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Characteristics of the municipal waste management process in the aspect of work effectiveness examination and means of transport capacity

Charakterystyka procesu gospodarowania odpadami komunalnymi w aspekcie badania efektywności pracy i ładowności środka transportowego

Abstract

The article describes road transport operation planning connected with municipal waste transport, and the organisation of mixed municipal waste collection base on the example of convey routes serviced by means of transport owned by service company in Wałcz Municipal in Zachodniopomorskie Province in 2016. The article presents stages of planning and convey processes for transporting municipal waste in road transport in legal, technical and economical terms. They include all legal information relating to road convey of commodities as well as conditions which must be met by the service company that conducts this kind of transport and business activity. Technical and legal characterization of vehicles for transporting municipal waste has been presented as were transport process, technologies and systems. The Authors also analyse work effectiveness based on the drivers working time and elaborate on the optimal routes for municipal service in technological process of municipal waste transport, including all process-related activities. The aim of this article is to present the results of research on the operation of the municipal company Altvater Piła — ENERIS based on the commune of Wałcz it serviced in 2016.

Key words:
road transport, municipal waste, provisions of law, transport centre, legislative directive, transport operation

Streszczenie

W artykule omówiono proces planowania drogowej operacji transportowej związanej z transportem odpadów komunalnych, a także przedstawiono organizację zbiórki zmieszanych odpadów komunalnych na przykładzie analizy tras przewozowych pokonywanych przez środki transportowe przedsiębiorstwa usługowego w gminie Wałcz w województwie zachodniopomorskim w 2016 roku. Zaprezentowano elementy procesu planistycznego i przewozowego odpadów komunalnych w transporcie drogowym w aspekcie prawnym, technicznym oraz ekonomicznym. Artykuł zawiera wszelkie informacje o wymogach prawnych dotyczących przewozu drogowego rzeczy oraz o warunkach, jakie musi spełniać przedsiębiorstwo usługowe wykonujące tego rodzaju przewozy. Scharakteryzowano pojazdy do przewozu odpadów komunalnych pod względem technicznym i prawnym. Dokonano również charakterystyki procesu transportowego, technologii transportowych, systemów transportowych, wykonano analizę wydajności pracy na podstawie czasu pracy kierowców oraz opracowano optymalne trasy do obsługi gminy w technologicznym procesie przewozowym odpadów komunalnych z uwzględnieniem wszystkich czynności towarzyszących temu procesowi. Celem artykułu jest przedstawienie wyników badań wydajności pracy przedsiębiorstwa komunalnego Altvater Piła — ENERIS na podstawie danych obsługiwanej gminy Wałcz (dane z 2016 r.).

Słowa kluczowe:
transport drogowy, odpad komunalny, przepisy prawne, środek transportowy, operacja transportowa

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Introduction

The problem of municipal waste management involves people and societies globally. This notion encompasses collection, storage and utilization of waste. Transport accounts for a significant part of the entire process, being a key factor in efficient waste collection, which in turn leads to keeping our planet clean. The process can be improved through implementing modern technical measures integrated with organization and effectiveness enhancing systems. Over the years, substantial progress can be observed in the field of waste management (Poskrobko, Poskrobko, 2012). Means of transport are constantly modified and become more and more advanced and multifunctional so they are no longer restricted to collection to one kind of waste. The logistic process with waste is very interesting and concerns every human being. Basic activity which is provided in the market of logistics services is rendering transport conveyance service. It is closely related to road convey of municipal waste. Methods of municipal waste management have changed radically in recent years, both in terms of waste collection and treatment. The underlying reason of the changes is law amendment that Poland had to introduce under supervision of the European Union. New legal provisions adopted in Poland and objectives set concern proper waste dealing and tighten the system (Rześny-Cieplińska, 2011). All actions undertaken in this area, from selective waste storing and collection to legally enforced achievement of certain levels of recovery and packaging waste recycling and limiting the weight of biodegradable waste directed towards the collection, are just a prelude to minimizing threats for the environment. It seems vital to provide continuous control of proper waste dealing at the level of a commune, a voivodeship and a country. This arises from the need to carry the goods from one place to another in order to meet business demand, which on the other hand increases the accumulated amount of waste. At present we ate witnessing further increase in waste trade, which enforces enterpreneurs to take up specific specialization within their services and to own specialised means of transport. The demand in the market contributes to further significant development of transport services.

Characteristics of monitoring system for the municipal waste collection and transport

Along with the enforcement of ordinance by the Minister of the Environment on detailed requirements in terms of municipal waste collection from property owners, each vehicle for waste collection must be equipped with Global Positioning System (GPS). This is essential to evidence the performance of work (Starkowski, Bardziński, 2017 a–e). Minimum law requirements include recording information on vehicle location, stops and unloading of waste. The municipal company Altvater Piła — ENERIS uses the RFID system for municipal sector called SMOK, offered by ELTE GPS company. Apart from the parameters related with the vehicle position, the system also enables recording other data, which then are passed to a GPS controller, and further via GSM/GPRS data transmission are transmitted to server. The information recorded optionally includes: fuel level, fuel consumption, engine revs, hopper openings, performance of the intake device or data from sensors installed which, among other things, allow for tracking of waste unloading sites (Toruński, 2010).

All vehicles owned by municipal company are equipped with touch-pad terminals which support and facilitate municipal waste collection process. The devices enable communication with the base, allow GPS navigation as well as diagnostics of the monitoring system elements. The main function of terminals is to display routes in the area with waste collection points (Figure 1). The driver ticks on a tablet at each address where the container has been emptied.

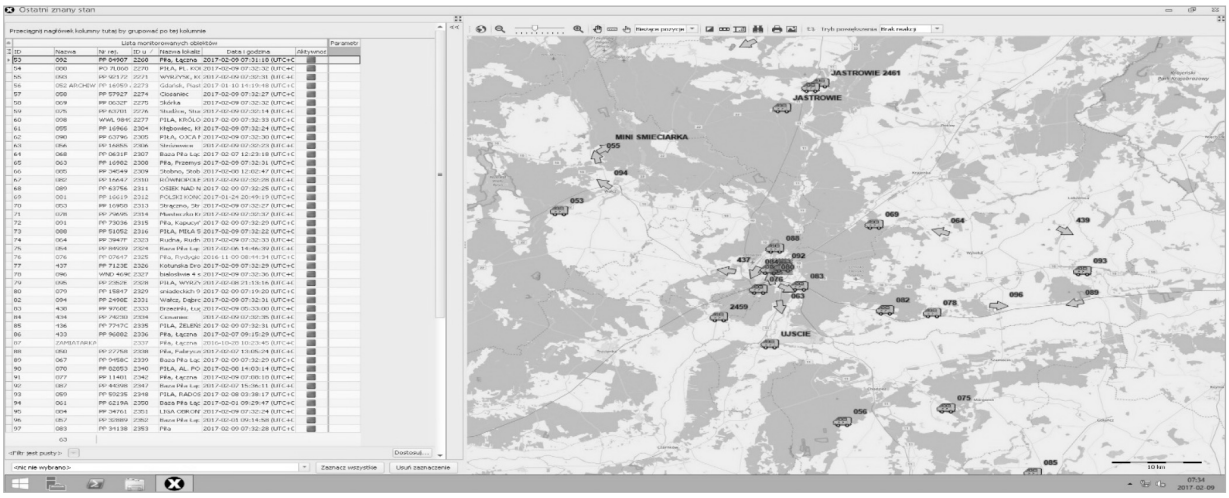
The driver can also send messages directly, which reports the impossibility of waste collection due to accidental reasons, with digital camera photos attached. General modul of positioning consists in mounting on vehicle a GPS controller which records data on the vehicle position, its speed, and direction of travel (Stanisławska, Bardziński, Kalka, 2015). The arrangement of all the system elements as well as its modern and economical design adapted to work on municipal and rural areas is shown in Elte GPS trading documents (Elte GPS, 2016).

Data recording is enabled by built-in inner memory. This enables generation of reports on transit routes of means of transport and on waste unloading — an examplary report is shown in Figure 2.

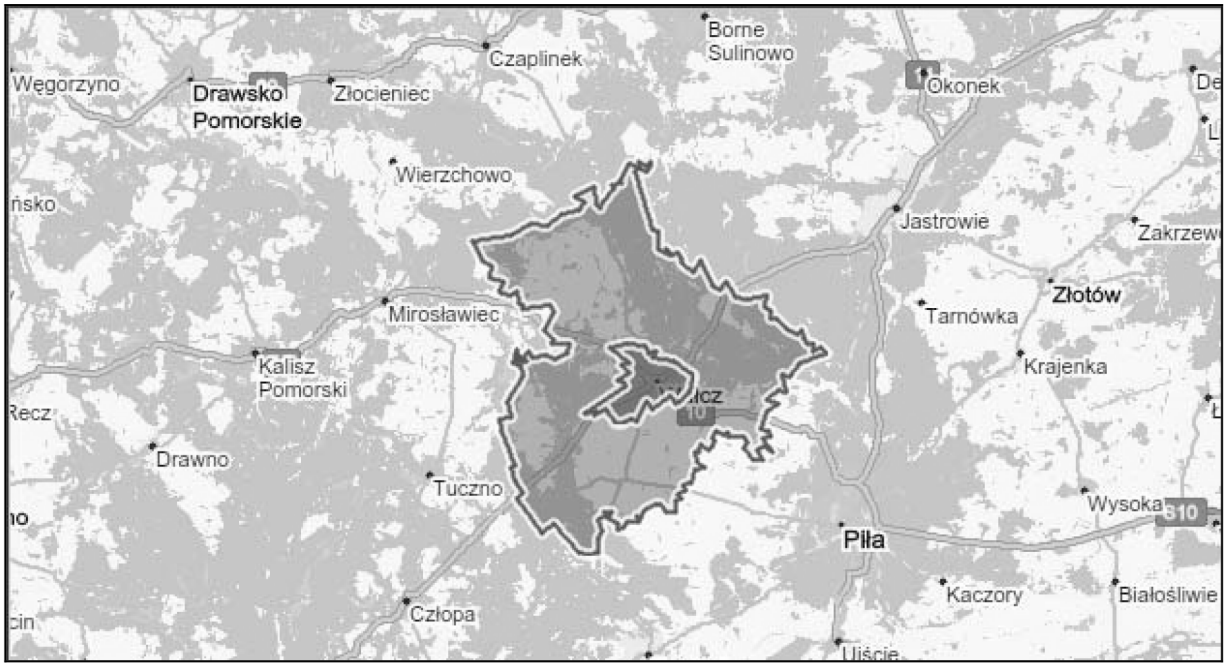
Apart from monitoring the means of transport, the municipal company has fully RFID-based system for monitoring bins' locations, their filling levels and their identification. The module enables to report container emptying and calculating the amount of work performed. Antennas fixed on a vehicle allow to identify the bins which pass data on the loading place and a number of emptied container to the server. The module enables to report emptied bins. For bin identification antennas, reading devices and identifiers are used (Zębek, 2018). The reading device is mounted on a garbage truck next to the handle used for lifting a bin. Its task is to read the information from the identifier mounted on a

Figure 1
The planned route with waste collection points (a) and a map with the collection zone marked (b)

(a)



(b)



Source: Elte GPS, 2016.

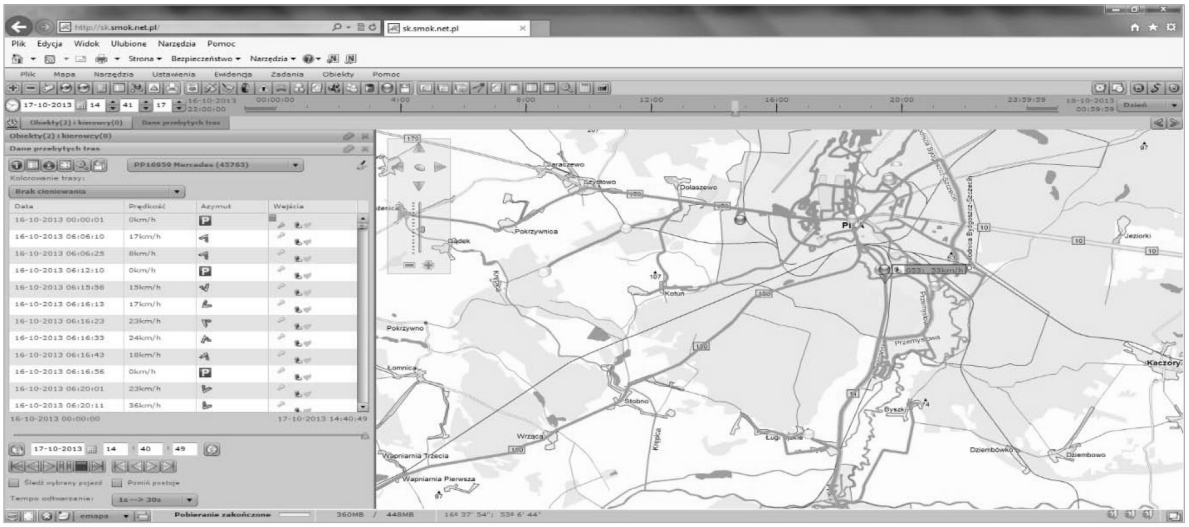
container. Usually, the vehicles are equipped with posts to load two bins of 60-140 liters or one large bin of 1100 liters of capacity. The identifier is an element marked with a unique number to enable to assign bins to a particular address (Stanisławska, Bardziński, Kalka, 2015). In bins factory-fitted with an outlet, identifiers are mounted in the form of so-called plugs. However, in a bin not fitted with such a socket, identifiers are mounted on a lateral or the front wall — in a position enabling to read it (Altvater Piła — ENERIS, 2016; Starkowski, Bardziński, 2017d).

Characteristics of means of transport for municipal waste collection

In the research aiming at optimization in the Wałcz commune, a modern waste collection vehicle was used, fitted with back loading system. The make/model was Scania P310 6x2 with equipment SEMAT type C388.03 (Starkowski, Bieńczak, Zwierzycki, 2011). The category of its official certification is shown in Table 1. Technical data used for vehicle testing are presented in Table 2.

Figure 2

The report on vehicle route and list of waste collection points based on the route in the regions served on Mondays, odd weeks



Legend to the Figure:

– place of commissioning of intake device which empties a bin,

– direction of vehicle travel,

– vehicle route based on GPS data.

Source: Altvater Piła — ENERIS, 2016.

Table 1
Category of official certification of vehicle SCANIA P310

Type		Sub-type		Purpose		Category of official certification
ITS code*	Name	ITS code	Name	ITS code	Name	N3
06	Motor truck	99	Other	308	Waste disposal	

* ITS stands for Instytut Transportu Samochodowego (Motor Transport Institute).
Source: Altvater Piła — ENERIS, 2016.

Table 2
Technical data used for testing the vehicle

Technical parameter	Value of the parameter
The maximum total truck weight with technically authorized load [kg]	26,000
The maximum total truck weight with technically authorized load, in motion, in a member country where it was registered [kg]	26,000
The maximum total equipment weight with technically authorized load, in motion, in a member country, where it was registered [kg]	29,500
The maximum total truck weight [kg]	13,640
The maximum payload [kg]	12,360
The maximum load per axles [kN ⇨ kg]	112.70 ⇨ 11,500

Source: see Table 1.

The use of means of transport — optimization analysis. Methodology of examination

Analysis of amounts of municipal waste transported, in terms of vehicle capacity

The service for the Wałcz commune is specific. It is situated on a different waste management area than the depot of the municipal company it is serviced by. This results in additional impediments, including, in particular, extended time of waste collection from a contractual place. The optimization analysis on the amount of waste transported in terms of time, considering the usage of optimal vehicle payload, was conducted in 2016. The commune of Wałcz was serviced in a streak of 10 working days. Within the period of the two working weeks one day is dedicated to collection of selective waste. The area of service is divided into sectors relative to even and odd weeks. The commune of Wałcz was served by collecting mixed municipal waste in 9 working days. On even and odd Thursdays the main target for waste collection are companies in Wałcz Town. Five towns belonging to the commune of Wałcz under analysis here are also included in the regions of service on these days. One should remember that most of the waste mass collected on Thursdays came from individual clients — firms. "Day" here is understood as a day covered by service for the commune of Wałcz, however the values for Thursday do not represent only this area. The table on the next page presents average values in tons of waste collected during each day in the region. They are compared to the number of bins and vehicle payload. The data are elaborated based on specifications by the company of Altvater Piła Sp. z o.o — ENERIS in 2016 — Table 3.

While carrying out the analysis worrying data were encountered. In the course of servicing Tuesday regions in even weeks it can be noticed that maximum authorized vehicle weight amounts to nearly 100%. The mean of waste mass on that day is to 11.60 tons, however on certain collection days some inconveniences may be noticed. In the Table 4, there is a comparison of weights of all days on which Tuesday region was serviced amounting up to 618 municipal waste collection points.

What follows from the data presented in Table 4 is a very unfavorable phenomenon of near overloading. This is due to a large area, and if further collection points are added, may lead to overloading

Table 3
Analysis of the usage of vehicle payload parameter of municipal mixed waste mass collected in 9 days of service in the commune of Wałcz in 2016

Region	Number of bins	Average waste mass [t]	Vehicle payload [t]	Unused payload [t]
Monday – odd week	489	6.80	12.36	5.56
Monday – even week	481	7.40	12.36	4.96
Tuesday – even week	618	11.60	12.36	0.76
Wednesday – odd week	434	7.60	12.36	4.76
Wednesday – even week	393	6.90	12.36	5.46
Thursday – odd week	firms + 54	5.80	12.36	6.56
Thursday – even week	firms + 108	7.60	12.36	4.76
Friday – odd week	353	6.20	12.36	6.16
Friday – even week	311	6.30	12.36	6.06
Mean:		7.30	12.36	5.06

Source: see Table 1.

Table 4
Specification of masses of collected waste on Tuesdays in even weeks in 2016

Item	Mass of waste collected [t]	Vehicle payload [t]	Unused payload or overload [t]
1	12.20	12.36	0.16
2	11.40	12.36	0.96
3	12.34	12.36	0.02
4	12.26	12.36	0.10
5	12.18	12.36	0.18
6	12.28	12.36	0.08
7	12.22	12.36	0.14
8	12.10	12.36	0.26
9	12.12	12.36	0.24
10	11.00	12.36	1.36
11	10.74	12.36	1.62
12	11.06	12.36	1.30
13	9.34	12.36	3.02
14	11.84	12.36	0.52
15	11.60	12.36	0.76
16	11.40	12.36	0.96
17	11.20	12.36	1.16
18	11.34	12.36	1.02
19	11.82	12.36	0.54
20	9.92	12.36	2.44
21	12.24	12.36	0.12
22	12.32	12.36	0.04
23	12.36	12.36	0.00

Source: see Table 1.

of transport means. It was decided to make a detailed specification in the case of that specific day of service, as the present inconveniences convince decision-makers to alter the routes in some particular areas in order to prevent the threat of vehicle overloading.

The analysis of waste collection productivity based on working time of transport means

Waste collected in the area of Wałcz commune is disposed of in the landfill in Wardyń Górny. This is due to the requirements which do not allow transport of

Table 5
The analysis of vehicle work time in 2016, depending on the number of bins and waste mass, based on collection and transport of mixed municipal waste, in 9 days, in the Watcz Commune

Collection time	Number of bins	Average load mass[t]	Collection time[h]	Transport time[h]	Total working time[h]
Monday – odd week	489	6.80	7	3	10
Monday – even week	481	7.40	8	3	11
Tuesday – even week	618	11.40	8	3	11
Wednesday – odd week	434	7.60	7	3	10
Wednesday – even week	393	6.90	7	3	10
Thursday – odd week	firms + 54	5.80	6.5	3	9.5
Thursday – even week	firms + 108	7.60	6.5	3	9.5
Friday – odd week	353	6.20	6.5	3	9.5
Friday – even week	311	6.30	6.5	3	9.5

Source: see Table 1.

waste between regions of municipal waste management. The distance of 100 km between landfills and company premises extends the time used for transport, adding 1 hour and 40 minutes. Then, one should add the travel time from the depot to the region, which on the average, takes 30 minutes, as well as the time of travel after the completion of work in the region, to the landfill which is 1 hour. Thus, the total transport time during working day exceeds 3 hours.

Considering 8-hour work standards and the area of the commune of Wałcz serviced, the employees have only about 5 hours altogether to perform waste collection. With the number of villages and bins in the commune of Wałcz, this was not feasible, within daily working time in 2016. Interdependencies between the number of bins and waste mass as well as the total work time are presented in Table 5.

Due to the distance from the company depot to the landfill, only 5 hours remain every day for waste collection while the transport takes 3 hours. This makes it impossible to fit in the standard working time. The minimum collection time for regions with about 300 bins is 6.5 hours. The findings of work productivity tests on servicing the commune of Wałcz, carried out in 2016, are presented in Table 6.

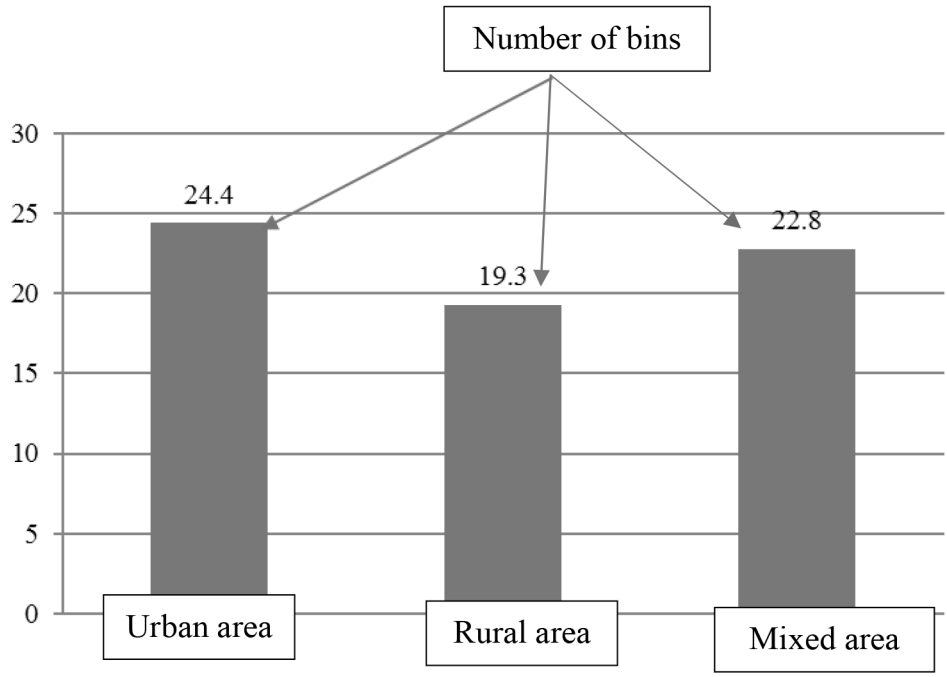
The average work productivity not only depends on the number of bins and collection points, but also on the travel time between villages which was included in the collection time. The result of 56 bins emptied per hour is the result confirming that 5 hours left for waste collection is definitely not enough. During that time there would be 280 bins emptied which is by far an unsatisfactory outcome considering the total number of collection points in the area of Wałcz Commune.

Table 6
The analysis of productivity of the staff performing the collection and transport of mixed municipal waste during 9 service days in the Commune of Watcz (2016)

Collection day	Number of bins	Collection time [h]	Transport time[h]	Total working time[h]	Work productivity [number of bins per 1 h]
Monday – odd week	489	7	3	10	65
Monday – even week	481	8	3	11	60
Tuesday – even week	618	8	3	11	77
Wednesday – odd week	434	7	3	10	62
Wednesday – even week	393	7	3	10	56
Thursday – odd week	firms + 54	4.5 + 2	3	9.5	27
Thursday – even week	firms + 108	4.5 + 2	3	9.5	54
Friday – odd week	353	6.5	3	9.5	54
Friday – even week	311	6.5	3	9.5	48
Average work productivity:					56

Source: see Table 1.

Figure 3
Effectiveness [the number of bins emptied per hour] depending on the area serviced, 2014



Source: Mytlewski, 2015.

At the same time, the effectivity outcome of 56 bins per hour is surprisingly high. According to statistical data the maximum effectiveness achieved in rural areas is 19.3 bins per hour which is less than a half of the result recorded in the commune of Wałcz. For comparison the information on statistics from 2014 was used. It referred to work effectiveness in communal waste collection per 1h which amounted up to 24 of bins emptied per hour of work, depending on the area serviced (Figure 3).

The specification shown in Figure 3 presents different results, depending on the area serviced. Rural areas score the lowest values, which is caused by slower travel to collection points as well as long distances between villages. In municipal areas, higher effectiveness stems from closer distances between collection points, without the need to travel from one village to another as the same number of bins is emptied along the town streets.

Work effectiveness of the crew of the municipal company Altvater Piła — ENERIS performing waste collection in the area of the commune of Wałcz in 2016 was 54 bins emptied per hour. The effectiveness of the municipal company, on the example of service rendered in the commune of Wałcz, certifies high competitiveness of the company. The effectiveness of crews in terms of the number of bins emptied per hour is a leading factor for controlling disposal effectiveness. The aspect which contributes to such a high result of the company is the fact that the commune of Wałcz is serviced by a well-trained staff who know the linear and point infrastructure of the serviced area of municipal waste producers.

Elaborating optimal routes for the service of the Watcz Commune

While calculating the average mass of waste collected and analyzing the working time in terms of the number of bins, it is difficult to spot a firm dependence. This is caused by the variety of terrain met each day in the region. The determining aspect here are the villages under service and how they are situated. Basing on the analysis of routes covered each day of service in the commune of Wałcz, some inconveniences were observed concerning distant locations/villages where collection on a given day is due. Undoubtedly, this factor extends the crew's working time. If optimized, routes of each day in the region serviced could contribute to reduce working time — and subsequently also to reduce the number of days of service. Such an optimization could consist in an improvement of activities carried out in order to obtain the best effects at the least input. Optimization of the routes could also lower the time and costs of transport, thanks to shortened mileage. In the prior analysis the waste collection was included into the travel time between individual villages in the region. While analyzing the data obtained, our attention

Table 7
The analysis of working time for collection of mixed municipal waste during 9 days of service in the commune of Watcz in 2016

Collection day	Number of bins	Collection time		Total distance between villages [km]
		total [h]	Travel time between villages [min]	
Monday – odd week	489	7.0	56	32.5
Monday – even week	481	8.0	79	58.4
Tuesday – odd week	618	8.0	28	23.0
Wednesday – odd week	434	7.0	33	32.5
Wednesday – even week	363	7.0	53	40.2
Thursday – odd week	firms + 54	6.5	21	10.9
Thursday – even week	firms + 108	6.5	16	10.7
Friday – odd week	353	6.5	109	63.4
Friday – even week	311	6.5	62	41.2
Average			51	35.0

Source: see Table 1.

focused on the following question: "Why the total collection time from regions with 481 and 618 bins, respectively, was the same?" The analysis of the routes in specific regions as well as travel time between villages allowed to draw sound conclusions — relevant data are presented in Table 7.

Without a doubt, the aspect which lowers the effectiveness of work is the travel time between villages. The analysis of village/town displacement included in the content of regions on particular days, encouraged us to carry out further research on optimization of service routes.

The optimization of a route on Monday odd week region. The region covered on every Monday in an odd week included 489 bins. Taking into account a distant setting of villages to be serviced on that day, it was necessary to decrease the number of municipal waste bins emptied. Optimization of the route on that day fails to deliver spectacular effects for the time being, but it does influence the research outcomes. Basing on research methodology adopted, an *ex ante* and *ex post* analysis of the optimization of region route was conducted, as presented in Figure 4 and in tables 8 and 9.

Optimization of the route on Monday in an even week. The major drawback of the region covered on Mondays in even weeks consists in a serious discrepancy between villages of Nakielno, Nagórze and Rutwica and the rest of the region. This results in a lengthy travel time between villages, verging on as long as 79 minutes. The purpose of optimization in the region was to shorten both the travel time and distance between sites included in the Monday service route. In line with the methodology adopted, a research analysis was carried out before and after the optimization of the route in the region, presented in Figure 8 and tables 10 and 11. The effect of the route optimization has now become more distinct. The travel time was reduced by 25 minutes and the distance by 26.8 km. At the same time, the number of bin meant to be emptied on the route remains on a similar level. Similar specifications were prepared for all the research periods analyzed in 2016 (Figure 5).

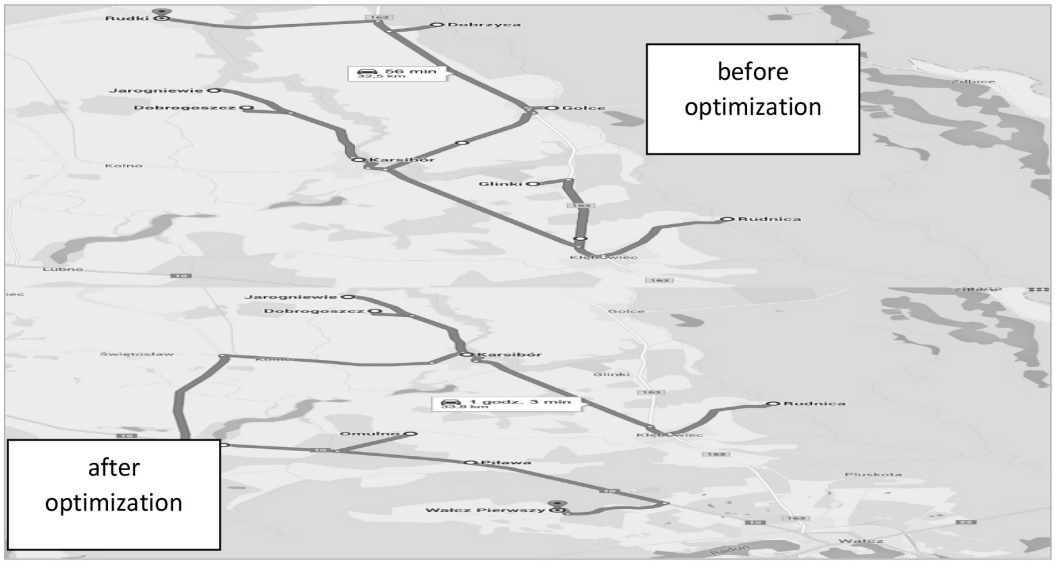
Table 8
The analysis of number of villages/bins before and after optimization of region routes of odd week Monday in 2016

Before optimization		After optimization	
Villages	Number of bins	Villages	Number of bins
Rudnica	13	Rudnica	13
Glinki	17	Karsibór	241
Karsibór	241	Dobrogoszcz+ Jarogniewie	7
Dobrogoszcz+ Jarogniewie	7	Lubno	140
Golce	83	Omulno	13
Dobrzyca Wałecka	34	Piława	8
Rudki	94	Wałcz Pierwszy	10

Source: see Table 1.

Figure 4

The arrangement of routes in the Monday region of an odd week before and after optimization



Source: see Figure 2.

Table 9

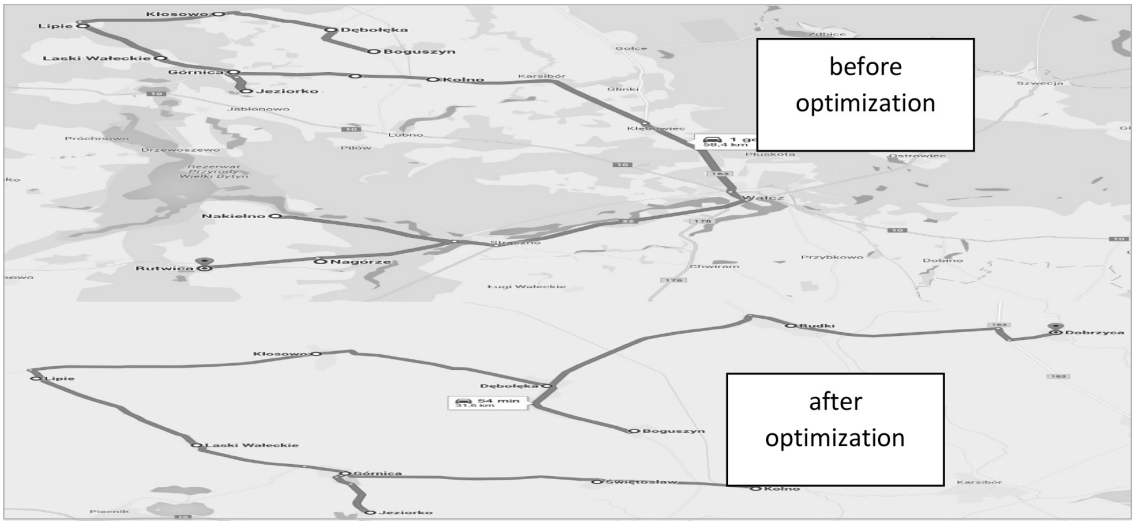
The comparison analysis of effects before and after optimization of Monday in an odd week

	Before optimization	**After optimization**
Number of villages in the commune	8	8
Total number of bins	489	432
Travel time between villages [min]	56	63
Total distance between villages [km]	32.5	33.8

Source: see Table 1.

Figure 5

Arrangement of a route of Monday region in an even week, before and after the optimization in 2016



Source: see Figure 2.

Table 10

The analysis of the number of villages and bins before and after the route optimization of Monday region in an even week in 2016

Before optimization		After optimization	
Villages	**Number of bins**	**Villages**	**Number of bins**
Boguszyn	23	Kolno	29
Dębołęka	79	Świętosław	14
Kłosowo	31	Górnica	75
Świętosław	14	Jeziorko	16
Górnica	75	Laski Wałeckie	13
Jeziorko	16	Lipie	8
Laski Wałeckie	13	Boguszyn	23
Lipie	8	Dębołęka	79
Kolno	29	Kłosowo	31
Nakielno	92	Rudki	94
Nagórze	4	Dobrzyca Wałecka	34
Rutwica	97		

Source: see Table 1.

Table 11

The comparison analysis of effects before and after the optimization of Monday region route in an even week, in 2016

Indicator	Before optimization	After optimization
Number of villages	12	11
Total number of bins	481	416
Travel time between villages [min]	79	54
Total distance between villages [km]	58.4	31.6

Source: see Table 1.

Table 12

Summary effects of optimization of transport routes

Parameter	Value
Total travel time between villages before the optimization [min]	457
Total travel time between villages after the optimization [min]	351
Travel time shortened by [min]	**106**
Total working time in 9 days of service [min]	5,300
Total mileage between villages before the optimization [km]	312.8
Total mileage between villages after the optimization [km]	229.2
Mileage reduced by [km]	**83.6**
Total mileage in 9 days of service	2,600
Number of days of service for the Wałcz commune before the optimization	9
Number of days of service for the Wałcz commune after the optimization	8
Number of days reduced [days]	**1**

Source: see Table 1.

The examination carried out achieved the goal set — both distances and time of travel were reduced by some margin. The effect of shortening the total time from 9 to 8 days for service in the Wałcz commune was also achieved. As within this period a vehicle travels 2,600 kilometers on the average, the

difference of 84 kilometers does not generate big savings. While not an objective sought in the first place, this additional conclusion resulted from the possibility to increase a daily number of collection points, thanks to the high level of the crew's working productivity. The detailed data about the effects obtained are presented in the Table 12. The travel time between villages after the examination has been reduced by 106 minutes and the distance by almost 84 km. Similar conclusions may be drawn from the amount of working time saved.

Summing up the analysis, the examination findings were used to draw the following conclusions:

- Crew work productivity is evaluated very high.
- Crew working time results from servicing a very large area.
- The examination proved that it is possible to achieve optimization in this field, reducing both time and distances of travel between villages, although the magnitude/extent of actual changes may in some cases occur insignificant.

Conclusions

The key research objective was to analyze the municipal waste collection and transport in the area of the Wałcz commune, including tests on the use of means of transport. The analysis of vehicle capacity, compared to the amounts of waste collected in the year of 2016, proved the sound choice of means of transport (with no overload effect occurring). The examination of work efficiency basing on data collected also resulted in a very high assessment. This encouraged the Authors seek for measures of optimization of routes covered in terms of travel distance and time. The effect enabled reduction of the number of days spent on service from 9 to 8 although the ultimate savings achieved in travel time and distance, compared to the total times and distances in performing the service were of minor significance. Still, the results of research/tests are positive. Waste collection services, and especially waste transport in the Wałcz Commune are highly effective and competitive.

Further on, it was concluded that factors affecting the implementation of routes' optimization are as follows:

- a threat of overload to occur on the completion of waste collection process on Tuesday regions in even weeks, if additional one-off tasks are added on that day,
- long crew's working time,
- excessive distances and travel time between villages due to their dispersion on most of routes in the area.

One of major aspects which regulates the collection and transport of municipal waste are provisions of law. The essential element was to enforce a new Waste Management Act in 2012 which allowed to consolidate Poland's national and EU provisions.

The only thing that remained to be done in the wake of the Act was to enact a regulation on particular requirements concerning waste transport. While its draft existed, its announced entry into force on 1 January 2016 did not happen and it was only implemented with much delay. Since the question of labelling a vehicle transporting waste, described in the resolution, is a priority in waste transportation, it is positive that this finally happened.

Optimization of all routes services in the Wałcz commune revealed a potential to save time and mileage. While the effect has not occurred influential or spectacular enough to apply this particular optimization, still the key to this kind of effective waste collection and transport process is in savings stemming from rational route planning. Especially in a situation when the crew is very productive, it is possible to save time and mileage this way.

Finally, we should point out the perfect selection of means of transport for the specific area serviced. The Wałcz commune, being quite large, with numerous collection points, requires usage of vehicles with large capacity. Three axle vehicles enable the operator to avoid the risk of overload. Summing up, the article constitutes a proposal for legal and logistic activities for traders who run business in waste management sector and to seek for optimization in the process.

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