

MODEL OF DATA OF THE SETTLEMENT OF COSTS OF PUBLIC TRANSPORT OPERATING ON THE TERRITORY OF THE UPPER SILESIAN METROPOLITAN UNION

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Purpose: Development of a coherent unified data model allowing multi-criteria analysis of data on accounting for the costs of public transportation provided in the Upper Silesian-Zagłębów Metropolitan Area (GZM) (<https://metropoliagzm.pl>).

Design/methodology/approach: The study used automatic data processing methods using Power Query mechanisms, data cleaning and unification techniques.

Findings: In the course of the work it was found: dispersion of data between different cost-controlling units, lack of uniform data structures between units, inconsistency of dictionaries over time.

Practical implications: The data model developed during the work was used to build the analytical platform used within the GZM.

Social implications: The developed model was used for presentation to the mayors of the municipalities that make up the GZM. It is an analytical tool used by the management of the GZM to present and optimize the scope of communication in the designated area.

Originality/value: Authorial model for processing data from heterogeneous sources into a coherent and unified data structure has been developed.

Keywords: Public transportation, public transport, data modeling, visualization.

Category of the paper: Practical implementation of data processing system and data model construction.

1. Genesis

In November 2017, the Metropolitan Transport Authority (ZTM) was established by the Assembly of the Upper Silesian and Zagłębie Metropolis (GZM), which took over the responsibilities of the three previous public transport organizers by combining the public transport system operating in Silesia and Zagłębie and serving the territory of 56 cities and municipalities (<https://metropoliagzm.pl/droga-do-metropolii/>).

Resolution No. 7/2020 of January 15, 2020 of the Board of Directors of the Upper Silesia-Zagłębiowska Metropolis (<https://bip.metropoliagzm.pl/uchwala/125860/uchwala-nr-07-2020>) adopted a document on "principles of proceeding in calculating the variable part of the Annual Contribution for municipalities of the Upper Silesia-Zagłębiowska Metropolis and subsidies for municipalities not belonging to the GZM." On December 23, 2021, amendments were made to the above-mentioned resolution, which were announced by Resolution 325/2021 of the GZM Board (<https://bip.metropoliagzm.pl/uchwala/128104/uchwala-nr-325-2021>).

These documents set out the rules of procedure for calculating the variable portion of fees to be paid by individual GZM municipalities and subsidies to non-GZM municipalities for public transportation provided on their territory.

The company responsible for organizing public transportation is the Metropolitan Transport Authority (ZTM) (<https://www.metropoliaztm.pl/pl/>). It should be noted here that ZTM performs its tasks mainly on the territory of the GZM, however a partial scope of its activities is also implemented on the territory of municipalities not belonging to the GZM.

Based on the aforementioned resolutions, employees of ZTM's controlling department have prepared planning and settlement sheets determining remuneration for individual operators providing public transportation, as well as sheets calculating the variable premium (<https://metropoliagzm.pl/tag/skladka-zmienna/>) which is charged to individual municipalities.

The amount of the variable premium is determined by two main factors:

- the portion resulting from the amount of transportation provided, and,
- the part resulting from the surcharge covering the organization's operating costs.

Implemented plans and settlements are carried out in annual cycles, their rules are gradually modified and therefore variable in subsequent years.

In 2021, there was a need to develop a data model that would allow the heads of individual municipalities (mayors, aldermen, mayors) to present the components of the surcharge that burden each municipality in a relatively simple way. This paper presents the issues and stages of building such a model.

2. Input data

The input data for the model were binders of data provided by two departments dealing with the settlement of transportation costs. One of them deals with the determination of the so-called variable contribution, i.e. the fee that individual municipalities pay to the joint budget. The characteristics of these data and how they were processed are presented in the following paragraphs.

2.1. Input data – carriage costs

Department one deals with planning and accounting for transportation costs.

Data is collected in the form of spreadsheet binders, each sheet contains a table that includes a plan and settlement of one unit during one month by individual transportation lines. Two types of billing are maintained. one for bus and trolleybus lines and the other for tramway billing. The units are respectively:

- municipalities included in the GZM (<http://gzmetropolia.pl/metropolia>),
- municipalities from outside the GZM,
- special units that account for additional special transportation tasks carried out, such as:
 - events,
 - detours,
 - commutes,
 - access to supermarkets,
 - trips charged entirely to the GZM.

The special units identified above are conventionally referred to by the term "virtual municipalities".

The individual tables include volume (kilometer) and value settlements. Value settlements include volumes resulting from the number of kilometers traveled, as well as volumes resulting from various additional charges specific to bus-trolleybus and streetcar fleets, respectively.

2.1.1. Data – Buses and trolleybuses

Data regarding planning and accounting for bus and trolleybus transportation was contained in 6 workbooks. Four contained planning data for 2020-2023 and two dealt with implementation from 2020-2021.

Within each workbook, there were up to 57 (varying by year) worksheets containing data on individual municipalities and virtual municipalities. Within each sheet, the table rows contained data on individual line numbers. A total of 521 bus lines (including bus lines operating vicariously on tramways) and 8 trolleybus lines were identified. The columns of the tables contain quantitative (wozokilometers - wkm) and value data on wkm traveled and other values charged to individual lines such as:

- AIR CONDITIONING net cost,
- MONITORING net cost,
- WIFI net cost,
- SDIP net cost,
- PPK net cost,
- MIN_WAGE net cost,
- OTHER net cost.

The structure of the data sheets within a single workbook (Fig. 1) was consistent while there were differences in construction between different workbooks (years).

LINIA	OPERATOR	OZNACZENIA	Dzień roboczy				PRACA WG ROZKŁADU JAZDY					
			M	A	B	C	Sobota					
NR	TYP	WYJĄTKI	UWAGI	ORG	UMOWA							
A4	0	ferie	PKM Gliwice		PO/68/R-I	0,00	0,00	0,00	0,00	0,00	0,00	0,00
A4N	n	0	PKM Gliwice		PO/68/R-I	0,00	0,00	0,00	0,00	0,00	0,00	0,00
0	0	0	PKM Katowice		PO/68/R-III	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1	0	0	PKM Tychy		PPN 0232 10.2015	0,00	0,00	1 339,20	9 039,60	0,00	0,00	0,00
1N	n	0	PKM Tychy		PPN 0232 10.2015	0,00	0,00	0,00	0,00	0,00	0,00	390,60
2	0	0	PKM Tychy		PPN 0232 10.2015	561,90	374,60	2 247,20	0,00	0,00	0,00	2 809,50
2A	0	ferie	PKS Południe		OP/80/CRU/638/RUZP/470/19	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3	0	0	Kons Swierklaniec-PKM		272.1.2014/KS	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4	0	0	PKM Tychy		PPN 0232 10.2015	0,00	0,00	5 556,00	4 896,00	0,00	0,00	0,00
5	0	0	Kons Swierklaniec-PKM		272.1.2014/KS	0,00	0,00	0,00	0,00	0,00	0,00	0,00
6	0	0	PKM Gliwice		PO/68/R-I	0,00	0,00	0,00	0,00	0,00	0,00	0,00
7	0	0	PKM Katowice		PO/68/R-III	0,00	0,00	0,00	0,00	0,00	0,00	0,00
7N	n	0	PKM Katowice		PO/68/R-III	0,00	0,00	0,00	0,00	0,00	0,00	0,00
8	0	ferie	PKM Gliwice		PO/68/R-I	0,00	0,00	0,00	0,00	0,00	0,00	0,00
9	0	0	PKM Katowice		PO/68/R-III	0,00	0,00	0,00	0,00	0,00	0,00	0,00
10	0	0	PKM Katowice		PO/68/R-III	0,00	0,00	0,00	0,00	0,00	0,00	0,00
11	0	0	PKM Katowice		PO/68/R-III	0,00	0,00	0,00	0,00	0,00	0,00	0,00
12	0	ferie	PKM Katowice		PO/68/R-III	0,00	0,00	0,00	0,00	0,00	0,00	0,00
13	0	0	PKM Katowice		PO/68/R-III	0,00	0,00	0,00	0,00	0,00	0,00	0,00
14	0	0	PKM Tychy		PPN 0232 10.2015	0,00	0,00	6 687,60	1 554,00	0,00	0,00	0,00
15	0	0	Pawelec	mzpk	PO/47/IPZ/362/DO/408/14	0,00	0,00	0,00	0,00	0,00	0,00	0,00
16	0	0	PKM Sosnowiec	Z	PO/68/R-II	0,00	0,00	0,00	0,00	0,00	0,00	0,00
17	0	0	Kons Swierklaniec-PKM		272.1.2014/KS	0,00	0,00	0,00	0,00	0,00	0,00	0,00
18	0	0	PKM Sosnowiec	G	PO/68/R-II	0,00	0,00	0,00	0,00	0,00	0,00	0,00
19	0	0	Kons Swierklaniec-PKM		272.1.2014/KS	0,00	0,00	0,00	0,00	0,00	0,00	0,00
20	0	0	Pawelec	mzpk	PO/5/PS/76/DO/89/16	0,00	0,00	0,00	0,00	0,00	0,00	0,00
21	0	0	PKM Tychy		PPN 0232 10.2015	0,00	0,00	2 998,80	4 185,60	0,00	0,00	858,00

Figure 1. An example of a workbook with source data.

Source: Górnośląsko-Zagłębiowska Metropolia (GZM).

2.1.2. Data - Trams

Data on planning and accounting for tram transport is contained in 6 workbooks. Four contain planning data for 2020-2023, and two implementations from 2020-2021. Within each workbook there were up to 17 (varying by year) sheets containing data on individual municipalities and virtual municipalities. Within each sheet, the table rows contained data on individual line numbers. A total of 42 tram lines were identified (Fig. 2).

LIN	DZIEŃ ROBOCZY																	
	105N/E1	2x105N	116Nd	PT-8	PTM	2012N	2017N	2020N	MF10	MF/AC	105NK	2*105NK	105HF	2*105HF	105N/E1	2x105N	116Nd	PT-8
1	Wozokilometry																	
0											7,65							
1																		
2																		
3																		
4																		
5																		
6	22,95		53,55			275,40		198,90							22,95		53,55	
7	23,60		52,00			120,70	92,00								23,60		28,00	
9	169,35									85,65			136,05		169,35			
10																		
11									126,10		201,60							
13																		
14																		
15																		
16																		
17									97,20		64,80		89,10					
18																		
19	38,25	122,40							145,35				30,60	413,10	45,90			
20	4,20		11,90			29,40	4,90								4,20		7,00	
21																		
22																		
23																		
24																		
26																		
27																		
28																		
29																		
30																		
31																		
32																		
33																		

Figure 2. An example of a workbook with source data.

Source: Upper Silesia and Zagłębie Metropolis (GZM).

The columns of the tables contain quantitative and valuable data on travelled wkm, pkm by type of rolling stock where the following types of tram rolling (Tundys, 2008; Lubka, Stiasny, 2011, pp. 20-21) stock are distinguished:

- 105N/E1,
- 2x105N,
- 116Nd,
- PT-8,
- PTM,
- 2012N,
- 2017N,
- 2020N,
- MF10,
- MF/AC,
- 105NK,
- 2*105NK,
- 105HF,
- 2*105HF,

and other valuable ones such as:

- Air conditioning.
- Cost of commuting courses.
- Bus stop fees.
- Property tax.
- Perpetual use of land.
- Depreciation of other assets.
- Maintenance of tracks, networks, substations.
- Depreciation of infrastructure.
- Depreciation of rolling stock.
- Redemption of bonds.
- Finance costs.

It should be noted that between 2020 and 2021 there was a change in the units of accounting for kilometers traveled by tramway rolling stock, and so until 2020 the applicable unit was wozokilometers (wzk), and from 2021 the applicable unit is train kilometers (pkm). The change consisted in the fact that rolling stock marked with the symbols 2x105N, 2*105NK and 2*105HF consisting of two identical wagons was counted until 2020 for the wagons traveled separately, and from 2021 individually for the entire squad.

2.2. Input data – other data on the calculation of the variable premium

The second department, which is in charge of calculating the surcharge part for individual municipalities, carries out the next step of cost settlements based on a single summary table on the basis of which it makes detailed settlements per line and municipality. The calculation of this part of the costs includes such elements as:

- Ticket revenue.
- Organization costs.
- Lost revenue (free rides for children and youth).
- Lost revenue (railroads).
- Lost revenue (other).
- Sheds (W).
- Other settlements (I).

3. Data processing

3.1. Data – Buses and trolleybuses

In order to aggregate data scattered between sheets additionally contained in separate workbooks, aggregation queries were created for individual workbooks. Due to the different construction of workbooks, it was necessary to create unique queries for each of them separately. The queries were constructed using MS Power Query and the M language that functions within it. A transcript of the translated query written in M is shown in Figure 3:

BUS_Wykon_2021

```
let
    Źródło = Excel.Workbook(File.Contents("C:\Users\.....\IGZM\Projekt_II\Dane\BUS_WYKON_2021 (1) 14-02-2022.xlsx"), true, true),
    #Przefiltrowano wiersze = Table.SelectRows(Źródło, each ([Kind] = "Sheet") and ([Hidden] = false) and ([Name] <> "GMINY" and [Name] <
    #Usunięto inne kolumny" = Table.SelectColumns(#Przefiltrowano wiersze,{"Name", "Data"}),
    #Rozwinięty element Data" = Table.ExpandTableColumn(#Usunięto inne kolumny", "Data", {"Column1", "Column4", "Column7", "Column49", "C
    #Zmieniono nazwy kolumn" = Table.RenameColumns(#Rozwinięty element Data",{"Data.Column1", "NR"}, {"Data.Column4", "OPERATOR"}, {"Dat
    #Przefiltrowano wiersze1" = Table.SelectRows(#Zmieniono nazwy kolumn", each ([NR] <> null and [NR] <> " " and [NR] <> "LINIA" and [N
    #Dodano kolumnę niestandardową" = Table.AddColumn(#Przefiltrowano wiersze1", "ROK", each 2021),
    #Zmieniono kolejność kolumn" = Table.ReorderColumns(#Dodano kolumnę niestandardową",{"ROK", "Name", "NR", "OPERATOR", "UMOWA", "M km"
in
    #Zmieniono kolejność kolumn"
```

Figure 3. Example of an M-language query for bus rolling stock.

Source: own study.

The main steps of the inquiry procedure were:

- Selecting the appropriate sheets within the workbook.
- Determining the target columns from which the data was extracted.
- Assigning understandable names to the extracted columns.
- Filtering the rows according to the developed criteria.

The result of carrying out the query procedure was the creation of structurally uniform tables from each year containing data that describe bus and trolleybus transportation.

An example of the table after the execution of the query is shown in Figure 4. The table contains in individual rows data on individual lines of transportation that carry out transportation in individual municipalities. The individual columns contain amount and quantity data that characterize each line.

ABC 123	ROK	A ^C Name	ABC 123 NR	ABC 123 OPERATOR	ABC 123 UMOWA	ABC 123 M km	ABC 123 A km	ABC 123 B km	ABC 123 C km	ABC 123 Razem km	ABC 123 M koszt ne...	ABC 123 A
1	2021	OBJ	A4	PKM Gliwice	OP/3/CRU/51/2021	0	0	1358,4	889,2	2247,6	0	0
2	2021	OBJ	A4N	PKM Gliwice	OP/3/CRU/51/2021	0	0	108	0	108	0	0
3	2021	OBJ	6	PKM Gliwice	OP/3/CRU/51/2021	0	0	0,2	608,2	608,4	0	0
4	2021	OBJ	15	Pawelec	null	0	0	541,8	0	541,8	0	0
5	2021	OBJ	24	PKM Sosnowiec	OP/1/CRU/4/2021	0	0	8,8	0	8,8	0	0
6	2021	OBJ	27	PKM Sosnowiec	null	0	0	198	80	278	0	0
7	2021	OBJ	32	PKM Gliwice	null	0	0	1566,9	17428,4	18995,3	0	0
8	2021	OBJ	32N	PKM Gliwice	null	0	0	1720,5	0	1720,5	0	0
9	2021	OBJ	35	PKM Sosnowiec	null	0	0	0	115,2	115,2	0	0
10	2021	OBJ	40	PKM Sosnowiec	null	0	0	154	0	154	0	0
11	2021	OBJ	41	Pawelec	null	0	0	1188,7	0	1188,7	0	0
12	2021	OBJ	42	PKM Sosnowiec	null	0	0	147	0	147	0	0
13	2021	OBJ	43	PKM Katowice	OP/1/CRU/4/2021	0	0	48,2	0	48,2	0	0
14	2021	OBJ	49	PKM Sosnowiec	null	0	0	8,4	0	8,4	0	0
15	2021	OBJ	52	Kons Lazar-Nowak-PKS Poł	null	0	0	445,6	0	445,6	0	0
16	2021	OBJ	61	PKM Sosnowiec	null	0	0	166,3	0	166,3	0	0
17	2021	OBJ	67	Pawelec	WH.50.55.2020	0	81,6	0	0	81,6	0	0

Figure 4. Example of the result table for bus fleet settlements.

Source: own study.

3.2. Data – trams

For input workbooks containing data on streetcar traffic, queries were created analogously to those for processing bus transport data, with the exception that procedure steps that aggregate individual types of streetcar rolling stock into groups according to Table 1 were additionally included. .

Table 1.

Tram rolling stock - groups

2021	grupa	Nazwa
105N/E1	I	A
2x105N	III	B
116Nd	IV	BN
PT-8	III	B
PTM	IV	BN
2012N	V	CN
2017N	IV	BN
2020N	V	CN
MF10AC	II	AN
MF/AC	IV	BN
105NK	I	A
2*105NK	III	B
105HF	I	A
2*105HF	III	B

Note. Division of tram rolling stock into groups.

Source: Upper Silesia and Zagłębie Metropolis (GZM).

The specifications of each group are shown in Table 2. It classifies each group according to the capacity of the carts, their length and types (high-floor, low-floor).

Table 2.
Tram rolling stock - description

Grupa	Nazwa	Opis
I	A	pojemności < 150 miejsc (długość < 20m), wysokopodłogowy
II	AN	pojemności < 150 miejsc (długość < 20m), niskopodłogowy
III	B	pojemności > 150 miejsc (długość 20m - 30m), wysokopodłogowy
IV	BN	pojemności > 150 miejsc (długość 20m - 30m), niskopodłogowy
V	CN	pojemności > 150 miejsc (długość > 30m), niskopodłogowy

Note. Description of streetcar fleet groups.

Source: Upper Silesia and Zagłębie Metropolis (GZM).

Analogous to the bus queries, the MS Power Query tool was used. Due to the inconsistency of the sheets between periods (years), queries were created separately for each period. A transcript of the translated query written in M is shown in Figure 5:

TRAM_Plan_2022

```
let
    Źródło = Excel.Workbook(File.Contents("C:\Users\mbartnicki\Documents\!GZM\Projekt_II\Dane\SZ_TRAM_2022_dojazdy_20.09.21.xlsx"), true, true)
    #"Przefiltrowano wiersze" = Table.SelectRows(Źródło, each ([Hidden] = false) and ([Kind] = "Sheet") and ([Name] <> "GMINY" and [Name] <> "Usunięto kolumny" = Table.RemoveColumns(#"Przefiltrowano wiersze",{"Item", "Kind", "Hidden"}),
    #"Rozwinięty element Data1" = Table.ExpandTableColumn(#"Usunięto kolumny", "Data", {"Column1", "Column145", "Column146", "Column147", "Column148", "Column149", "Column150"}, 3),
    #"Usunięto pierwsze wiersze" = Table.Skip(#"Rozwinięty element Data1",3),
    #"Nagłówki o podwyższonym poziomie" = Table.PromoteHeaders(#"Usunięto pierwsze wiersze", [PromoteAllScalars=true]),
    #"Zmieniono nazwy kolumn" = Table.RenameColumns(#"Nagłówki o podwyższonym poziomie",{"Column2", "T_NR"}, {"ZREALIZOWANA", "105N/E1 PLN"}),
    #"Przefiltrowano wiersze1" = Table.SelectRows(#"Zmieniono nazwy kolumn", each ([T km] <> null and [T km] <> 0 and [T km] <> "RAZEM") and [T km] <> "RAZEM") and [T km] <> "RAZEM") and [T km] <> "RAZEM"),
    #"Dodano kolumnę niestandardową" = Table.AddColumn(#"Przefiltrowano wiersze1", "T ""A""", each [{"105N/E1"}+["105NK"]+["105HF"]}),
    #"Dodano kolumnę niestandardową1" = Table.AddColumn(#"Dodano kolumnę niestandardową", "T ""AN""", each [{"105N/E1"}+["105NK"]+["105HF"]}),
    #"Dodano kolumnę niestandardową2" = Table.AddColumn(#"Dodano kolumnę niestandardową1", "T ""B""", each [{"105N/E1"}+["105NK"]+["105HF"]}),
    #"Dodano kolumnę niestandardową3" = Table.AddColumn(#"Dodano kolumnę niestandardową2", "T ""BN""", each [{"116Nd"}+["PTM"]+["2017N"]+["MF/AC"]}),
    #"Dodano kolumnę niestandardową4" = Table.AddColumn(#"Dodano kolumnę niestandardową3", "T ""CN""", each [{"2012N"}+["2020N"]}),
    #"Dodano kolumnę niestandardową5" = Table.AddColumn(#"Dodano kolumnę niestandardową4", "T ""A"" koszt", each [{"105N/E1 PLN"}+["105NK PLN"]}),
    #"Dodano kolumnę niestandardową6" = Table.AddColumn(#"Dodano kolumnę niestandardową5", "T ""AN"" koszt", each [{"105N/E1 PLN"}+["105NK PLN"]}),
    #"Dodano kolumnę niestandardową7" = Table.AddColumn(#"Dodano kolumnę niestandardową6", "T ""B"" koszt", each [{"2x105N PLN"}+["PT-8 PLN"]+["PTM PLN"]+["2017N PLN"]}),
    #"Dodano kolumnę niestandardową8" = Table.AddColumn(#"Dodano kolumnę niestandardową7", "T ""BN"" koszt", each [{"116Nd PLN"}+["PTM PLN"]+["2017N PLN"]}),
    #"Dodano kolumnę niestandardową9" = Table.AddColumn(#"Dodano kolumnę niestandardową8", "T ""CN"" koszt", each [{"2012N PLN"}+["2020N PLN"]}),
    #"Usunięto kolumny1" = Table.RemoveColumns(#"Dodano kolumnę niestandardową9",{"105N/E1", "2x105N", "116Nd", "PT-8", "PTM", "2012N", "2017N", "2020N"}),
    #"Zmieniono kolejność kolumn" = Table.ReorderColumns(#"Usunięto kolumny1",{"T_GMINA", "T_NR", "T ""A""", "T ""AN""", "T ""B""", "T ""BN""", "T ""CN""", "T km", "T ""A"" koszt", "T ""AN"" koszt", "T ""B"" koszt"}),
in
    #"Zmieniono kolejność kolumn"
```

Figure 5. Example of an M-language query for streetcar rolling stock.

Source: own study.

The result of running the query procedure was the creation of structurally uniform tables from each year containing data that describe streetcar transportation.

An example of the table after the query procedure is shown in Figure 6.

Zapytania	A ₁₂₃ T_GMINA	ABC ₁₂₃ T_NR	ABC ₁₂₃ T ""A""	ABC ₁₂₃ T ""AN""	ABC ₁₂₃ T ""B""	ABC ₁₂₃ T ""BN""	ABC ₁₂₃ T ""CN""	ABC ₁₂₃ T km	ABC ₁₂₃ T ""A"" koszt	ABC ₁₂₃ T ""AN"" koszt	ABC ₁₂₃ T ""B"" koszt
1	BĘDZ	21	106183	0	13685,8	98581,85	0	218450,65	1041106,976	0	180445,03
2	BĘDZ	22	98273	0	0	68762,95	0	167035,95	963350,7176	0	0
3	BĘDZ	27	130193,75	0	53705,5	0	0	183899,25	1276528,459	0	708098,24
4	BĘDZ	28	66414	18649,8	0	0	0	85063,8	651178,425	208035,4736	0
5	BĘDZ	42	6827,6	0	0	0	0	6827,6	66943,50309	0	0
6	BĘDZ	ZASTĘPCZA T.ŚL.	1,0E-17	0	0	0	0	1,0E-17	1,081E-16	0	r
7	BYTO	2	44369,4	0	30353,4	100991,85	0	175714,65	435034,7217	0	400204,62
8	BYTO	5	11304,4	0	0	113888,6	0	125193	110837,7961	0	0
9	BYTO	6	20515,5	0	0	26987,4	279941,4	327444,3	201151,1274	0	0
10	BYTO	7	9894	0	17136	49388,4	75711,2	152129,6	97009,05437	0	225935,36
11	BYTO	9	110754,1	0	0	28342,25	0	139096,35	1085925,865	0	0
12	BYTO	17	12707,8	0	0	0	0	12707,8	124597,9039	0	0
13	BYTO	19	131256	129650,85	235321,65	0	0	496228,5	1286943,647	1446234,061	3102677,5
14	BYTO	30	18308	0	0	0	0	18308	179506,9504	0	0
15	BYTO	38	0	38130,2	0	0	0	38130,2	0	425336,1546	0
16	BYTO	49	140681,05	0	0	0	0	140681,05	1379354,723	0	0
17	BYTO	ZASTĘPCZA	1,0E-44	0	0	0	0	1,0E-44	1,081E-43	0	r
18	CHOR	6	11130,75	0	0	14642,1	151883,1	177655,95	109135,1862	0	0
19	CHOR	7	5747,4	0	10080	29052	44536	89415,4	56352,31848	0	132903,1
20	CHOR	9	114794,35	0	0	28962,75	0	143757,1	1125539,857	0	0
21	CHOR	11	13688,4	0	13889,7	122372,1	37615,65	187565,85	134212,5268	0	183133,42
22	CHOR	17	73523,7	0	0	0	0	73523,7	720887,8725	0	0
23	CHOR	19	42755,85	42403,95	77066,1	0	0	162225,9	419214,1275	473009,1379	1016103,5
24	CHOR	20	28473,7	0	39	84435	84734,6	197682,3	279179,9789	0	514,20863
25	CHOR	40	11035,9	0	0	0	0	11035,9	108205,1974	0	0

Figure 6. An example of a result table for the settlement of tramway rolling stock.

Source: own study.

The table contains, in individual rows, data on individual streetcar lines that carry out transportation in each municipality. The individual columns contain amount and quantity data characterizing each line.

3.3. Input data – other data on the calculation of the variable premium

With regard to the remaining data, the structure of which was already partially aggregated, only the necessary range of data was selected and filtered.

In terms of source data, there was no standardized approach to the naming and data types used. Thus, for example, the name of one municipality, depending on the data source, was presented in the following forms:

- CZER.
- Czerwionka-Leszczyny.
- CZERWIONKA LESZCZYNY.

Accordingly, relevant dictionaries were created to standardize the naming of municipalities and the numbering of individual lines. Procedures were developed to emerge headings describing individual data. Thus, individual data are described with the following headings.

- Type of data.
 - Plan.
 - Execution.
- Affiliation.
 - Other.
 - Municipalities GZM.
 - Foreign municipalities.
 - Airport.
 - GZM.
- Operator type.
 - PKM.
 - PRYW.
 - TROLLEYBUS.
 - TRAM.
- Line_Type.
 - A – Bus.
 - TR – Trolleybus.
 - T – Tram.
- Municipality (name of Municipality).
- Number of line.
- Opreator (name of Operator).

All data after the process was aggregated into one standardized dataset. On the basis of the obtained data, a model was developed for the analysis and presentation of the acquired data. This model received approval and was made available to the heads and treasurers of each municipality. A sample table and charts are shown in Figure 7 and 8.

Wartości	2021	2021	2021-2021	2021-2021	2021-2021	Wykonanie-Plan
	Plan	Wykonanie	Różnica Wykonanie-Plan	Odchylenie % Wykonanie-Plan	Efekt wzkm (PLN)	Efekt stawki (PLN)
M koszt netto	16 295 957	15 676 879	-619 078	-3,8%	-994 362	375 284
A koszt netto	22 599 137	22 454 352	-144 786	-0,6%	-743 747	598 961
B koszt netto	308 501 419	328 288 699	19 787 280	6,4%	5 001 140	14 786 140
C koszt netto	196 232 990	212 817 356	16 584 426	8,5%	6 754 663	9 829 763
TB koszt netto	11 817 481	12 704 174	886 694	7,5%	886 694	0
T koszt netto	222 617 629	199 627 138	-22 990 490	-10,3%	-19 088 796	-3 901 695
A i TB koszty dodatkowe	13 333 495	13 531 146	197 651	1,5%		
T koszty dodatkowe	39 467 920	38 834 920	-633 000	-1,6%		
Klimatyzacja	0	0	0			
Koszt kursów dojazdowych	0	0	0			
Finansowane przez Gminy (T)	39 467 920	38 834 920	-633 000	-1,6%		
Finansowane przez GZM			0			
Koszty Przew. finansowane przez Gminy	791 398 049	805 099 745	13 701 696	1,7%		
Dochody z biletów	237 800 000	145 752 718	-92 047 282	-38,7%		
Koszty organizacji	35 383 179	13 516 178	-21 867 001	-61,8%		
Utracone dochody (bezpłatne przejazdy dzieci i młodzieży)	15 616 653	15 697 000	80 347	0,5%		
Utracone dochody (kolej)	2 314 815	1 537 396	-777 419	-33,6%		
Utracone dochody (inne)	0	61 724	61 724			
Składka zmienna	571 049 760	655 567 085	84 517 324	14,8%		
Wiaty (W)	1 024 743	0	-1 024 743	-100,0%		
Inne rozliczenia (I)	0	31 238	31 238			
Składka zmienna + T + W + I	611 542 423	694 433 242	82 890 819	13,6%		
M wzkm	3 949 423	3 711 261	-238 162	-6,0%		
A wzkm	4 589 286	4 440 258	-149 028	-3,2%		
B wzkm	54 579 660	55 443 906	864 247	1,6%		
C wzkm	29 407 592	30 395 515	987 923	3,4%		
TB wzkm	1 320 389	1 419 461	99 072	7,5%		
T pkm	13 818 542	12 622 690	-1 195 852	-8,7%		
T"A" pkm	6 200 316	4 731 969	-1 468 347	-23,7%		
T"AN" pkm	785 775	899 111	113 336	14,4%		
T"B" pkm	2 790 504	2 119 947	-670 557	-24,0%		
T"BN" pkm	2 033 852	2 838 831	804 979	39,6%		
T"CN" pkm	2 008 095	2 032 832	24 737	1,2%		
Kursy Dojazdowe pkm	0	0	0			
Praca eksploatacyjna (wzkm;pkm)	107 664 892	108 033 092	368 199	0,3%		
Koszt M PLN/wzkm	4,13	4,22	0,10	2,4%		
Koszt A PLN/wzkm	4,92	5,06	0,13	2,7%		
Koszt B PLN/wzkm	5,65	5,92	0,27	4,8%		
Koszt C PLN/wzkm	6,67	7,00	0,33	4,9%		
Koszt TB PLN/wzkm	8,95	8,95	0,00	0,0%		
Koszt T PLN/pkm	16,11	15,81	-0,30	-1,8%		
Koszt przewozowy PLN/wzkm;pkm	7,23	7,33	0,10	1,4%		
Koszt całkowity z narzutami PLN/wzkm;pkm	5,68	6,43	0,75	13,2%		
Wydatki ZTM + UM nie finansowane składką zmienną - razem	64 234 842	22 258 913	-41 975 929	-65,3%		
Wydatki UM nie finansowane zmienną częścią składki rocznej	64 234 842	22 258 913	-41 975 929	-65,3%		
Wydatki ZTM nie finansowane zmienną częścią składki rocznej	151 361 633	73 047 799	-78 313 834	-51,7%		

Figure 7. Example of the result table for bus fleet settlements.

Source: own study.

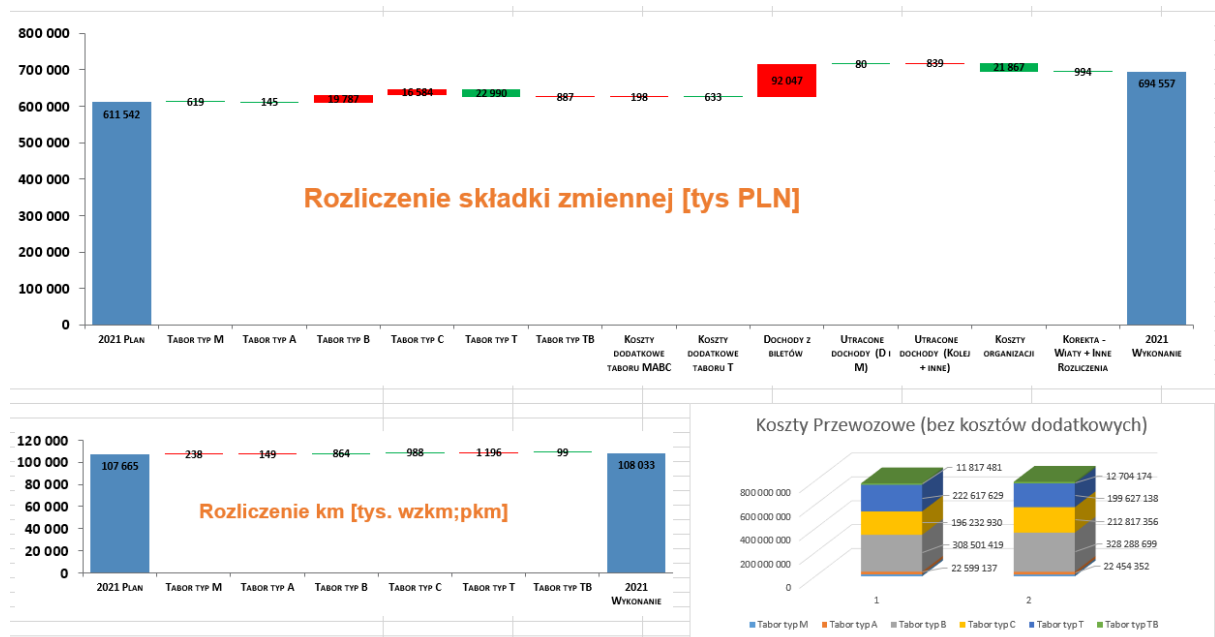


Figure 8. Example of the charts presenting bus fleet settlement.

Source: own study.

The scope of this paper is limited to the first stage of the work, which was the collection and processing of data. The problems of building a model for data processing and analysis will be presented by the author within the framework of the next article in this series.

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postępowania przy wyliczaniu zmiennej części składki rocznej dla gmin Górnośląsko-Zagłębiowskiej Metropolii (GZM) oraz dotacji dla gmin nienależących do GZM”.

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