from the commune administrator) and pay them for their service. Instead, inhabitants have been required to pay municipal waste management fees to the municipality. Depending on the Commune Council decision, the fee amount depends on one of three elements:
– number of residents living in a given property,
– amount of water used from a given property,
– area of a residential unit.

Thus, charges for individual households in Poland do not depend directly on the amount of waste generated. The adopted system assumes that a household with a larger number of inhabitants, higher water consumption, or a larger area of residential unit generates more waste. In practice, however, this relationship is not clear and obvious. An additional resident who lives in a given property usually does not increase the amount of waste generated proportionally. Moreover, the fixed costs (administration costs, costs per container, part of the waste collecting costs) are independent of the number of residents in a given property (household). However, a solution considering water consumption is also not optimal. Large houses with a garden, using a lot of water for gardening, do not necessarily generate much more waste. Moreover, they have the ability to prevent waste by composting kitchen waste in their own garden. Therefore, the implemented fee system does not reflect the actual amount and type of waste generated. Besides, residents do not have the option of a fee reduction by preventing the generation of municipal waste. Any efforts in waste segregation or limiting their generation are not linked to any financial bonuses. It results, e.g., from the lack of correlation between the amount of collected waste and the number of fees and too small differences in fees for collecting mixed and selectively collected waste.

Depending on the adopted system of fees for communal waste, their rates vary in Poland regionally. On average, in 2019, residents of the Śląskie, Dolnośląskie, Opolskie, and Lubuskie Voivodships paid the most for garbage collection, while the lowest rates for waste disposal were in Podlaskie and Świętokrzyskie Voivodships (Figure 3).

From the collected fees for waste, the commune covers the costs of the municipal waste management system, which include the costs of:
– collection, transport, recovery, and disposal of municipal waste,
– creating and maintaining separate collection points for municipal waste,
– the system administration.

Annual revenues from municipal waste management fees must be in line with annual expenditure on the municipal waste management system. Due to this balancing problem, in subsequent years, the fees for collecting waste from residents will increase. This is mainly due to additional requirements and fees that are imposed on waste processing companies. Moreover, the permission to import (to Poland) waste from other countries where there are subsidies for recycling increases the number of raw materials on the

Figure 3. Average annual family expenses for the collection of selectively collected municipal waste by voivodship in Poland in 2019

Rysunek 3. Średnioroczne wydatki rodzinne na wywóz selektywnie zebranych odpadów komunalnych w województwach w Polsce w 2019 roku

Source: based on [Polski Instytut Ekonomiczny 2020].

Polish market. It replaces more expensive domestic waste with cheaper ones from abroad. As a consequence, the price of waste used in the secondary raw materials' production falls. This means that municipalities have to pay more and more companies for the transferred waste from the selective collection. This, in turn, contributes to an increase in waste management fees offered by the entities in public tenders.

Pay-as-you-throw system – characteristics

Considering the current solutions for collecting waste produced by households in Poland, the pay-as-you-throw (PAYT) system seems fairer. PAYT schemes become widespread solid waste management systems in several countries [Elia et al. 2015]. Even countries with traditional reservations for direct charging have started to consider PAYT in the revision of their national policy programmes [Reichenbach 2008]. This strategy for pricing local solid waste collection and disposal services for how much the residents generate waste, pay for how much waste you throw away) [Folz and Giles 2002]. PAYT is an innovative solution, both in terms of process and organization. Its essential feature is that it links the amount of waste generated with the fee for its management. In practice, different baseline indicators are used to calculate collection fees. The basic values include volume, frequency, and mass, which can be used separately or in combination [Boer et al. 2018]:

1. Volume – In a volume-based system, a household is billed by the volume of the bin used to collect waste. By choosing the size of the container, residents can, therefore, regulate the amount of waste generated and reduce household budget expenses.

2. Frequency – in the frequency-based system, the commune charges the household based on the number of container empties, e.g. once, twice, or four times a month. Depending on the chosen empty out frequency, the containers have lids of different colours. There are also flexible systems. A flexible system, in which the containers placed on the edge of the street or outside the property are emptied, need monitoring the frequency of waste collection.
3. Volume and frequency – In a mixed system based on volume and frequency, residents can choose the size of the container and how often it is emptied. The frequency selection can be fixed or flexible.
4. Mass – in a system based on the mass of generated waste, the household is billed based on the generated waste mass. Garbage trucks are equipped with a scale and can monitor the weight of waste in a given container.
5. Mass and frequency – in a mass and frequency system, the household is billed for both the weight of waste and the number of emptied containers. The frequency selection can be fixed or flexible.
6. "Expensive bag" – a special case of the volume and frequency system, based on the so-called "purchased bag", also referred to as "expensive bag". A household that generates more waste also needs more bags, which leads to proportionally higher fees for their waste collection. Labelled bags can be purchased from supermarkets or other retailers.

Launching the PAYT system requires its design and significant financial outlays. To organise this system and facilitate the collection of various types of waste, the following tasks are required [Sprawdzone metody... 2010]:

– measurement of the amount of generated waste and/or services needed for it,
– identification system implementation for recording the waste generator,
– implementation of unit prices for an individual waste unit or the services used.

Thus, in the PAYT system, all containers need to be coded, and garbage trucks are equipped with a reader and scales. The data are transferred to the headquarters via real-time telemetry, where processing, billing, and invoicing occur. The collected data are also used to measure the economic efficiency of the system and to optimise its logistics.

In 2015 PAYT system was implemented by the 28 EU capital cities: Berlin, Budapest, Dublin, Helsinki, Ljubljana, Tallinn and Vienna. The average separate collection rate on total municipal waste generation in these cites is 35%. The applied PAYT schemes tend to be based on charges on the residual waste used to fund the separate collection of recyclables [European Commission 2015]. In the second half of 2015, the PAYT system was implemented in the municipality of Parma in Italy too. The collection fee for each household has two main components: fixed component, depending on the number of people and household space, and variable, depending on the amount of waste generated. The fee is calculated based on the number of bags, bins, or containers collected and whether the bio-waste is home-composted. The fixed part of the fee covers the minimum number of waste collections. Its purpose is to prevent illegal waste disposal. The additional rate depends on whether the waste is collected in a bag, bin, or container. Since the introduction of the PAYT system in Parma, the amount of waste collected has decreased. The system operator and environmental protection services ensure that selective collection is carried out correctly, and the residents receive feedback.

Benefits and side effects related to the pay-as-you-throw system implementation

The PAYT system is most often used in smaller municipalities, where most households have their own container. In the case of shared containers, e.g. in a block of flats, the waste management costs are billed collectively. The main benefits of using the PAYT system include [Boer et al. 2018]:

- encouraging selective collection,
- encouraging waste prevention,
- changing the behaviour and shopping habits of residents,
- rewarding good behaviour and punishing bad ones considering waste management,
- reducing municipal waste management costs.

As a consequence of implementing the PAYT system, the amount of generated waste is reduced.

Dahlen and Lagerkvist [2010] indicate the following strengths of PAYT systems:

- households' acceptance,
- fair allocation of costs to the system users,
- a substantial reducing waste in bags, bins, and containers (15-90% reduction reported),
- ensuring transparency of waste management costs,
- increasing sorting of recyclables,
- encouraging home composting.

However, apart from the positive features of the system, including waste management cost reduction, increased level of waste segregation, reduction of waste generation, the PAYT system can lead to several unintended side effects. These effects are mainly related to throwing mixed waste in illegal places. Based on experiences from other countries, four different cases were observed [Boer et al. 2018]:

- waste is not in the right container,
- waste is not in the resident's container,
- waste is near instead of in a container,
- waste is not even near the container.

Dahlen and Lagerkvist [2010] indicate the following weaknesses of PAYT systems:

- increased investment and operational costs of the system,
- encouraging waste tourism (is. Waste moved to neighbouring household or communities),
- encouraging illegal waste dumping,
- increased amounts of contaminants in recyclables.

Littering areas with waste is a frequently used argument against the pay-as-you-throw system. Experiences from the municipality of Brixen in Italy have shown that finding the original owners of the waste and imposing appropriate penalties on them is an effective measure in reducing the formation of such illegal landfills. Simultaneously, the combination of system improvement, quick cleaning of litter, prosecution of criminals, and environmental education can reduce the problem to an acceptable level [AOO 2004, Weijers et al. 2013].

Brown and Johnstone [2014], based on a web-survey on environmental behaviours with 4000 households across four countries, i.e. Canada, Netherlands, Sweden, Sweden, showed that experience with PAYT increased residents' support for the system. Only households that generate relatively more waste were less PAYT supportive.

Conclusions

The system of fees for municipal waste in force in Poland is ineffective. Its obligatory nature means that it is not profitable for anyone to throw waste outside the containers intended for this purpose. Still, the lack of appropriate differentiation of fees does not encourage limiting waste generation and segregation. In 2014–2019, the amount of municipal waste generated in Poland increased by 2.4 million t, i.e., almost a quarter. Moreover, in 2019, only 25% of the collected waste was recycled, and as much as 43% of municipal waste was landfilled.

Based on the analysis, we should assume that the implementation of the fee for waste through the principle of the pay-as-you-throw seems the most appropriate option to ensure reliability in paying for waste management services. Moreover, the experience of other regions in the world has shown that the system effectively supports the reduction of disposable packaging and creates incentives for at source segregation and composting. The system respects the polluter pays principle fairly by charging citizens according to the amount of waste they produce and the corresponding services they have gained access to.

Unfortunately, the implementation of the pay-as-you-throw system in Poland is not possible in the current situation (as of 2020), as the legal system does not allow for the implementation of the system of determining the fee for waste management depending on the amount of waste generated. Furthermore, considering the current Polish reality with the existing large grey zone in other areas of waste management (e.g. end-of-life vehicles, waste electrical and electronic equipment), the probability of system abuse on a larger scale is much higher than in the other EU countries.

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Correspondence addresses:

assoc. prof. Elżbieta J. Szymańska, PhD, Eng
(https://orcid.org/0000-0001-7686-1243)
Warsaw University of Life Sciences – SGGW
Institute of Economics and Finance
Department of Logistics
166 Nowoursynowska St., 02-787 Warsaw, Poland
e-mail: elzbieta_szymanska@sggw.edu.pl

Michał Wielechowski, PhD
(https://orcid.org/0000-0002-1335-8971)
Warsaw University of Life Sciences – SGGW
Institute of Economics and Finance
Department of Economics and Economic Policy
166 Nowoursynowska St., 02-787 Warsaw, Poland
e-mail: michal_wielechowski@sggw.edu.pl

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Ireneusz Żuchowski
University of Agribusiness in Łomża

The influence of managers on the introduction of innovations in logistics in Poland

Wpływ menedżerów na wprowadzanie innowacji w logistyce w Polsce

Abstract. The innovativeness of logistics companies depends on the quality of management staff. Logistics is an area where innovation largely determines the competitiveness of the company and its position on the market. Managers can have a strong influence on the level of innovation, but the way they interact can vary. The paper presents the results of the study of 200 managers working in small and medium-sized enterprises from the Podlaskie Voivodeship responsible for logistics activities and their subordinates. The aim of the research was to assess the impact of SME sector managers working in the area of logistics on the innovation of the enterprise in the context of management style and their relations with subordinates. The research shows that managers characterized by a democratic style of management and having better relationships with subordinates have a greater impact on innovation in the area of logistics. Sharing your own knowledge with subordinates is the most frequently indicated method of influencing the company's innovativeness by managers.

Key words: logistics, innovations, manager, management style, relations with subordinates

Synopsis. Innowacyjność przedsiębiorstw logistycznych zależy od jakości kadry kierowniczej. Logistyka jest tym obszarem, w którym innowacyjność decyduje w dużej mierze o konkurencyjności przedsiębiorstwa i jego pozycji na rynku. Kierownicy mogą mieć silny wpływ na poziom innowacyjności, jednak sposób oddziaływania może być różny. W pracy przedstawiono wyniki badań 200 kierowników pracujących w małych i średnich przedsiębiorstwach z województwa podlaskiego odpowiadających za działania logistyczne oraz ich podwładnych. Celem badań była ocena wpływu kierowników sektora MSP pracujących w obszarze logistyki na innowacyjność przedsiębiorstwa w kontekście stylu kierowania i ich relacji z podwładnymi. Badania wskazują, że kierownicy charakteryzujący się demokratycznym stylem kierowania oraz mający lepsze relacje z podwładnymi mają większy wpływ na innowacyjność w obszarze logistyki. Dzielenie się własną wiedzą z podwładnymi jest najczęściej wskazywanym sposobem wpływania przez kierowników na innowacyjność przedsiębiorstwa.

Słowa kluczowe: logistyka, innowacje, menadżer, styl kierowania, relacje z podwładnymi

Introduction

The modern economy is characterised by high competitiveness, which forces enterprises to constantly search for sources of competitive advantage. One of the ways to build this advantage is the continuous implementation of innovations in the area of company logistics. Innovation is considered to be a very important area of the company's operation and a source of competitive advantage and economic growth [Damanpour and Schneider 2006, p. 216].

The expectation that sustainable development will attract the attention of managers in the logistics industry, supported by the pressure of various stakeholders, including consumers, investors and decision makers, has made it a subject of great interest for organisations in recent years, especially in the transport industry [Rossi et al. 2013, p. 2] especially in the field of the fleet, concerning fuel-consuming vehicles and the use of alternative fuels [Marchet et al. 2014, p. 794].

The need to integrate logistics with the process of sustainable development was demonstrated in their research by Zailani, Amran and Jumadi [2011, p. 112], indicating that the aim of this is to reduce the environmental impact through more energy-saving technologies and changes in processes implemented in companies. Such an approach, therefore, requires innovation in logistics processes.

Innovations have a positive impact on sustainable development in the supply chain, and they can significantly affect the company's results due to their positive impact on the market share and reputation, which may translate into increased income [Björklund and Forslund 2018, p. 2].

The introduction of innovativeness faces external and internal barriers. Barriers to innovation include:

- financial restrictions (lack of external financing),
- radicality and controversy of innovation,
- the impact of external stakeholders who are key actors,
- barriers along the innovation value-added chain, such as an insufficient technical support from suppliers, limited supply, competitive pressure and the lack of customers,
- barriers at the organisational and structural level – lack of compliance of innovation goals with the organisation's strategy,
- failure of the organisation to learn, including organisational culture and inappropriate training in the organisation,
- skills barriers hindering innovation (lack of qualified personnel),
- lack of information about technology,
- lack of information on markets,
- lack of innovative partners (difficulty in finding partners for cooperation in the field of innovation) [Abdullah et al. 2015, pp. 686–687].

Innovation in logistics does not only benefit logistics practitioners, but it also has impacted marketing, sales, finance practitioners and even end consumers. Containerisation, cross-docking, EDI, RFID and temperature control technologies are some examples of logistics innovations that have influenced the way companies do business. Many logistics innovations are not visible to the wider business community as they manifest themselves in process changes that allow for more visible improvements in other areas. The improved temperature integrity during the transportation of products is one of the exam-

ples. It is not easily visible to outsiders and it improves the quality of fruit and vegetables in the grocery store, which is quickly noticed by consumers. A better understanding of such innovations and their impact can help companies to establish processes to generate further logistics innovations [Grawe 2009, p. 374].

The paper presents the results of the study of 200 managers working in small and medium-sized enterprises from the Podlaskie Voivodeship responsible for logistics activities and their subordinates. The aim of the research was to assess the impact of SME sector managers working in the area of logistics on the innovation of the enterprise in the context of management style and their relations with subordinates.

Theoretical background

Innovation and creativity in the workplace are becoming more and more important determinants of organisational performance, success and long-term survival. Using the ideas and suggestions of employees allows you to increase your competitive advantage. However, creativity and innovation are complex, multi-level and emerging phenomena that go beyond time and require skilful leadership. Only this approach allows maximizing the benefits of new and improved ways of working [Anderson et al. 2014, p. 1299].

Managers are often expected to be the source of innovation in a company. The wide range of their duties and their functions and roles may limit their activity in this respect. They can focus more on assessing the innovations proposed by colleagues and subordinates.

Managers are often promoted to management positions for their success in generating ideas and innovations. However, their role as managers in creating ideas is diminished due to the fact that they often spend a lot of time evaluating other ideas rather than generating their own. While performing their basic functions, they are cut off from the creative process, despite the fact that the generation and evaluation of ideas are closely related [Berg 2016, p. 436].

The role of managers should be to support and encourage employees to undertake creative activities, generate useful ideas, which are of key importance for the survival and effectiveness of the organisation. Managers and team leaders can play an important role in facilitating individual and team creativity. By adopting a dual focus on transformational behaviours, they can meet a dual challenge that requires them not only to develop creative team members, but also to foster joint idea generation. To increase individual creativity, team leaders can undertake individual-oriented activities such as expressing high expectations, intellectually demanding, and offering cognitive and socio-emotional support. At the team level, it is helpful to involve team leaders in team-level behaviours such as articulating vision and facilitating acceptance of team goals. They also suggest that promoting individual members to generate creative ideas can be beneficial as it provides opportunities for skills development through various mechanisms such as training programs, conference attendance and mentoring. At the level of the TSL team, it can be complemented by a clear focus on knowledge sharing, especially since knowledge sharing directly supported the team's creativity, as well as individual creativity when the development of individual skills was lower. As knowledge sharing can have a double favourable effect, it is worth considering rewarding knowledge sharing in the team [Dong et al. 2016].

Sharing knowledge plays a key role in effective knowledge management. Employee knowledge-sharing behaviours are associated with a wide range of job-related positive outcomes, such as individual results, team creativity and innovation, and financial performance of the organisation [Arain et al. 2018, p. 7]

A manager can also be effective in influencing the team's learning to build and create innovation routine, as this combination of Transactional and Transformational Leadership at the same time provides the team with a clear direction and supports team members in sharing and co-creating their ideas [Koeslag-Kreunen et al. 2016, p. 501].

In a leadership theory, a constructive dialogue is the realisation of adaptive space. The dialogue, in which people speak freely and listen in depth, can be a driving force behind organisational changes and a continuous innovation [Bäcklander 2018, p. 55].

In today's competitive global economy, a company's success in supply chains is attributed to effective knowledge management or knowledge sharing between partners. There is a significant positive link between knowledge sharing, the ability to collaborate on innovation and the company's ability to innovate. Moreover, sharing knowledge between companies increases the company's ability to continue to innovate in the long run [Butt and Ahmad 2019, p. 1]

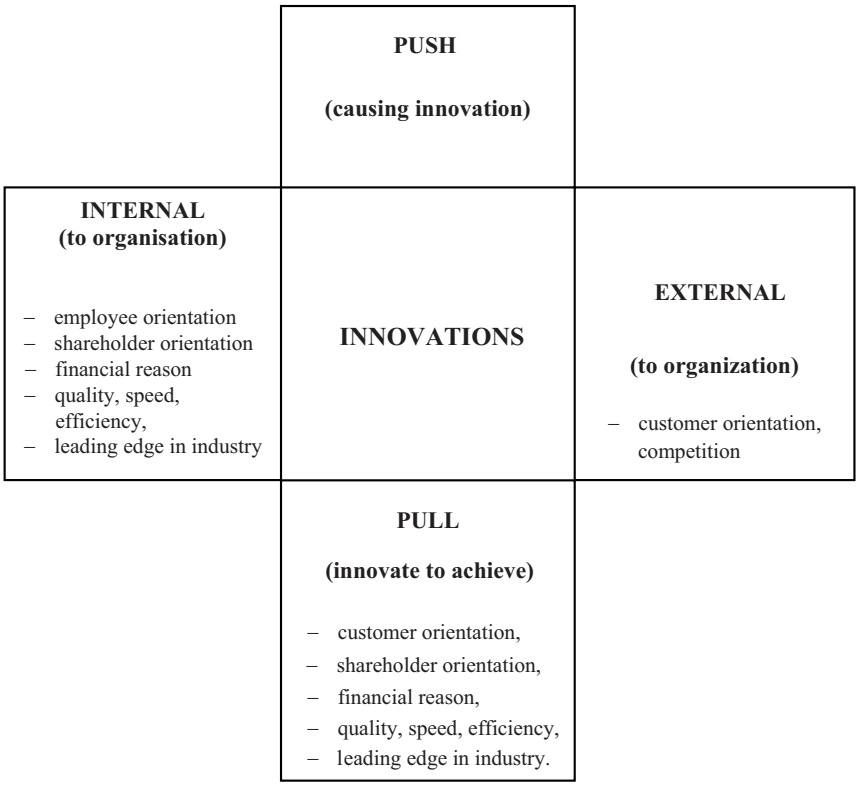

Figure 1. Drivers of innovation grouped into push, pull, internal and external factors

Rysunek 1. Czynniki napędzające innowacje pogrupowane w czynniki popychania, ciągnięcia, czynniki wewnętrzne i zewnętrzne

Source: [Soosay and Hyland 2004].

Social networks can be a source of innovation, but their role is ambiguous. Strong ties can have a positive effect on innovation in some phases of creating innovation, but in the others they can affect them negatively. However, an important factor may be trust, which facilitates cooperation and knowledge transfer [Perry-Smith and Mannucci 2015 pp. 36–37].

Soosay and Hyland [2004, p. 49] identified in their research the factors that drive innovation in companies. They classified them into four groups of factors (Figure 1):
- PUSH (causing innovation),
- PULL (innovate to achieve),
- INTERNAL (to organization,
- EXTERNAL (to organization).

Research by Cui et al. [2012] found that customer requirements, environmental factors, increased efficiency and effectiveness, provision of a broader service portfolio and diversification are the key drivers for third-party logistics companies to innovate in China.

The research by Seo et al. [2014] confirmed that companies in the supply chain compete with each other, using innovative technologies such as Internet procurement and integrated communication systems to create knowledge and networking based on multiple collaborations. Without collaboration or strategic partnerships in implementing integrated systems, joint planning and forecasting, and information sharing, innovation is no longer a driver of better performance. Therefore, the right degree of integration and collaboration is the main catalyst for better performance in the context of knowledge management of the supply chain; information management; technology adaptation and management skills; and the ability to manage cooperation.

Purpose and methodology of research

The study involved 200 managers working in small and medium-sized enterprises from the Podlaskie Voivodeship responsible for logistics activities. The respondents for the study were selected using the purposive sampling method. The following selection criteria were used:
- in case of managers, work in a managerial position in an enterprise of the SME sector in the Voivodeship Podlasie,
- in case of subordinates, work as a direct subordinate of the manager participating in the study,
- work in a logistics company or in a logistics unit.

The characteristics of managers include gender, age, education, and the number of years of work in a managerial position (Table 1). The 200 employees of direct subordinates of the surveyed managers (the manager and one of his subordinates) also participated in the study. The aim of the research was to assess the impact of SME sector managers working in the area of logistics on the innovativeness of the enterprise in the context of management style and their relations with subordinates. The research was carried out in the period of February to September 2019. The research used a questionnaire, delivered to respondents via email.

The following research hypotheses were formulated:
- H1: Managers characterised by a democratic management style, according to their subordinates, have a greater impact on the company's innovation in the area of logistics;
- H2: Managers who maintain good relations with subordinates, in their opinion, have a greater impact on the company's innovation in the area of logistics.

Table 1. Characteristics of managers participating in the study
Tabela 1. Charakterystyka kierowników biorących udział w badaniu

Factor	Number	[%]
Sex		
female	50	25.0
male	150	75.0
Age		
below 30 years	30	15.0
between 30 to 40 years	40	20.0
between 40 to 50 years	100	50.0
above 50 years	30	15.0
Education		
higher	160	80.0
secondary	40	20.0
Number of years of work in a managerial position		
below 5 years	45	22.5
between 5 to 10 years	74	37.0
between 10 to 15 years	44	22.0
above 15 years	37	18.5

Source: own research.

The scope of the research included the identification of the management style with the use of the self-assessment test of the management style on the NL and NZ management grid in accordance with the procedure presented by Tokarski [1997, pp. 217–223] and the examination of the supervisor-subordinate relationship. A questionnaire was used to assess the relationship between managers and subordinates and the impact of managers on innovation in which the questions referred to the subjective assessment of relations by subordinates and the assessment of the supervisor's impact on the innovation of the company in the area of logistics by the subordinate.

Research results

The 50% of the managers participating in the research are characterised by a democratic style of management (Figure 2). A small percentage of the surveyed managers (5%) is characterised by an autocratic management style. On the other hand, laissez-faire style is represented by 22% of the respondents, and the integrated style is represented by 23% of the respondents.

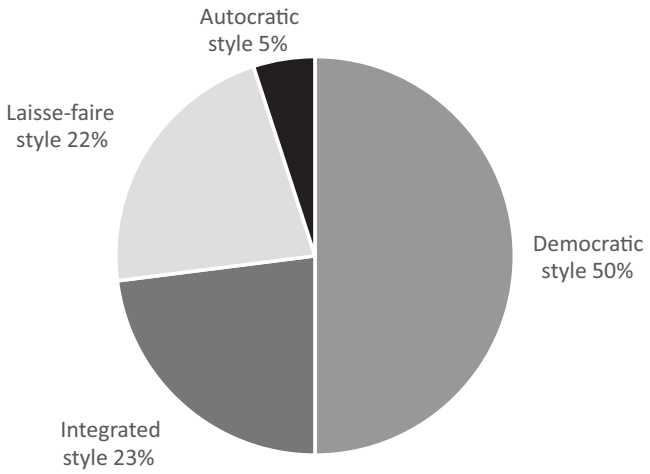

Figure 2. Management styles of surveyed managers [%] N = 200
Rysunek 2. Style kierowania badanych kierowników [%] N = 200
Source: own research.

In the opinion of the subordinates, the assessment of the relationship of the subordinate-superior indicates a positive reception by the respondents (Figure 3). As many as 84% of respondents assess their relationships with managers as average and above. The relationship was assessed by 22% of respondents as very good, and only 5% as very bad. A large proportion of democrats were identified among the managers. At the same time, the assessment of the quality of relationships is high, which may indicate that the management style influences their assessment by subordinates.

The surveyed employees believe that their superiors have a high impact on the innovativeness of the companies they work for. As many as 85% of the surveyed subordinates

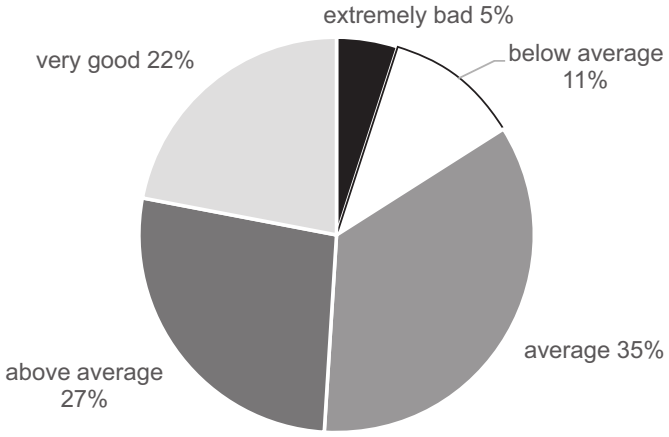

Figure 3. Opinions of subordinates on the quality of their relations with managers [%] N = 200
Rysunek3. Opinie podwładnych na temat jakości ich relacji z kierownikami [%] N = 200
Source: own research.

assess this impact at 3 or more on a 5-point scale (Figure 4). The average rating was 3.55. Only 1% of the respondents assessed the influence of their supervisor on the innovativeness of the enterprise as very low, and 12% as low.

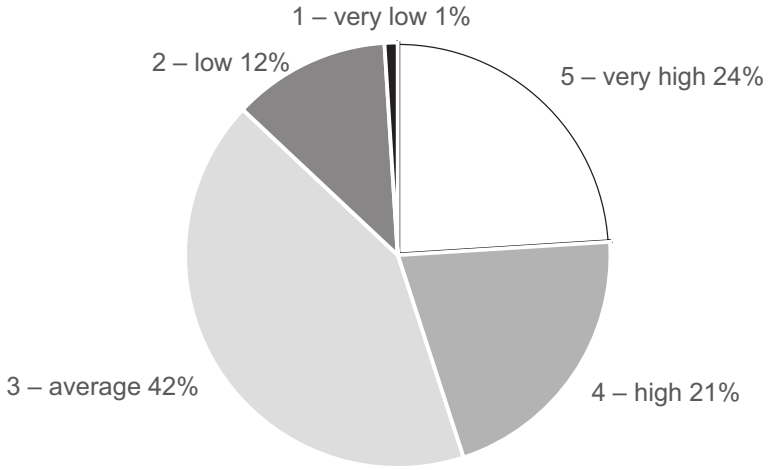

Figure 4. The assessment of the influence of managers on the company's innovation on the scale 1–5
Rysunek 4. Ocena wpływu kierowników na innowacyjność przedsiębiorstwa w skali 1–5
Source: own research.

The research also allowed to identify ways of influencing managers on the innovativeness of enterprises noticed by their subordinates (Figure 5). The most frequently mentioned method of the influence of managers on the innovativeness of enterprises in the area of logistics is sharing their knowledge (78% of respondents). A large percentage (67%) of the respondents indicated that their manager motivates them to share knowledge among their colleagues. For 62% of the respondents, the action carried out by managers that influences the innovativeness of the company is to ensure the possibility of a dialogue between subordinates and with subordinates and thus building an atmosphere of trust (62% of responses). According to the respondents, a large percentage of managers (59%) spend time assessing their subordinates' ideas for innovation. According to the respondents, 45% of managers are independently involved in generating ideas for innovation. The research has shown that subordinates notice a number of activities undertaken by managers aimed at increasing the innovativeness of enterprises.

The identified management styles were compared with the assessment of managers' impact on the innovativeness of enterprises (Table 2). The analysis shows that a high rating of the level of managers' impact on innovation is more often associated with a democratic style of management. Hypothesis 1 was verified positively. On the other hand, managers representing an autocratic management style received only low and very low ratings for the impact on innovation.

The comparison of the assessment of the relationship between managers and subordinates with the assessment of their impact on the innovation of the company indicates that

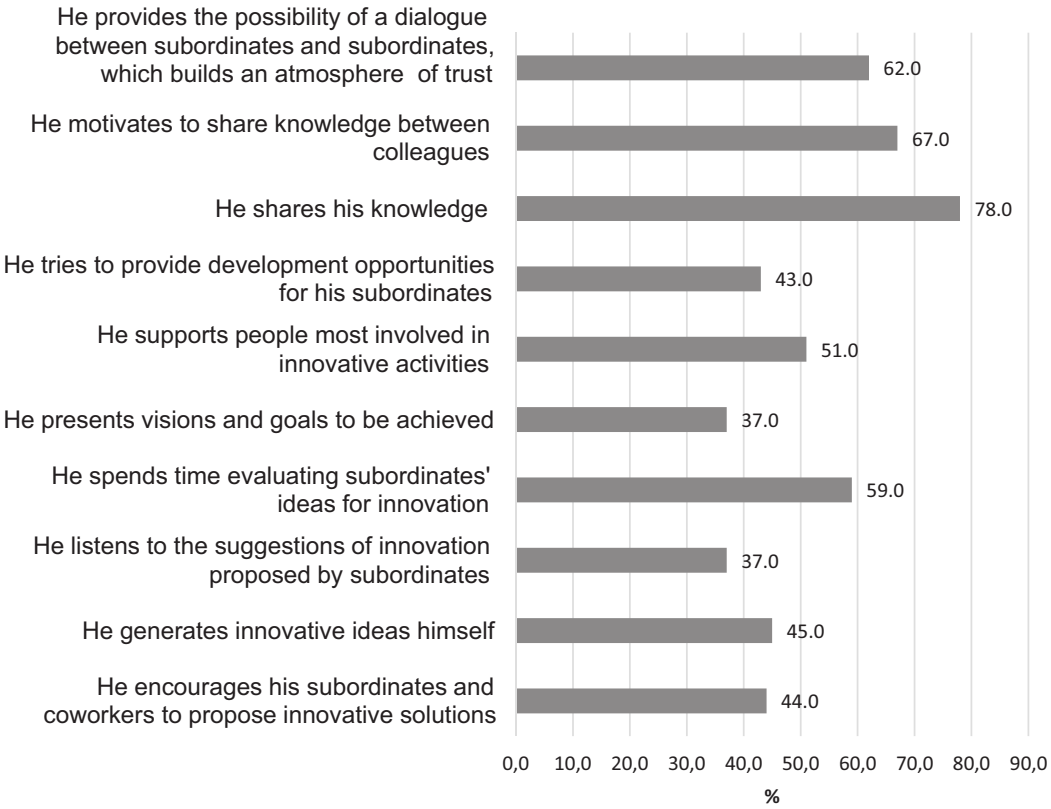

Figure 5. Ways of influencing managers on the innovativeness of enterprises in the area of logistics in the opinion of subordinates

Rysunek 5. Sposoby wpływania kierowników na innowacyjność przedsiębiorstw w obszarze logistyki w opinii podwładnych

Source: own research.

Table 2. Management style and the influence of managers on the company's innovation [%]

Tabela 2. Styl kierowania a wpływ kierowników na innowacyjność przedsiębiorstwa [%]

Identified management style	The influence of managers on the company's innovation [%]				
	very high	high	average	low	very low
Democratic	20	17	11	2	0
Integrated	3	2	15	3	0
Laissez-faire	1	2	16	3	0
Autocratic	0	0	0	4	1

Source: own research.

managers who have good relations with subordinates are more often assessed by them as those who have a high impact on the innovation of the company in the area of logistics (Table 3). Hypothesis 2 was verified positively.

Table 3. Management style and the influence of managers on the company's innovation [%]
Tabela 3. Styl kierowania a wpływ kierowników na innowacyjność przedsiębiorstwa [%]

The influence of managers on the company's innovation [%]	Assessment of relations with subordinates				
	extremely bad	below average	average	above average	exceptionally good
Very high	0	0	6	6	12
High	0	2	2	11	6
Average	2	2	24	10	4
Low	2	7	3	0	0
Very low	1	0	0	0	0

Source: own research.

Summary and conclusion

The success of an enterprise, its ability to effectively respond to phenomena occurring in a competitive environment, depends primarily on the quality of the manager's work [Kaczmarek, 2013, p. 175]. The management style, the manager's relationship with subordinates and the pursuit of innovation are important elements of the evaluation of their work by means of which its quality can be measured. Managers may, with their attitude, strive to increase innovation in every area of the company's operation, including logistics activities.

The results of the presented research indicate a link between the management style and the manager's level of influence on innovation in logistics noticed by subordinates. At the same time, it can be noticed that good relations between a manager and subordinates influence the level of assessment of their impact on innovation in the area of logistics.

The presented research results, due to the area of research and the size of the research sample, do not allow the results to be generalized to the entire population. These studies, on the other hand, can be an inspiration for further research to assess the impact of the management style, the level of relations between managers and subordinates, on the impact of managers on the level of companies in the area of logistics. These studies should also be extended to assess the impact of the above dependencies on the efficiency of enterprises and logistics departments, or the level of competitiveness, which was not possible at this stage due to limitations. In future studies, statistical analysis of the data should be performed to allow generalization of the study results.

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Correspondence address:

Ireneusz Żuchowski, PhD
(https://orcid.org/0000-0002-3998-1892)
University of Agribusiness in Łomża
Department of Management and Economics
19 Studencka St., 18-400 Łomża, Poland
e-mail: ireneusz.zuchowski@wsa.edu.pl